



East Asia-Pacific's Participation in the Global Value Chain for Electronic Products

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Abstract

This paper traces the East Asia-Pacific (EAP) region's participation in the global value chain (GVC) for electronic products over the past 20 years, with particular attention to trade in intermediate goods and recent foreign direct investment (FDI) into the region. During this time, China has been the principal driver of the GVCs for electronic products. However, recent increases in China's production costs have created opportunities for other countries in the region—such as Malaysia, Singapore, Thailand, and Vietnam—to increase their participation in the sector's GVC. In discussing these trends, this paper uses the World Bank's Measuring Competitiveness in Global Value Chains (MC-GVC) database and provides a case study on the development of the semiconductor industry's presence in the EAP region to illustrate the region's role in the GVC for electronic products.

Keywords: China, electronic products, East Asia-Pacific, global value chains, GVC

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Introduction

Global value chains (GVCs) are the cross-border iterative steps that transform material and parts into a finished product.¹ They increasingly involve a geographically and organizationally fragmented production process,² with developed countries often specializing in high-value-added activities (e.g., research and development, product design, and production of high-value components) and lower-income countries typically concentrating on low-value-added, labor-intensive activities, such as production of lower-value parts and components (e.g., intermediate goods) and final assembly. Trade in intermediate goods can provide a very rough estimate of a country's participation in GVCs,³ providing a proxy for the GVC's division of labor between higher- and lower-income countries.⁴ Further, inward foreign direct investment (FDI) can also indicate a country's relative involvement in GVCs, due to the participation of foreign affiliates. Trade in intermediate goods is most commonly conducted through networks established by multinational corporations (MNCs), also known as "lead firms."⁵

For the past 20 years, the East Asia-Pacific region (hereafter EAP) has been one of the most GVC-intensive regions with regard to the electronic products sector. The EAP's extensive involvement in this sector's GVC reflects robust capital investments by MNCs seeking to either outsource or offshore low-value-added elements of their supply chains to countries with low labor costs. It also reflects international sourcing by global buyers and factory-less manufacturers.⁶ China has been the primary recipient of this FDI, attracting nearly half of the foreign capital investments made during 2003–18,⁷ and is the principal driver of the GVCs for electronic products within the region.

However, rising production costs within China have translated into increased participation in this GVC by regional players—especially Malaysia, Singapore, Thailand, and Vietnam. The growing involvement of these countries is evidenced by a dramatic increase in their imports of

¹ The concept can be distinguished from a "supply chain" in that it includes the intellectual, financial, and organizational assets that participating companies contribute to the process, from product conception to end use.

² Meng, Wang, and Koopman, "How Are Global Value Chains Fragmented?" July 31, 2013.

³ A more detailed discussion of GVC participation is provided in appendix A of this article.

⁴ WTO, *World Trade Report 2014*, 80.

⁵ Specifically, GVC trade is often carried out via intra-firm trade, where MNCs trade with their foreign affiliates (also known as vertical FDI), or through "arms-length" transactions (also known as foreign outsourcing), where an MNC trades with an unaffiliated foreign entity. These two sets of transactions are otherwise known as offshoring and outsourcing, respectively. Oldenski, "Reshoring by U.S. Firms," September 2015; UN ESCAP, *Asia-Pacific Trade and Investment Report 2015*, 2015. For a brief review of the literature on how GVCs are influenced by FDI, please see Torsekar, "China Climbs the Global Value Chain," March 2018, 7.

⁶ This desire to outsource or offshore low-value-added work partially stems from cost pressures associated with Moore's Law, which correctly forecast increasing computing performance at decreasing prices for the past 40 years. This "law" has applied pressure on MNCs engaged in the electronic products sector to seek out means of reducing costs so that they can re-invest revenue in the research and design needed to stay ahead of the competition. Thornhill. "As Moore's Law Fades," November 6, 2018.

