2. Reaping the Benefits from Global Value Chains

Introduction and Main Findings

Over the past 30 years, the growing technological complexity of products, trade liberalization, and lower transportation and communications costs have reshaped the landscape of global trade. In particular, production has become increasingly fragmented through the growing prevalence of global value chains (GVCs), with components crossing numerous international borders. This has resulted in faster growth of trade in intermediate inputs than of trade in final goods. Asia has especially exemplified this new pattern of production: during 1995–2013, the region's trade in intermediate goods grew by a factor of six, while trade in final goods grew almost four times. This compares with fourfold and threefold increases, respectively, in the rest of the world.

The rise of GVCs calls for a different mindset in calibrating economic policies and, in particular, three major areas of policy consideration emerge:

- Integration into GVCs brings benefits beyond those traditionally associated with international trade in final goods, reflecting the more granular division of production and task specialization, which enables each participating country to exploit finer comparative advantage niches and raises the benefits from economies of scale and scope. Indeed, empirical evidence (such as Baldwin and Yan 2014) shows that joining GVCs brings positive and significant gains in productivity. In this connection, a relevant policy question is, what factors and policies foster greater participation in GVCs?
- While participation in GVCs is largely beneficial, the GVC pie is not sliced equally. As illustrated by the classic example of the iPod supply chain by Dedrick, Kraemer, and Linden (2010), Apple—a U.S.-based company—captures between one-third and one-half of an iPod's retail price while Japanese firms such as Toshiba and Korean firms such as Samsung capture another major share as profits from producing high-value components such as the hard disk drive, display, and memory. By contrast, it is estimated that firms and workers in China capture no more than 2 percent from assembling the product. Given that capturing a bigger slice of the GVC pie is positively associated with productivity gains and higher per capita growth, a route for Asian emerging market economies to escape the middle-income trap and for low-income economies to sustain strong growth over the medium term could be to reposition themselves toward higher-value stages of production. In this connection, an important policy question is, what factors and policies cause economies to capture a bigger slice of the GVC pie?
- The rise of GVCs also has important macroeconomic implications. One aspect relates to the increase in interconnectedness among countries, which Chapter 3 of the April 2014 *Regional Economic Outlook: Asia and Pacific* addresses. A second aspect is that the rising importance of GVCs may have altered the traditional relationship between exchange rate movements and competitiveness because imports of intermediate goods in a GVC are inputs into exports. Therefore, the impact of exchange rate changes on trade may change and could be dampened or amplified depending on an economy's position in the GVC.

This chapter sheds light on these issues by focusing on the following: first, it documents key stylized facts about Asia's GVC participation, where within GVCs Asian economies are situated, and how much of the GVC pie they capture. It then assesses which factors support GVC

Note: The authors of this chapter are Kevin Cheng (lead), Dulani Seneviratne, and Shiny Zhang. The analysis relies on Cheng and others (forthcoming).

participation and helps raise the captured share of value added. Finally, it examines how GVC participation affects the impact of exchange rate changes on external competitiveness.

The chapter relies on a unique Organisation for Economic Co-operation and Development–World Trade Organization database on trade in value added for GVCs covering 57 countries, which became available only recently, to address these questions—an impossible task just a few years ago. The main findings are the following:

- While the rise of GVCs has been ubiquitous across the globe, the expansion has been particularly pronounced among Asian emerging market economies, including those in the Association of Southeast Asian Nations (ASEAN). Moreover, Asian economies, particularly China, have captured an increasingly larger share of the value added generated in GVCs, even after adjustments are made for their recent rapid growth in relative economic size. Some advanced Asian economies, notably Korea, have also captured a bigger slice of the GVC pie in high-tech manufacturing. By contrast, adjusted for relative economic size, shares of value added in GVCs accruing to Japan and advanced economies outside Asia have declined.
- Both advanced and emerging market economies in Asia have moved upstream (that is, providing intermediate inputs to other countries) rather than downstream (processing inputs from more upstream countries) in GVCs. Within high-tech manufacturing, Asian advanced economies remain substantially more specialized in upstream production than Asian emerging market economies.
- Moving toward a more upstream position in production and raising economic complexity—a measure of an economy's productive knowledge and capabilities (see Box 2.1)—are associated with a growing share of GVC value added captured by countries.
- The rise of GVCs has altered the responsiveness of trade volumes to exchange rate changes. Based on a new measure of GVC-adjusted real effective exchange rates (REERs), both GVC-related exports and imports react positively to a real depreciation, with upstreamness (downstreamness) tending to amplify (dampen) the impact. These results are intuitive: the gain in export competitiveness from a real depreciation in a country upstream in the production chain will "trickle down" along the GVC, leading to increased exports. But the benefits will also "trickle up," as the derived demand for imports used in the production of exports will also rise, even though imports become relatively more expensive. However, for a country farther downstream, where production and exports have a higher foreign content relative to domestic content, the positive impact of a real depreciation on export (and import) volumes is blunted. This is because the higher cost of imports used in the production of exports tends to offset the lower cost of domestic content in exports. In the case of exports and imports of goods not produced by GVCs, the impact of REER changes is in line with the standard trade literature; that is, exports (imports) react positively (negatively) to a real depreciation.
- A future challenge for policymakers, particularly in emerging market and frontier economies, will be to foster GVC participation and to expand these economies' share of the GVC pie while minimizing spillover risks associated with increased trade linkages. This will require reducing trade barriers, strengthening infrastructure, enhancing human capital formation, supporting research and development (R&D), improving institutions, and strengthening resilience to shocks.

Key Stylized Facts

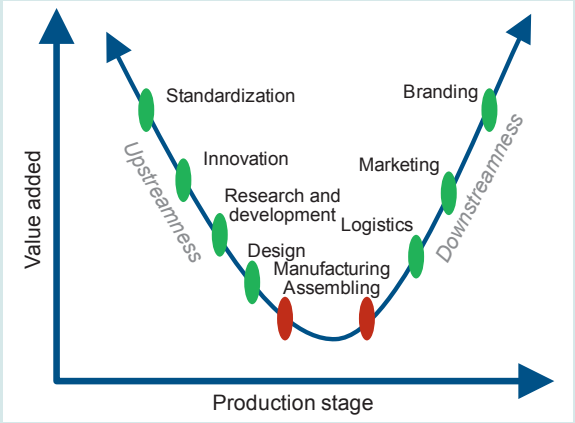
What Are GVCs?

A GVC is a network of interlinked stages of production for the manufacture of goods and services that straddles international borders. Typically, a GVC involves combining imported intermediate goods

and domestic goods and services into products that are then exported for use as intermediates in the subsequent stage of production.

A standard GVC encompasses a number of production stages from upstream product conception to midstream assembly and then to downstream branding and marketing. As Figure 2.1 illustrates, a hypothesis in the GVC literature is that the relationship between the production stage and value added exhibits a "smiley" shape, suggesting that most value added in a GVC accrues to firms at the two ends of the production line, such as R&D in the upstream and marketing in the downstream, with a smaller share of value added captured by assembly in the midstream.

Figure 2.1
A Hypothesized "Smiley-Shaped" Relationship between Value Added and Global Value Chain Position



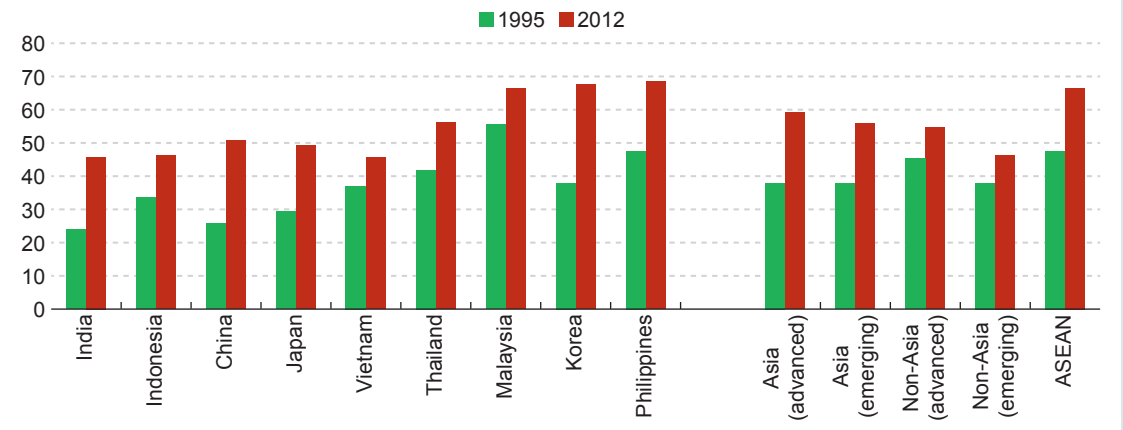
Source: World Economic Forum (2012).