⁷ Through August 2018. fDi Intelligence, fDi Markets Database (date accessed August 28, 2018).

intermediate electronic products,⁸ along with substantial capital investments from MNCs in mostly low-value-added activities. Taken in sum, these trends suggest a likely “downstreaming” of electronic goods production, a process characterized by the shift of production (and exports) of goods to lower-income countries.⁹ Our analysis reinforces prior research in to China's hub-and-spoke relationship with the EAP. It adds a new dimension, however, by looking at how the value-added exports and imports of electronic products indicate that MNCs are diversifying their operations away from the “hub” to various “spokes.”¹⁰ It also touches on the role of lead firms/MNCs in establishing and managing GVCs; explores why the electronic products sector is perhaps uniquely modular; and suggests that, at least in the semiconductor industry, gross export statistics do not reflect the value-added contributions made by countries in the EAP.

In cataloguing these trends, this paper makes extensive use of the World Bank's Measuring Competitiveness in Global Value Chains (MC-GVC) dataset. MC-GVC enables analysis of the underlying structure of GVCs by compiling statistics on the intermediate and final goods trade in four sectors over an extended period.¹¹ This analysis of gross trade statistics is complemented by other analysis using information from international input-output datasets, such as the Trade in Value Added (TiVA) database managed by the Organisation for Economic Cooperation and Development (OECD); the UNCTAD-Eora database supported by the United Nations Conference on Trade and Development (UNCTAD); and Asian Input-Output tables managed by the Institute of Developing Economies (IDE-JETRO).¹²

The paper proceeds by first explaining global value chains, with particular attention to the use of trade in intermediate goods as a proxy for GVC participation by countries in EAP. Next, the paper discusses China's central role in GVCs for electronic products, and notes increases in production costs in that country. Finally, the paper analyzes the growing participation of regional countries in this GVC, including a case study on the global semiconductor industry, before concluding.

⁸ This is considered the simplest way to measure GVC participation. However, this method tends to double-count the value of intermediate goods in these transactions. WTO, *World Trade Report 2014*, 80.

⁹ This has been defined by Lauren Deason and Michael J. Ferrantino as the shifting of exports from higher- to lower-income economies. OECD, *Globalisation, Comparative Advantage and the Changing Dynamics of Trade*, 2011, 261.

¹⁰ This trend has partially been explained as a strategy known as “China plus one,” whereby firms pair their China investments with a second facility in a nearby Asian economy. This strategy posits that firms do so either to reduce costs, manage risks, or both. Enderwick, “A ‘China-Plus-One’ Strategy,” 2011.

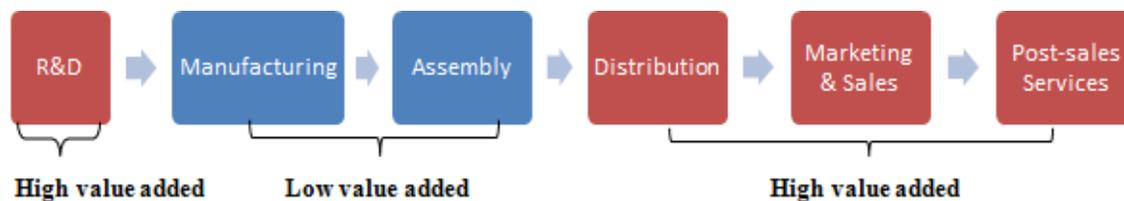
¹¹ This dataset also provides GVC data on autos, textiles, apparel, and footwear.

¹² Ferrantino and Schmidt, “Using Gross Trade Data to Map Archetypal GVCs,” October 6, 2017.

What Are Global Value Chains?

GVCs encompass the range of cross-border iterative tasks required to develop, produce, and sell goods and services. These activities can be broadly divided according to their relative value-added contributions to eventual finished goods (figure 1). Because GVCs are generally fragmented across several countries, they drive up the volume of intermediate goods trade, with value being added at each stage of production in an iterative process.¹³ As discussed earlier, this trade is commonly conducted through MNCs either via vertical FDI (offshoring) or through arms-length relationships with unaffiliated local suppliers in foreign markets who may be contract manufacturers (outsourcing).¹⁴ These sourcing relationships may also be closely managed and coordinated by lead firms or by large suppliers to lead firms. In most instances, lower-middle-income countries enter value chains by specializing in the low-value-added tasks, such as components manufacturing and final assembly.¹⁵ Given this pattern, trade that is lopsided in the direction of high-value intermediate goods imports can be seen as a proxy for participation in lower-value-added segments of GVCs.¹⁶

Figure 1. Example of a basic global value chain



Source: Adapted from Bamber and Gereffi, *Costa Rica in the Medical Devices Global Value Chain*, August 2013.

The leading product categories within the electronic products sector include computers, consumer electronics, and communications and networking goods. The GVC for electronic products is considered one of the world's leading sectors for intermediate goods trade, involving trade in numerous components (including printed circuit boards, batteries, and semiconductors).¹⁷ The varying intensities of the factors of production used in the different production stages for electronic goods (i.e., labor-intensive vs. capital-intensive activities) helps to shape GVCs in the sector.¹⁸ For example, various stages of the semiconductor production process require highly skilled research, development, and design; capital-intensive front-end manufacturing; and less skilled labor-intensive tasks (e.g., packaging and final assembly).¹⁹

¹³ OECD, "How Imports Improve Productivity and Competitiveness," May 2010.

¹⁴ Oldenski, "Reshoring by U.S. Firms," September 2015.

¹⁵ UN ESCAP, *Asia-Pacific Trade and Investment Report 2015*, 2015.

¹⁶ WTO, *World Trade Report 2014*, 2014, 79.

¹⁷ Sturgeon, *Mapping Global Value Chains*, May 2010.

¹⁸ UNIDO, *Global Value Chains and Industrial Development*, June 2018, 78.

¹⁹ SIA and Nathan Associates, *Beyond Borders: The Semiconductor Global Value Chain*, May 2016.

Motivated by the cost pressures associated with Moore's Law,²⁰ semiconductor firms have established a modular supply chain in which the various stages of value-added production can be done in different locations, depending on the factor intensity associated with a given stage in production. In practice, this means a lead firm such as Texas Instruments will engage in high-value and capital-intensive tasks in correspondingly high-skilled locales, such as its headquarters in Richardson, TX, while outsourcing low-value-added final assembly to a company-owned facility in the Philippines, where labor costs are lower.

Lead firms are also critical in extending GVCs by outsourcing part of the production process to third-party suppliers. This is accomplished through supply chain management, with lead firms choosing to locate high-value-added activities within their GVC in countries with correspondingly high skills, while offshoring or outsourcing the low-value-added elements of the production process in places where labor is cheaper. For example, Apple outsources the manufacturing of its consumer goods to contract manufacturers in Asia, such as Foxconn, and concentrates largely on design, marketing, and retail in the United States.²¹ The decision to outsource or offshore will likely depend on the ability of local suppliers to maintain high productivity, to adopt new technologies, and engage in cross-border trade.²² Lead firms in the United States' electronic products sector have relied heavily on offshoring, and most have product assembly done by contract manufacturers. For example, U.S. related-party imports from China²³ for computer and electronic products was 40 percent of total U.S. imports for those products in 2016.²⁴

The East-Asia Pacific's Participation in Electronics Global Value Chains

Gross trade statistics, measures of intra-regional trade, and FDI all demonstrate the extent to which the East Asia-Pacific has come to dominate the production segments of GVCs in the electronic products sector in the past 20 years.²⁵ For example, EAP ranked highest of all regions in total trade of intermediate goods within this sector during this time, while being a principal source of intermediate goods. EAP's exports of intermediate goods as a share of the region's

²⁰ See footnote 6 for brief summary of Moore's Law.