How Much Do Asian Economies Participate in GVCs?

The extent to which an economy is engaged in a GVC can be measured by the GVC participation index, developed by Koopman and others (2010). The index is defined as the ratio to a country's gross exports of the sum of foreign value added in domestic exports (backward participation) and domestically produced intermediates to be used in third countries (forward participation). This measure therefore excludes exports of final goods that have no foreign-input content.

As Figure 2.2 shows, the extent of GVC participation has been relatively high in Asia, including in Korea, Malaysia, and the Philippines. The growth in GVC participation has also been

Figure 2.2
Participation in Global Value Chains: 1995 versus 2012
(Share of foreign inputs and domestically produced inputs used in third countries' exports in a country's gross exports; in percent)



Sources: Organisation for Economic Co-operation and Development and World Trade Organization, Trade in Value–Added database; and IMF staff estimates.
Note: ASEAN = Association of Southeast Asian Nations. Non-Asia includes comparable advanced and emerging market economies.

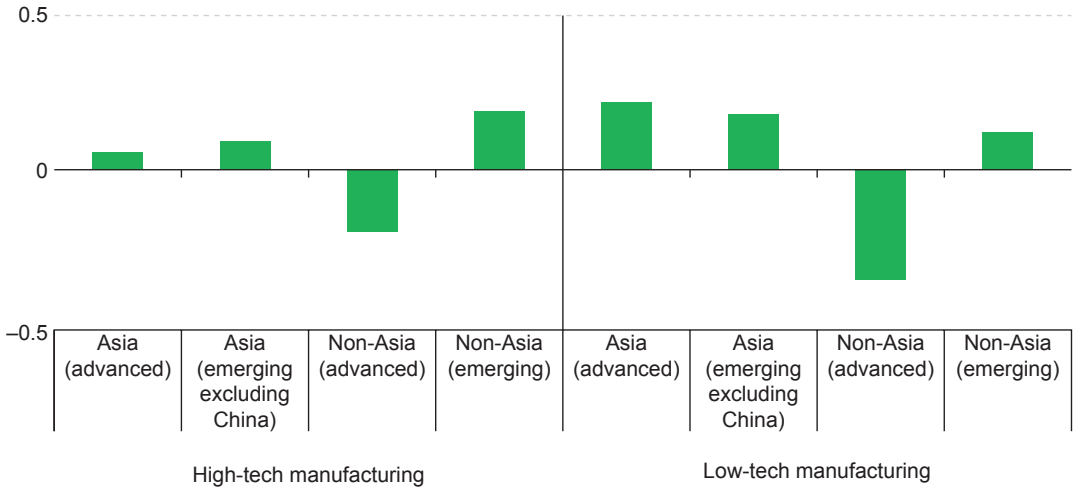
faster in Asia, particularly in ASEAN. China's participation also grew significantly during 1995–2012, likely reflecting its accession to the World Trade Organization, although China's participation rate is lower than the Asian average.

How Are GVC Pies Sliced?

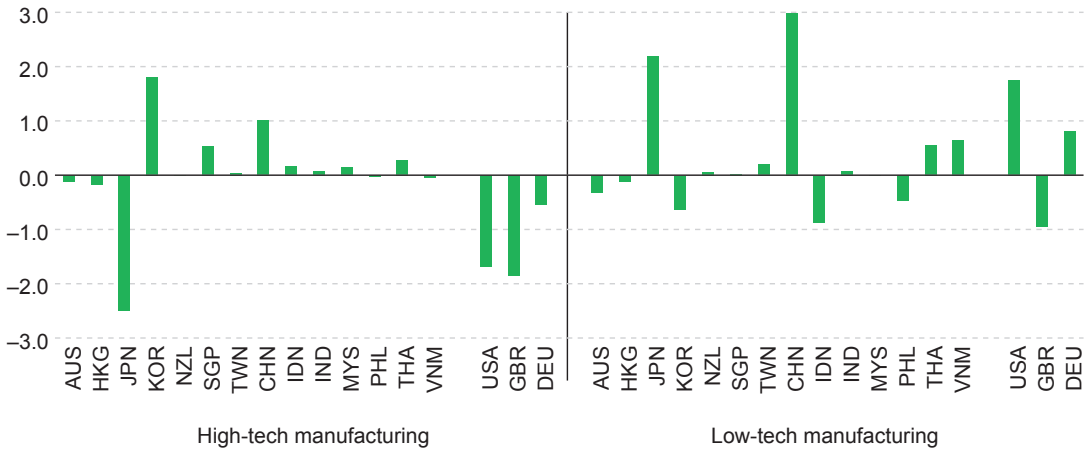
The GVC pie is not sliced evenly, and the shares of value added captured by economies vary over time and across sectors. Figure 2.3 illustrates the

Figure 2.3
Domestic Value-Added Share in Global Value Added

1. Domestic Value-Added Share by Industry: Change from 1995 to 2009
(Share in percent of world's DVA in the industry; adjusted for the GDP share)



2. Domestic Value-Added Share by Industry: Change from 1995 to 2009
(Share in percent of world's DVA in the industry; adjusted for the GDP share)



Sources: Organisation for Economic Co-operation and Development and World Trade Organization, Trade in Value-Added database; and IMF staff estimates.
Note: DVA = domestic value added. High-tech manufacturing includes chemicals and nonmetallic mineral products, electrical and optical equipment, transportation equipment, machinery, and equipment not elsewhere classified. Low-tech manufacturing includes food products, beverages, and tobacco; textiles, textile products, leather, and footwear; wood, paper, paper products, printing, and publishing; basic metals and fabricated metal products; and manufacturing not elsewhere classified and recycling. DVA values are adjusted for the GDP share by taking the residual after regressing the DVA share on the GDP share. Countries are classified into advanced and emerging market economies based on IMF World Economic Outlook database classifications. Country abbreviations in panel 2 use the three-letter International Organization for Standardization country codes.

dynamics within GVCs for Asia and elsewhere. Key patterns can be summarized as follows:

- During 1995–2009, both advanced and emerging market economies in Asia gained value-added shares in GVCs, but the gains were larger in low-tech than in high-tech manufacturing. Outside Asia, emerging market economies gained, while advanced economies lost, shares in GVCs during the same period (Figure 2.3, panel 1).
- Among individual countries, Japan's value-added share in high-tech manufacturing was significantly eroded, while Korea gained in share of value added during the same period (Box 2.2). China has also moved up GVCs, but the gain is most significant in low-tech manufacturing. Advanced economies outside Asia, notably Germany, the United Kingdom, and the United States, have lost value-added shares in high-tech manufacturing and gained them in low-tech manufacturing (Figure 2.3, panel 2).

Upstreamness versus Downstreamness

Upstreamness (or downstreamness) refers to where an economy is located in a GVC. One measure, developed by Fally (2012), looks at how many stages of production remain before the final product reaches consumers (referred to as "distance to final demand"). A long distance to final demand suggests that a country is upstream in the production process, such as a producer of raw materials or product design and research. Conversely, a short distance to final demand suggests that a country is downstream in the production process, such as customer service.

Figure 2.4 illustrates the main characteristics of upstreamness and downstreamness in Asia. Key patterns include the following:

- In high-tech manufacturing, advanced economies tend to specialize in upstream stages, while emerging market economies specialize in more downstream stages. This differentiation is more pronounced in Asia, where Asian advanced economies are more upstream than their counterparts in the rest of the world, with the opposite holding for Asia's emerging market economies. During 1995–2008, Asian economies moved upstream relative to the rest of the world (Figure 2.4, panel 1).
- Among individual countries, Asian advanced economies (Hong Kong Special Administrative Region, Korea, Singapore) are generally located upstream in high-tech manufacturing, whereas the region's emerging market economies, such as China, India, and Vietnam, are generally located downstream (Figure 2.4, panel 2).
- In low-tech manufacturing, both advanced and emerging market economies in Asia have moved slightly upstream, but have remained downstream relative to the rest of the world. Unlike in high-tech manufacturing, there is no dichotomy between emerging and advanced economies in Asia in regard to upstreamness and downstreamness in low-tech manufacturing.

How Can Economies Increase GVC Participation?

Impact of Tariffs on Intermediate Goods

Several factors may affect the extent to which an economy participates in GVCs. Tariffs on intermediate goods significantly increase costs associated with trade in intermediate goods, thereby reducing participation. Indeed, GVCs tend to amplify the distortionary impacts of tariffs, as these are compounded along GVCs when intermediate inputs are traded across borders numerous times throughout the entire production chain. As Blanchard (2015) indicates, fragmentation essentially increases the so-called effective rate of protection, even if tariffs and other trade costs remain unchanged.

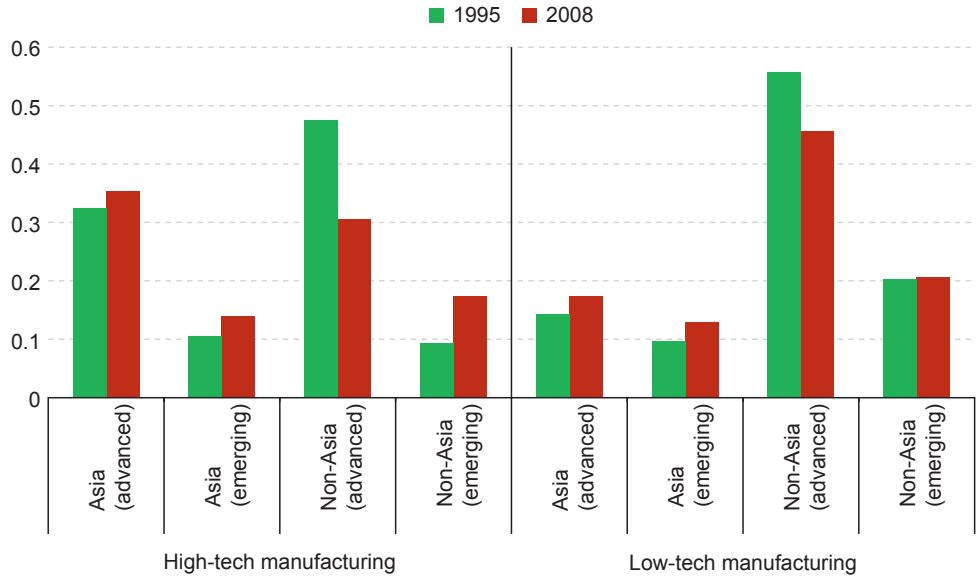
Empirically, there is indeed a strong negative correlation between tariff rates on intermediate

Figure 2.4

Upstreamness or Downstreamness

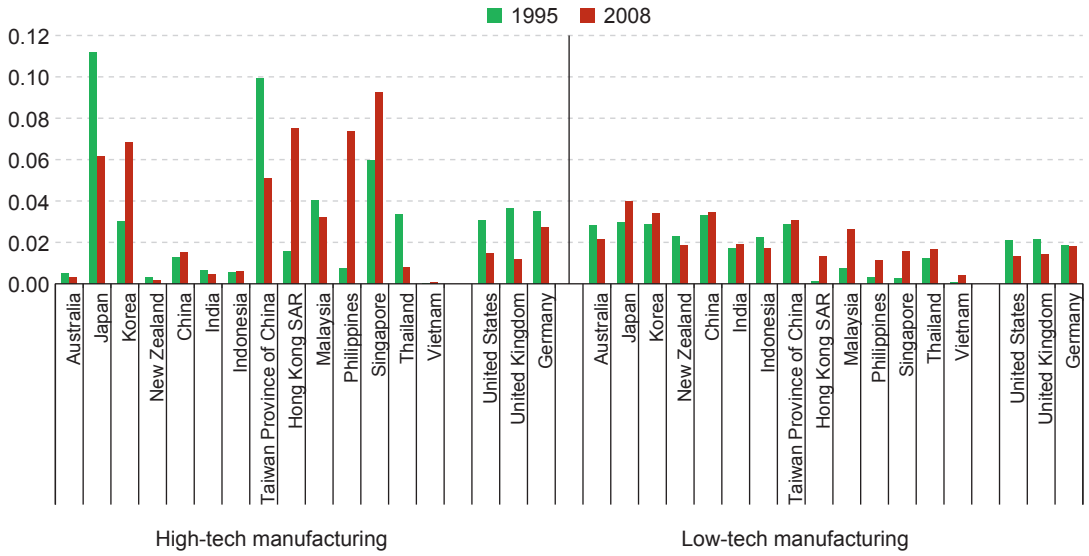
1. Relative Distance to Final Demand, Weighted Average

(By region and industry type; adjusted for changes in length over time)



2. Relative Distance to Final Demand, Weighted Average

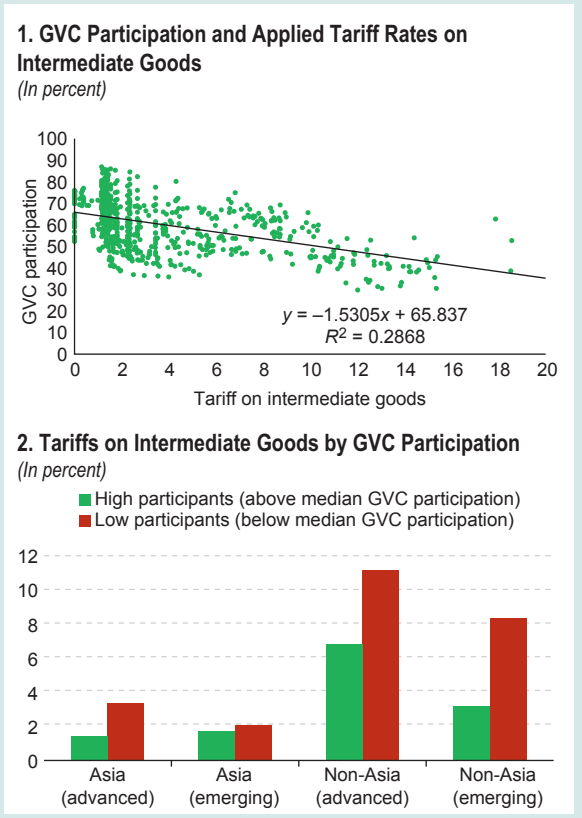
(Normalized by the length of the sectoral value chains)



Sources: Organisation for Economic Co-operation and Development and World Trade Organization, Trade in Value-Added database; and IMF staff estimates.

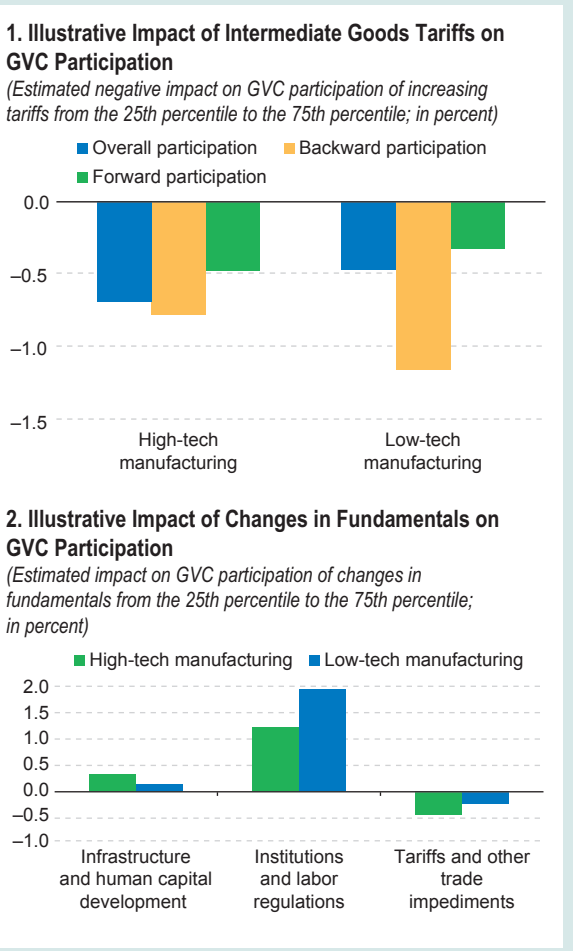
Note: Given that production processes have become more fragmented, the length (total number of production stages) has increased. Therefore, the distance to final demand as shown in the figure in each year in each industry has been adjusted for changes in length. The underlying data for distance to final demand are based on Fally (2012).