²¹ Linden, Kreamer, and Dedrick, "Who Captures Value?" 2007; Rapoza, "Foxconn Shows Why Apple Devices," February 25, 2012.

²² Ferrantino and Schmidt, "Using Gross Trade Data to Map Archetypal GVCs," October 6, 2017.

²³ Related-party trade includes trade by U.S. companies with their subsidiaries abroad, as well as trade by U.S. subsidiaries of foreign companies with their parent companies. For more information, visit <https://relatedparty.ftd.census.gov/>.

²⁴ U.S. Census Bureau, NAICS Related Party Database (accessed August 31, 2018).

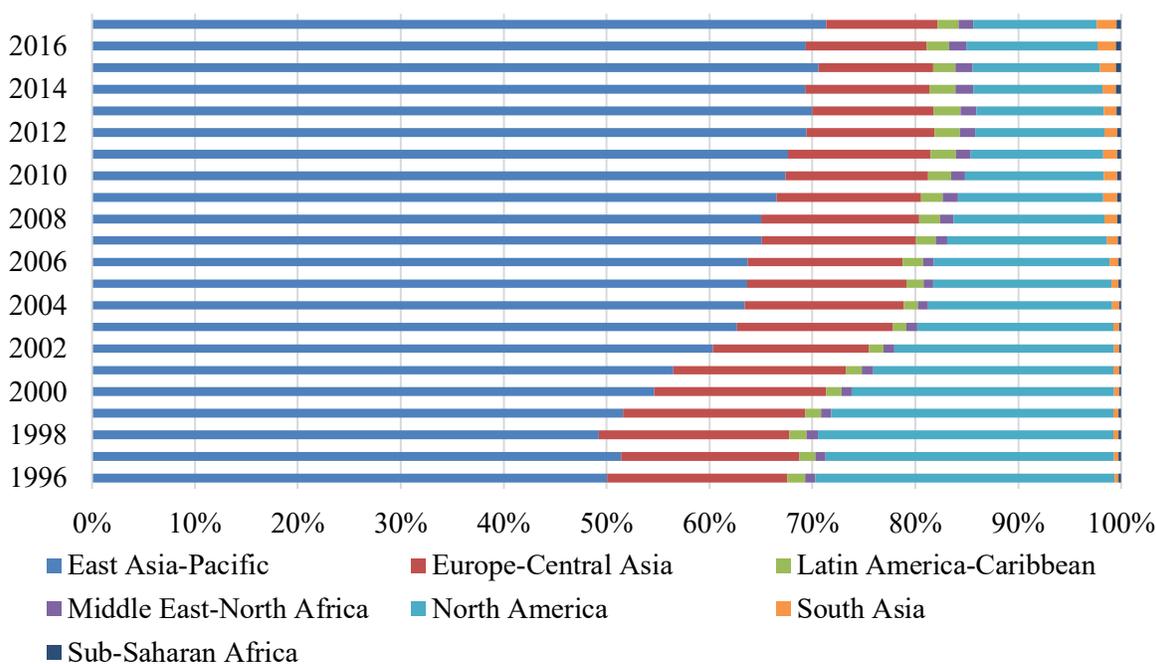
²⁵ UN ESCAP, *Asia-Pacific Trade and Investment Report 2015*, 2015.

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total manufacturing exports—a measure of GVC participation²⁶—was higher than those of any other region at 16 percent.²⁷

Notably, a growing majority of EAP's electronic goods trade (i.e., both intermediate and final goods) during 1996–2017 was conducted within the region; intra-EAP trade in electronic goods grew from 50 percent of world trade in 1996 to 71 percent as of 2017 (figure 2).²⁸ In addition, regional integration is high, and intermediate goods drive nearly three-quarters of total intra-regional electronics trade, with China, Hong Kong, South Korea, and Malaysia being the largest contributors (figure 3). At the same time, the region's electronic products sector has attracted substantial amounts of FDI from MNCs. During 2003–18, capital investments into the region amounted to \$270 billion, much of which was directed towards low-value-added manufacturing activities.²⁹

Figure 2. Shares of total trade in electronic goods between East-Asia Pacific and its trading partners, by region, 1996–17



Source: UNIDO, *Global Value Chains and Industrial Development*, June 2018.