Figure 2.5
Tariffs and GVC Participation



Sources: Organisation for Economic Co-operation and Development and World Trade Organization, Trade in Value-Added database; United Nations Conference on Trade and Development, Trade Analysis Information System (TRAINS) database; and IMF staff estimates.
Note: GVC = global value chain.

Figure 2.6
Illustrative Impact: GVC Participation



Source: IMF staff estimates.
Note: GVC = global value chain. The illustrative impact of tariffs is not so small, as the GVC participation index subcategories are measured against (i.e., the denominator) total exports in the economy; for instance, median backward and forward participation rates in the low-tech manufacturing sectors are typically 3–6 percent. Underlying data on the effective tariff rates are measured using the weighted average across sectors.

goods and GVC participation (Figure 2.5, panel 1). Across Asia and elsewhere, economies with higher tariffs on their intermediate goods imports are less likely to participate in GVCs. Notably, Asian emerging market economies that participate less in GVCs impose higher effective tariff rates on intermediate imports (Figure 2.5, panel 2).

Taking this analysis further, the chapter explores empirically whether the impact of tariffs differs depending on whether forward participation (using domestic intermediate goods for export to a third country) or backward participation (using foreign inputs in exports) is involved. The main results, shown in panel 1 of Figure 2.6, suggest that

- Tariffs on intermediate goods have a significant negative effect on GVC participation, both backward and forward, in high-tech and low-tech manufacturing. Specifically, if a country moves from the 25th to 75th percentile of the cross-country distribution of tariffs (an increase in tariffs), GVC-linked trade (i.e., participation) will decline by ¾ percentage point to 1¼ percentage points of gross exports depending on the depth of backward and forward linkages. The estimated impact is not so small, particularly for low-tech manufacturing industries, given that the median backward and forward participation rates are typically 3 percent to 6 percent.

- Overall, the negative impact on backward participation (the import content in exports of the tariff-imposing country) is found to be larger than the negative impact on forward participation (the extent to which domestic production of the tariff-imposing country is used as inputs by a third country). Thus, the distortionary effect on the tariff imposer's imports is higher than the carry-forward effect on its exports. Furthermore, the results are strongest in regard to low-tech manufacturing.

Impact of Fundamentals

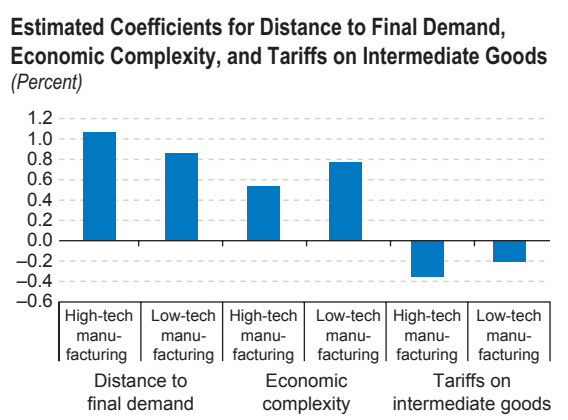
In addition to tariffs, economic and institutional fundamentals are also found to play a role in determining the extent of GVC participation (Figure 2.6, panel 1). Empirical analysis (see Box 2.3 for details) finds that, in addition to low tariffs and other trade impediments, good infrastructure, high human capital development, and strong political and legal institutions, as well as less restrictive labor market regulations, all positively contribute to greater GVC participation.

How Can an Economy Capture a Bigger Slice of the GVC Pie?

As noted, the GVC pie is not sliced evenly, and capturing a bigger piece generally implies a higher level of GDP. An econometric analysis (see Box 2.3 for methodology) is employed here to assess which factors underlie an economy's ability to acquire a greater share of value added along the GVC. This analysis focuses on a number of explanatory variables, including upstreamness and economic complexity, as well as the level of tariffs on intermediate goods. Key findings and interpretations include the following (Figure 2.7):[1]

Figure 2.7

Assessing the Link between Moving Up Global Value Chains, Upstreamness, Economic Complexity, and Tariffs



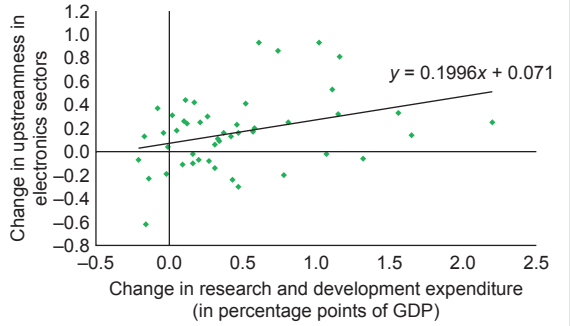
Source: IMF staff estimates.

- Overall, economies in the upstream—measured by a longer distance to final demand—tend to capture a larger share of the value added generated in GVCs than more downstream economies. The impact of upstreamness on the ability to increase the share of value added captured from GVCs is larger in high-tech manufacturing than in low-tech manufacturing. Intuitively, this may reflect the fact that upstreamness typically involves activities with higher value added such as R&D (Figure 2.8), and R&D plays a greater role in high-tech manufacturing (such as electronics).[2]
- Not surprisingly, countries with greater economic complexity have tended to capture a larger share of the value added from GVCs than those with lower economic complexity. Economic complexity has a greater impact, however, for low-tech manufacturing than for high-tech manufacturing.

[1] Specifically, in the absence of data at the product level, one cannot fully infer from the data the nature of the task—such as R&D versus raw materials or assembling versus marketing—that each economy specializes in at each GVC position.

[2] These econometric results, which are based on industry-level data, need not be inconsistent with the "smiley shape" hypothesis discussed earlier, as this applies at the individual product level.

Figure 2.8
Research and Development Expenditure and Upstreamness



Sources: International Institute for Management Development, World Competitiveness database; Organisation for Economic Co-operation and Development and World Trade Organization, Trade in Value-Added database; and IMF staff calculations.

- In addition to lowering their participation in GVCs, economies that impose higher tariff rates on intermediate goods are also less likely to increase their share of GVC value added conditional on their participation in these production networks. The negative impact is higher in high-tech manufacturing than in low-tech manufacturing.

Effect of Exchange Rate Changes within a GVC

The traditional relationship between exchange rates and trade volumes may be altered—even reversed—in the context of GVCs because imports are inputs into exports along the production chain. For example, a real exchange rate appreciation that decreases a country's exports may also depress its imports of intermediate goods. Garcia-Herrero and Koivu (2009) find that an appreciation of the Chinese renminbi leads to a decline in total exports to China from a number of Asian countries, possibly pointing to Asian countries' dependence on China's exports in the context of a GVC.

Similarly, using a computed partial-equilibrium simulation, Riad and others (2012) find that a downstream position in a GVC cushions the impact of an exchange rate change on both exports and imports. This reflects the higher foreign content in the downstream country's exports, which mitigates the impact of a change in its own exchange rate because the appreciation implies that imports become cheaper.

To further empirically assess these propositions, the chapter estimates export and import equations, distinguishing trade in non-GVC final goods from trade in intermediate goods. Specifically, using a panel framework with time and country fixed effects, the analysis regresses exports or imports on REER, demand, and other control variables. To gauge the importance of countries' positions in GVCs (upstream or downstream), an interaction term between upstreamness and REER is included.[3]

The novelty in the approach is twofold. First, instead of the traditional REER measure that uses weights based on gross trade, it employs weights based on domestic value added in exports. This avoids the potentially large distortion inherent in traditional REER measures coming from the inclusion of GVC-related reexports, as discussed in IMF (2013). Second, unlike previous studies, such as Garcia-Herrero and Koivu (2009) that rely on proxies for intermediate and non-GVC goods, this chapter uses the Organisation for Economic Co-operation and Development–World Trade Organization database, allowing division of trade flows into (non-GVC related) final goods and GVC-related goods. Key findings, presented in Table 2.1, include the following:

- Not surprisingly, the estimated sign of the impact of a REER change on trade in final goods not produced in GVCs is in line with traditional trade theory. Specifically, a real appreciation leads to a decline in export volumes of final goods and an increase in imports of final goods. A country's position in GVCs does not affect the impact of REER changes on trade in non-GVC products.
- A real depreciation leads to an increase in GVC-related exports, and the quantitative

[3] To circumvent, though not eliminate, the endogeneity issue, lagged values of explanatory variables are used as regressors.

Table 2.1. Exchange Rate Competitiveness in Final Goods versus GVCs

	(1)	(2)	(3)	(4)
	Final Demand		GVC	
Variables	Imports for Final Demand	Exports for Final Demand	GVC-Related Imports	GVC-Related Exports
Lagged log (REER-value-added-based)	0.395***	–0.247***	–0.296*	–0.285**
	(2.939)	(–4.792)	(–1.736)	(–2.091)
REER-upstreamness interaction (REER × upstreamness)	**–0.048**	**0.070**	**–0.060**	**–0.149*** **
	(–1.278)	**(1.671)**	**(–1.049)**	**(–3.447)**
Lagged log (demand)	0.385***	0.365**	0.427**	0.378**
	(3.156)	(2.637)	(2.282)	(2.519)
Time fixed effects	Y	Y	Y	Y
Country fixed effects	Y	Y	Y	Y
Additional controls	Y	Y	Y	Y
Clustering	Country level	Country level	Country level	Country level
Number of observations	209	209	176	176
R-squared	0.869	0.863	0.910	0.940
Number of country code	52	52	52	52

Source: IMF staff estimates.
Note: GVC = global value chain; REER = real effective exchange rate. Specification: log (Exports [Imports] volume)$_{c,t}$ = $\alpha_t + \alpha_c + \alpha_1 \log(\text{REER})_{c,t-1} + \alpha_2 \log(\text{REER})_{c,t-1} \times (\text{Upstreamness})_{c,t-1} + \alpha_3 \log(\text{Demand})_{c,t-1} + \alpha_i \log(\text{Controls})_{c,t} + \varepsilon_t$. Additional controls included in the specifications are log of real stock of foreign direct investment, upstreamness, tariffs, and output gap. Demand is proxied by GDP. Robust *t*-statistics are in parentheses.
*p < 0.1; **p < 0.05; ***p < 0.01.

impact is larger for a country operating upstream in production chains. This result is quite intuitive, because the gain in competitiveness of an upstream economy trickles down the GVC, thereby amplifying the impact. On the other hand, the impact is dampened for countries downstream in GVCs as their exports have a higher import content, such that currency depreciation also implies more expensive imports.

- In contrast to standard import elasticities, a real depreciation raises GVC-related imports because the depreciation-induced rise in exports leads to an increase in the derived demand for imports of intermediate inputs used in the production of exports. Upstreamness tends to amplify this impact, although the amplification (i.e., interaction) effect is not statistically significant.

Using the estimated coefficients, Figure 2.9 presents the impact of a real appreciation on GVC-related trade. Specifically, for high-tech manufacturing, the impact of an appreciation on trade is larger in advanced Asia than in emerging Asia or the rest of the world. This is because Asia's advanced economies tend to be relatively more upstream than other economies in high-tech manufacturing. In low-tech manufacturing, the impact is more uniform across regions, reflecting a more balanced regional distribution of upstreamness in low-tech manufacturing.

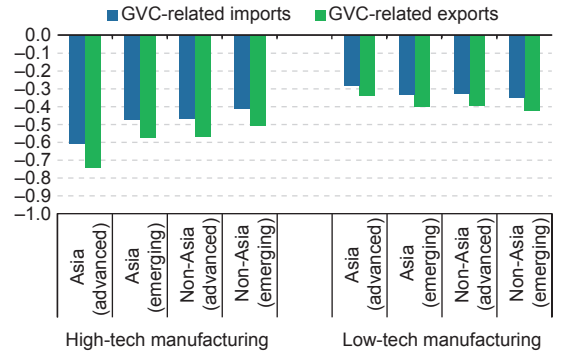
Conclusions and Policy Implications

Asian economies have increased their participation in GVCs, captured an increasingly bigger slice of the GVC pie, and relocated toward upstream production. In addition, upstream production (particularly in high-tech manufacturing), a higher degree of economic complexity, and a lower level of tariffs on intermediate goods are associated with improved prospects for capturing a higher share of value added along a GVC.

Meanwhile, the rise of GVCs has also altered the responsiveness of trade to exchange rate changes, since within a GVC, in which imports are essentially inputs into exports, a real depreciation may induce an increase in imports of intermediate goods. Moreover, this responsiveness is found to depend on a country's

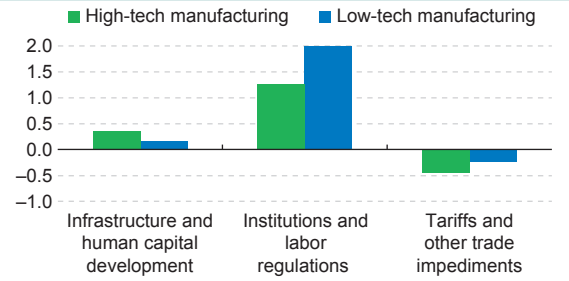
Figure 2.9

Illustrative Impact of 1 Percent Appreciation in the Real Effective Exchange Rate on GVC-Related Trade



Illustrative Impact of Changes in Fundamentals on GVC Participation

(Estimated impact on GVC participation of changes in fundamentals from the 25th percentile to the 75th percentile; in percent)

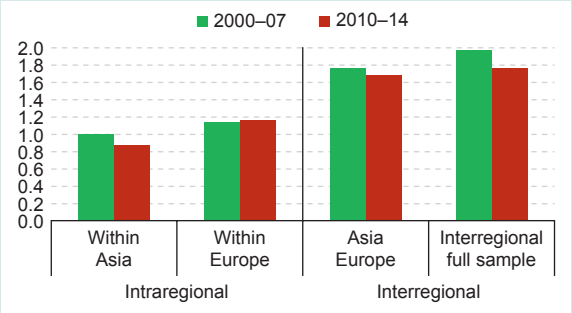


Source: IMF staff estimates.
Note: GVC = global value chain. The illustrative impact of tariff is not so small, as the GVC participation index subcategories are measured against (i.e., the denominator) total exports in the economy; for instance, median backward and forward participation rates in the low-tech manufacturing sectors are typically 3–6 percent. Underlying data on the effective tariff rates are measured using the weighted average across sectors.

Figure 2.10

Average Exchange Rate Variability, 2000–14

(Standard deviation of monthly change in bilateral exchange rates [U.S. dollar/national currency])



Source: IMF staff calculations.
Note: Intra-Asia and Intra-Europe include major regional trading partners. Asian regional trading partners include China, Japan, Korea, India, Indonesia, Malaysia, the Philippines, Singapore, Taiwan Province of China, and Thailand. European regional trading partner currencies include the euro, the European Union's 27 non-euro member currencies, Norwegian krone, Icelandic króna, and Swiss franc.

position in the GVC, with upstreamness (downstreamness) amplifying (dampening) the effect. This has important policy implications:

- For a downstream country, the effect of a real depreciation may be muted in the presence of GVCs. This is because at late stages in the production chain, exports have a high import content and the increased cost of intermediate imports tends to offset any boost to exports from the lower cost of domestic value added, thereby partly undermining the price competitiveness gain typically associated with depreciation.
- For a country upstream in the GVC, exchange rate shifts may entail large trade flow responses in the country whose currency has depreciated, as well as those further down—and even up—the value chain as price competitiveness gains work their way through the GVC.
- Therefore, the increased interconnectedness and trade spillovers brought about by GVCs tend to complicate assessments of how exchange rate changes might impact trade. To limit these concerns, members of individual value chains may be more inclined to keep their currencies aligned. Indeed, exchange rate variability among currencies within different regional supply chains—such as those in Asia and those in Europe—is considerably lower than across regional supply chains (Figure 2.10).