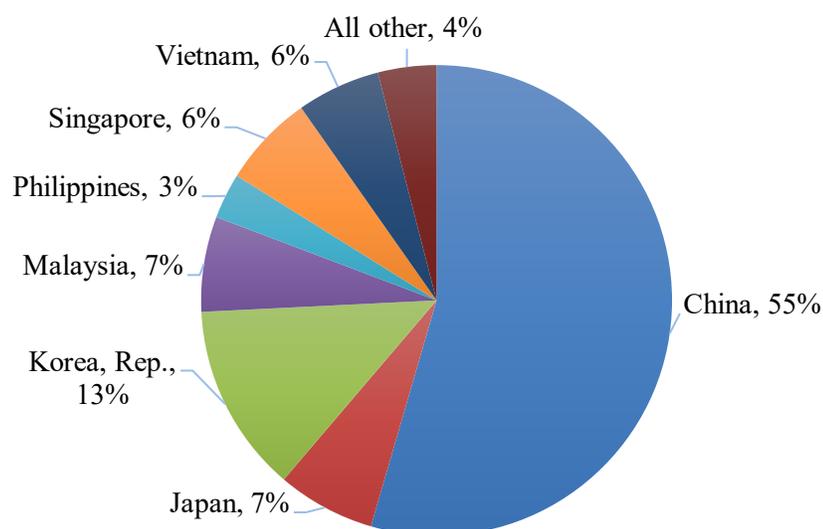
²⁶ Ferrantino and Schmidt, “Using Gross Trade Data to Map Archetypal GVCs,” October 6, 2017.

²⁷ World Bank, MC-GVC database (accessed August 30, 2018); World Bank, “East Asia and Pacific Manufactures,” (accessed August 30, 2018).

²⁸ Intermediate goods are most commonly traded within regions due to their high sensitivities to trade costs. OECD, “How Imports Improve Productivity and Competitiveness,” May 2010; UNIDO, *Global Value Chains and Industrial Development*, June 2018. .

²⁹ fDI Intelligence, fDI Markets database (accessed August 31, 2018).

Figure 3. Shares of total trade in intermediate electronic goods to the East Asia-Pacific region, by country, 2017



Source: World Bank, MC-GVC database (accessed August 30, 2018).

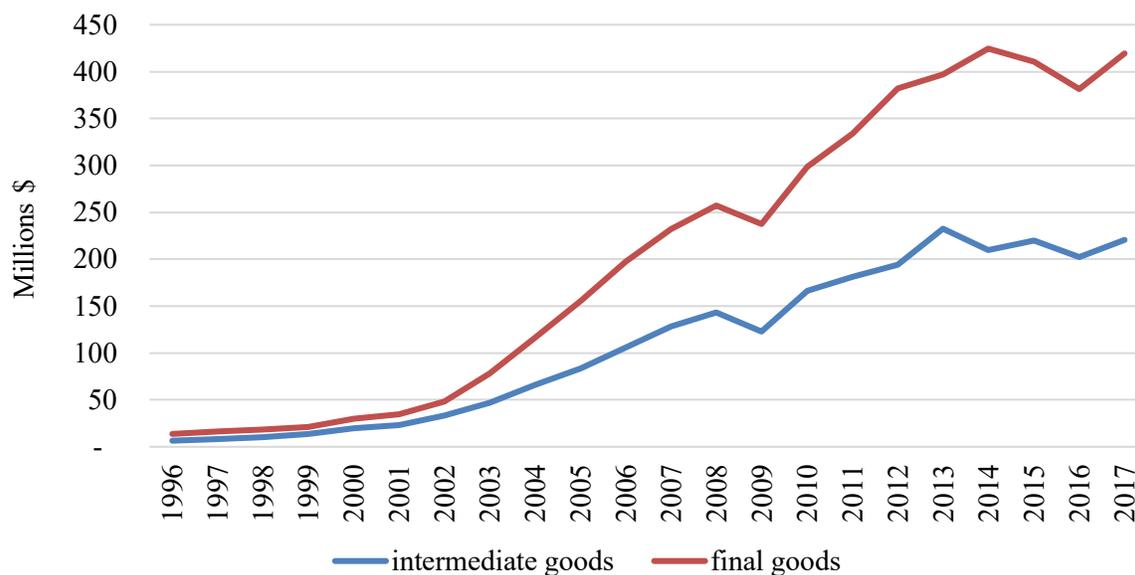
China Drives the Global Value Chain for Electronics