For Asian economies, integration into GVCs has provided an important path for transitioning from low- to middle-income status and, in a few instances, for moving up to advanced economy status. The main policy challenge is to secure these gains while exploring opportunities to capture an even larger slice of the GVC pie by repositioning

toward higher-value-added production. Against this background, key policy lessons include:

- *Removing trade barriers*—The chapter's empirical analysis finds that tariffs on imports of intermediate goods reduce GVC participation, but also hamper an economy's ability to capture a higher share of value added along a GVC once the economy is a member of a GVC. This is because when intermediate inputs cross borders multiple times, they compound the detrimental effect of a given trade barrier. In fact, within a GVC, imports are essentially inputs into exports, and thus any trade barrier imposed by an economy on its imports of intermediate goods is effectively a tax on that economy's own exports. Against this background, removing tariffs and other forms of trade barriers would benefit all GVC participants. More specifically, as indicated in IMF (2015), advanced economies should focus on opening services markets, while emerging market economies should move away from import substitution policies and avoid protectionism in the form of nontariff barriers.

- *Facilitating trade and regional cooperation*—Apart from eliminating trade impediments, policymakers should go a step further to reduce costs of trade, for example, by implementing trade-facilitating measures such as simplifying port and customs procedures. Regional trade agreements and cooperation will also help. In particular, given the high GVC participation of ASEAN economies, commitments for greater regional integration under the ASEAN Economic Community, beginning at the end of 2015, are welcome.

- *Enhancing human capital formation and technology development*—Upstreamness is generally associated with capturing a higher share of value added along a GVC, particularly in high-tech manufacturing, likely reflecting the higher value added of R&D and similar activities. Accordingly, shifting upstream requires a wide range of knowledge- and technology-enhancing measures. These include investing in human capital as well as measures to encourage innovation and R&D.

- *Improving fundamentals*—Enhanced participation in GVCs and economic sophistication also require a host of efficiency-enhancing structural reforms. These include better infrastructure, a more efficient regulatory framework, and stronger economic and legal institutions, as well as unwinding overly rigid labor market regulations.

- *Mitigating GVC-related risks*—In the presence of GVCs, a supply shock originating in one part of a GVC—such as the 2011 tsunami in Japan—may propagate to all downstream and upstream countries in the GVC unless there are built-in redundancies through duplication or sufficient inventories. Accordingly, participation in GVC networks may make countries more vulnerable to spillovers from external shocks, thus calling for more policy coordination across borders. Participants should strengthen their economies' resilience to macroeconomic shocks as well as ensure adequate financial safety nets.

Box 2.1

What Underlies Economic Complexity?

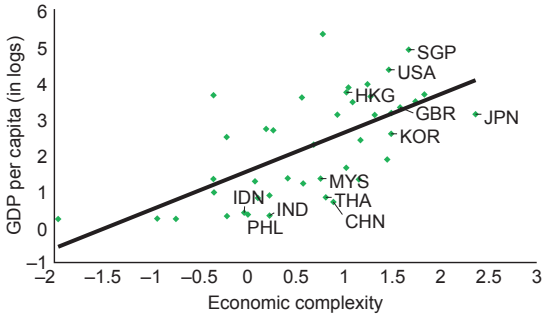
An important concept related to global value chains is the economic complexity index (ECI). Developed by Hidalgo and Hausmann (2009), the ECI is a holistic measure capturing a country's productive knowledge and capabilities. A higher index value suggests that a country is capable of producing a more *diverse* range of products and products that are less *ubiquitous* among other countries. Hidalgo and Hausmann (2009) showed that a high ECI has led to higher growth in per capita income over time (Figure 2.1.1, panel 1).

While the ECI has generally increased across the globe, compared with that of economies at similar income levels outside Asia, the ECI for Asia is lower (Figure 2.1.1, panel 2). Indeed, key emerging market economies in Asia, including China, India, and Indonesia, have a relatively low ECI. Likewise, some advanced economies in Asia, such as Japan and Korea, have lower ECIs than Germany, the United Kingdom, and the United States. (Figure 2.1.1, panel 3). Relative to that in the rest of the world, the ECI—which captures productive knowledge and capabilities and has been shown to be positively correlated with faster income growth—has risen in Asia. The ECI is found to be driven by better institutional quality, enhanced macroeconomic stability, and greater trade openness. However, ECIs for Asia, including China and India, remain low.

Despite its importance, there has been little research on what drives the ECI. Against this background, this box assesses the index's key drivers. In the absence of a theoretical model for the drivers of the ECI, the Bayesian model averaging approach is used to select from a wide range of factors that may explain the ECI. Specifically, the approach starts with thousands of plausible socioeconomic variables that might affect the ECI and uses the Bayesian model averaging to narrow the list of variables; variables with a probability less than 0.5 of inclusion among the explanatory variables are eliminated from the selection. Based on Bayesian model averaging, five variables are selected, including geographical distance from the rest of the world, size of government, trade openness GDP per capita, and composite institutional quality.

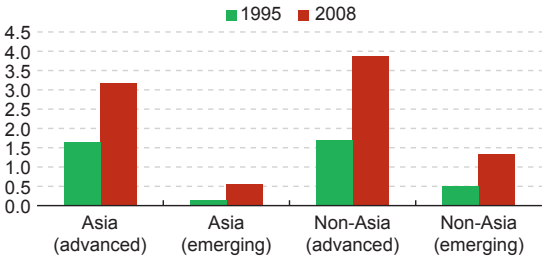
Figure 2.1.1
Economic Complexity

1. Economic Complexity and GDP per Capita, 2008

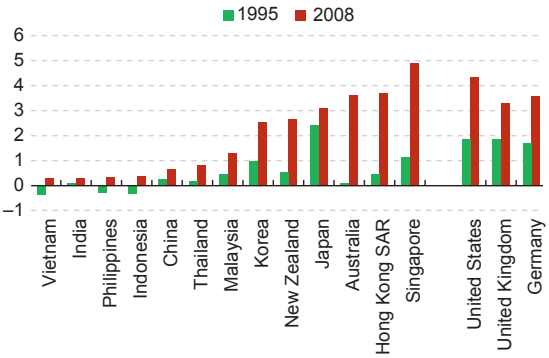


2. ECI by Region

(Weighted by purchasing power parity GDP share)



3. ECI by Country



Sources: Atlas of Economic Complexity (for the ECI); Penn World Table 8.0; United Nations, Comtrade database; and IMF staff estimates.
Note: ECI = economic complexity index. The ECI is calculated using an iterative method, where the average value of the measure is calculated with the initial values being a country's diversification and a product's ubiquity; measured as a z-score. Country labels in panel 1 use International Organization for Standardization country codes. Non-Asia (advanced) = Austria, Canada, Denmark, France, Finland, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, United States, and United Kingdom. Non-Asia (emerging) = Argentina, Bulgaria, Brazil, Chile, Hungary, Mexico, Poland, Saudi Arabia, Turkey, and South Africa.

Prepared by Kevin Cheng, Sidra Rehman, and Shiny Zhang. For further methodological details, see Cheng and others (forthcoming).

(*continued*)

Box 2.1 *(continued)*

The ECI is then regressed on these five variables using the following panel equation, with country fixed effects for 93 countries during 1980 to 2010:[1]

$$ECI_{c,t} = \alpha_{c,t} + \beta_1(\text{GDP per capita})_{c,t-1} + \beta_2(\text{Trade Openness})_{c,t-} + \beta_3(\text{Distance})_{c,t-1} + \beta_4(\text{Size of Government/GDP})_{c,t-1} + \beta_5(\text{Composite Institutional Quality})_{c,t-1} + \alpha_c + \varepsilon_{c,t}.$$

The main results, shown in Table 2.1.1, suggest that the ECI is positively correlated with greater trade openness and higher institutional quality, but negatively correlated with geographic distance from the rest of the world and size of government.

Table 2.1.1. Drivers of Economic Complexity (Panel BMA Best Specification)

	(1)	
Dependent Variable: ECI	**Coefficient**	**Standard Error**
GDP per capita (lag 1)	–0.027	(0.026)
Trade openness (lag 1)	0.341***	(0.078)
Distance weighted by GDP (lag 1)	–0.901***	(0.118)
Size of government (lag 1)	–0.095***	(0.026)
Composite institutional quality (lag 1)	0.170***	(0.025)
Number of observations	136	
R-squared	0.773	
Robust standard error	Y	
Time dummy	Y	

Source: IMF staff estimates.
Note: BMA = Bayesian model averaging. *** $p < 0.01$.

[1] To address the endogeneity issue, a two-step, least-squares approach is estimated in which the GDP per capita variable is estimated in the first step and the corresponding predicted values are used for the ECI regression.

Box 2.2

Case Study: Comparing Electronics Value Chains in Korea and Japan

Japan's and Korea's shares of world value added in electronics production chains have shifted significantly over time. During 1995–2009, Japan's share halved from 22 percent to 11 percent, while Korea's increased from 3½ percent to 6 percent. Over the same period, the shares captured by Germany and the United States also declined, although the U.S. share is somewhat higher than Japan's. However, scaling value-added shares according to a country's share of world GDP indicates much larger growth in Korea's value added from electronics, which is consistent with the country's greater specialization into electronics global value chains (GVCs) (Figure 2.2.1, panel 1). What might explain these developments? This box sheds light on this by drawing inferences from the behavior of key GVC statistics for the two countries' electronic sectors.

Key Developments in GVC Statistics

Over this period, GVC developments in these two economies showed a few similarities as well as differences:

- Their electronics production chains lengthened (i.e., the number of production stages has increased), implying greater fragmentation of production and thus providing the opportunity for increased task specialization. These production chains are longer than those in Germany and the United States. The increase in the number of production stages reflects the increasing role of other countries in Japanese and Korean electronics chains. However, the increase in fragmentation is much greater in Korea than in Japan, largely owing to the higher foreign content in Korea's electronics production chain, which has an index value between two and three times that in Germany, Japan, and the United States (Figure 2.2.1, panel 2).
- The share of electronics GVC-related value added in gross exports—also known as GVC participation in the electronics sector—in both countries is much higher than that for the rest of the world, including those of Germany and the United States. In addition, GVC participation in Korea has increased at a much faster pace over the past decade than in Japan (Figure 2.2.1, panel 3).
- Specialization in higher-value-generating tasks in electronics value chains—typically positioned toward the early or late stages of the production process—has increased in Korea. Specifically, Korea has moved more upstream in electronics GVCs—as shown by a significant increase in the distance to final demand—relative to Japan and elsewhere, such as Germany and the United States, whose GVC positions are roughly similar to that of the median country (Figure 2.2.1, panel 4). This suggests that Korea has become more specialized in higher-value-generating intermediate electronics inputs, while Japan's upstreamness has increased only at a marginal pace.
- The role of technology intensity within the electronics sector in Japan and Korea has also changed. Dividing the electronics sector further into high-tech and medium-tech electronics shows that Korea reoriented its specialization from medium-tech electronics in early 2000 toward high-tech electronics. In the 1990s and early 2000s, more than 70 percent of value added in the electronics sector in Japan came from high-tech electronics industries, while the most recent input-output tables show that only 40 percent of electronics' value added in the country's exports is derived from high-tech electronics industries. In contrast, Korea's high-tech value added in exports was less than 40 percent in the early 2000s, while over 90 percent of the country's value added in exports now comes from high-tech electronics sectors (Figure 2.2.1, panel 5).

Factors Underpinning Korea's Success in Electronics GVCs

A brief look at firm-level data[1] for firms operating in the electronics industry shows an increase in value added captured by firms in Korea. Gross margins—a firm-level proxy for domestic value added (Shin, Kraemer, and

Prepared by Dulani Seneviratne.

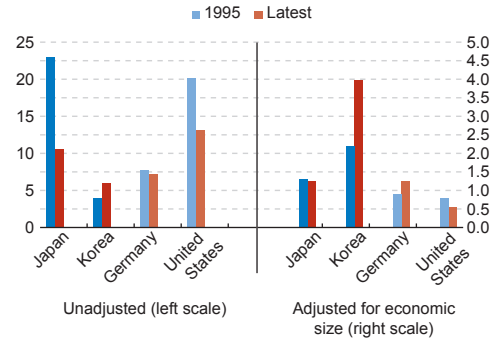
[1] Firm-level data are from Orbis and cover both listed and unlisted firms in the electronics sector in Japan and Korea; the data set includes more than 900 firms.

(*continued*)

Figure 2.2.1

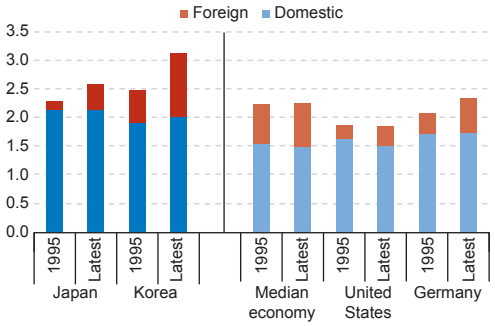
1. The share of value captured within the electronics sector has shifted in both Korea and Japan.

Domestic Value-Added Share in Electronics
(In percent of world's electronics value added)



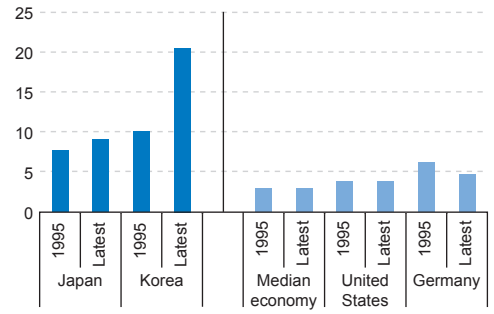
2. The fragmentation in production processes—task specialization—has increased.

Length of Electronics GVCs
(Index)



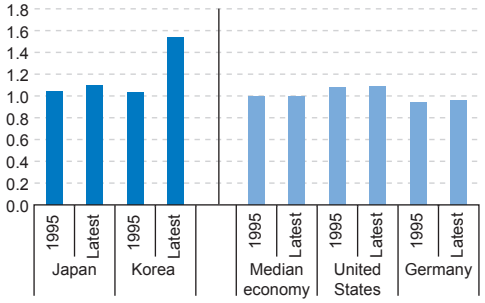
3. Electronics GVC participation has increased more in Korea ...

Electronics GVC Participation
(In percent of gross exports)



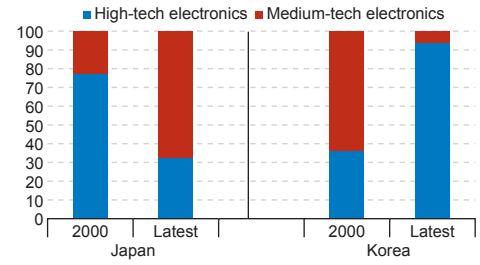
4. ... as well as specialization in higher-value-generating upstream tasks.

Upstreamness in Electronics GVCs: Distance to Final Demand
(Higher index = more upstream; in relative terms where the median = 1)



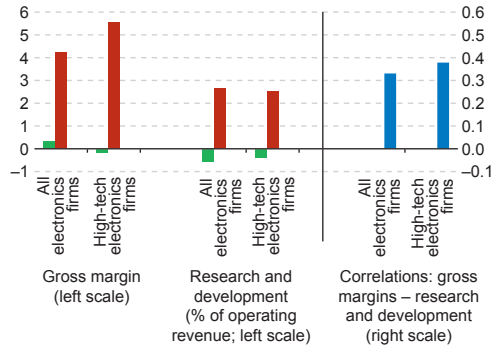
5. The role of technology intensity within the electronics sector has changed ...

High-Tech versus Medium-Tech Electronics Value Added in Electronics Exports
(In percent of electronics exports)



6. ... while firm-level data also show an increase in high-tech electronics firms' value added in Korea, driven by productivity improvements.

Electronics Firms: Change in Average Profit Margins and Research and Development Spending, and Pearson Correlation Coefficients
(Left scale: in percentage points; right scale: between –1 and +1)



Sources: Bureau Van Dijk, Orbis database; Organisation for Economic Co-operation and Development and World Trade Organiztion, Trade in Value-Added database; Organisation for Economic Co-operation and Development, International Input-Output Tables; and IMF staff calculations.
Note: GVC = global value chain.

(*continued*)

Box 2.2 *(continued)*

Dedrick 2012)—increased only slightly in Japan within the last decade, while in Korea gross margins increased about 4 percent for the average firm. In Japan, gross margins of high-tech electronics firms—which are typically either very upstream or downstream—deteriorated on average within this time frame, while in Korea, gross margins of high-tech firms improved more than the electronics industry's overall average (Figure 2.2.1, panel 6).

What might account for this trend? Oikawa (2008) associates the weak Japanese gross margins in electronics with declining research and development, investment, and human capital. The correlation between research and development spending and gross margins is indeed positive in the sample of firms considered; in addition, intellectual property rights, capital expenditure, and worker productivity are also positively correlated with gross margins. In a nutshell, all of the firm-level data, as well as the macro-level GVC indicators, suggest that maintaining and improving competitiveness in electronics value chains will depend on the ability to continually raise productivity.

Box 2.3

Assessing Drivers of GVC Participation and Moving Up in GVCs

GVC Participation

With the rapid growth and complexity in global value chains (GVCs), there has been a widespread recognition among policymakers of the importance of GVCs; thus this is an area in which continued research is needed to identify how GVCs work, how they affect economic performance, and what policies help economies derive greater benefits through GVCs (Organisation for Economic Co-operation and Development [OECD] 2013). With the increase in research in this area by scholars and organizations such as the OECD, the United Nations Conference on Trade and Development, and the Asian Development Bank, drivers of GVCs are frequently discussed in value chain literature given the importance of GVCs in growing linkages and opportunities, as well as challenges to export performance. Changes to business and regulatory environments, shifts in business strategies at the firm level, adequate infrastructure, access to trade finance, and barriers such as tariffs and investment restrictiveness are identified as factors that would fuel GVC participation with the right set of policies or hinder GVC activities if wrong policies are enacted (Blanchard 2015; Hummels and Schaur 2012; OECD 2013; OECD, United Nations Conference on Trade and Development, and World Trade Organization 2013; World Trade Organization 2014).

Against this background, this box assesses the empirical determinants of GVC participation with the following explanatory variables: level of development, infrastructure and human capital development, institutions and labor regulations, and tariffs and other trade impediments. Panel regressions are run separately for high-tech and low-tech manufacturing sectors, controlling for time and country fixed effects.

The key results, presented in Table 2.3.1, suggest that—with the level of income controlled for—better fundamentals such as a sound regulatory environment, human capital development (education, health), basic infrastructure, and lower tariffs and other trade barriers tend to increase a country's participation in GVCs. While the results show that these drivers contribute to the emergence of GVCs, industry-specific determinants of GVC participation also matter. As the Asian Development Bank (2013) notes, drivers across industries vary, specifically low-tech versus high-tech manufacturing, and to improve GVC participation, countries need to improve the quality of local institutions and infrastructure quality to make it conducive to technological upgrading and integrated industrial production. This requires continued upgrading within and between industries. The results illustrate that precise relevant variables vary between high-tech and low-tech manufacturing. For instance, while human capital may improve trade in GVCs, basic education is a significant driver of participation only for low-tech manufacturing. In regard to high-tech manufacturing, what matters is the improvements to the quality of education, probably owing to the technology intensity in most of these industries. Moreover, in low-tech manufacturing sectors, the analysis finds that a conducive business climate to create an employment base with internationally competitive minimum wages and other standards would improve GVC participation.

Capturing a Greater Share of Value Added in GVCs

The following analysis assesses the link between an economy's ability to capture a greater part of the value added generated in global industry and three explanatory variables—upstreamness (measured by distance to final demand [DFD]), the economic complexity index (ECI), and tariffs on intermediate goods—while controlling for relative economic size (measured by the share of GDP in global output).

Prepared by Kevin Cheng, Dulani Seneviratne, and Shiny Zhang. For further methodological details, see Cheng and others (forthcoming).

(*continued*)

Box 2.3 *(continued)*

Table 2.3.1. Drivers of Increased Participation in Global Value Chains

	(1)	(2)
	GVC Participation: High-Tech Manufacturing	GVC Participation: Low-Tech Manufacturing
Dependent Variable: log (PI)	**Coefficient**	**Coefficient**
Level of Development		
Real GDP per capita (lag 1)	0.153***	–0.268***
Infrastructure and Human Capital Development		
Infrastructure (lag 1)	0.079***	0.128**
Years of schooling (lag 1)		0.551**
Quality of education system (lag 1)	0.053**	
Health expenditure (lag 1)	0.079**	
Institutions and Labor Regulations		
Governance (lag 1)	0.230***	
Laxity of labor regulations (lag 1)		0.264***
Tariffs and Other Trade Impediments		
Distance weighted by economic size (lag 1)		–0.325***
Trade restrictiveness (lag 1)	–0.115**	
Investment restrictiveness (lag 1)		–0.364***
Tariff on intermediate goods (lag 1)	–0.118***	–0.074*
Number of observations	431	346
R-squared	0.993	0.824
Robust standard errors	Y	Y
Country and time fixed effects	Y	Y

Source: IMF staff estimates.
Note: GVC = global value chain; PI = participation index. *p < 0.1; **p < 0.05; ***p < 0.01.

Relative economic size is controlled for because as an economy expands, its share of value added along a GVC should naturally rise, and the interest here is in the gain in share of value added along GVCs above and beyond the impact of economic size. Estimation is based on the following panel estimation with industry, country, and year fixed effects:

$$\log(\text{DVA Share})_{c,i,t} = \alpha_t + \alpha_{c,i} + \alpha t_i + \alpha_{c,t} + \beta_1 \log(\text{GDP Share})_{c,t-1} + \beta_2 \log(\text{DFD})_{c,i,t-1} + \beta_3 \log(\text{ECI})_{c,i,t-1} + \beta_4 \log(\text{Tariffs})_{c,i,t-1} + \varepsilon_{c,i,t}.$$

where DVA is domestic value added. Key results, shown in Table 2.3.2, suggest that upstreamness and the ECI have led to an increasing share of value added along a GVC captured by a country. On the other hand, in addition to hampering a country from participating in GVCs, a higher rate of tariffs on intermediate goods has led to a decreasing share of value added along a GVC captured by a country.

(*continued*)

Box 2.3 *(continued)*

Table 2.3.2. Capturing a Bigger Slice of the Pie in Global Value Chains

	(1)		(2)	
	High-Tech Manufacturing		Low-Tech Manufacturing	
Dependent Variable: Log (DVA)	Coefficient	Standard Error	Coefficient	Standard Error
Log (GDP)	0.874***	(0.12)	0.678***	(0.10)
Log (DFD)	1.065**	(0.42)	0.860**	(0.43)
Log (ECI)	0.531	(0.34)	0.770***	(0.20)
Log (Tariff)	–0.359***	(0.09)	–0.211**	(0.10)
Number of observations	723		939	
R-squared	0.882		0.77	
Industry fixed effects	Y		Y	
Country fixed effects	Y		Y	
Year fixed effects	Y		Y	
Cluster standard errors	Country and industry		Country and industry	
Classification	High-tech manufacturing		Low-tech manufacturing	

Source: IMF staff estimates.
Note: DFD = distance to final demand; DVA = domestic value added; ECI = economic complexity index.
**$p < 0.05$; ***$p < 0.01$.