As total intra-regional trade within the electronics products sector has grown from a negligible level in 1996 to 40 percent of as of 2017, China has remained the principal driver of GVC trade.³⁰ During 2003–18, China accounted for roughly 44 percent of the region's cumulative capital investments and 32 percent of high-value-added regional investments (e.g., software and information technology services, chemicals, and communications investments).³¹ At the same time, the composition of China's exports has increasingly diverged, with higher-value-added exports (e.g., final goods) far outpacing that of low-value-added exports (e.g., intermediate goods) over the previous 20 years (figure 4). In addition to the observable growth reflected in gross export statistics (which include a mix of imported and domestically produced intermediate goods), some estimates suggest that the percentage of value added in China's exports grew from 55 percent to 67 percent over the same period.³²

³⁰ World Bank, MC-GVC database (accessed August 30, 2018).

³¹ fDI Intelligence, fDI Markets database (accessed August 28, 2018). These findings are consistent with other reports positing that recent FDI into China's overall manufacturing sector has transitioned into high-value-added production. Liu and Daly, "Foreign Direct Investment in China Manufacturing Industry," July 2011.

³² *Economist*, "China's Share of Global and Asian Exports Is Falling," March 8, 2018; Kowalski et al., *Participation of Developing Countries in Global Value Chains*, 2015, 16.

Figure 4. China's intermediate and final goods electronic products exports, 1996–2017 (million \$)

Source: World Bank, MC-GVC database (accessed August 30, 2018).

These trends suggest China has been progressing along the global value chain, entering higher-value-added segments of production as the divergence between its exports of intermediate and final goods expands.³³ For example, an estimated two-thirds of electronic goods sold in China in 2015 were Chinese brands, reflecting the growing number of local firms that are assuming lead-firm status. Moreover, the share of Chinese brands in global sales of cellphones and televisions has increased from 1 percent and 11 percent, respectively, in 2007 to 21 percent for both in 2015.³⁴ The emergence of both domestic lead firms and increased exports also suggest a relatively high rate of productivity in China's electronic products manufacturing sector.³⁵

These trends towards increased higher-value-added activities have been associated with rising production costs within China. According to some estimates, during 2011–16 China's wage rates within the manufacturing sector rose by 64 percent to \$3.60 per hour, reaching a level similar to that of middle-income countries like South Africa.³⁶ Further, for much of the past decade, China's eastern coastal regions, where much of the FDI in industrial development is concentrated, have witnessed rising office rents, land shortages, and escalating utility costs.³⁷

³³ *Economist*, "China's Share of Global and Asian Exports," March 8, 2018. For more information, see appendix A.

³⁴ UNIDO, *Global Value Chains and Industrial Development*, June 2018, 53.

³⁵ Ferrantino and Schmidt, "Using Gross Trade Data to Map Archetypal GVCs," October 6, 2017.

³⁶ Aleem, "Why 'Made in China' Could Soon," February 27, 2017; CNBC, "'Made in China' Isn't So Cheap Anymore," February 27, 2017.

³⁷ *Economist*, "The Problem with Made in China," January 11, 2007.

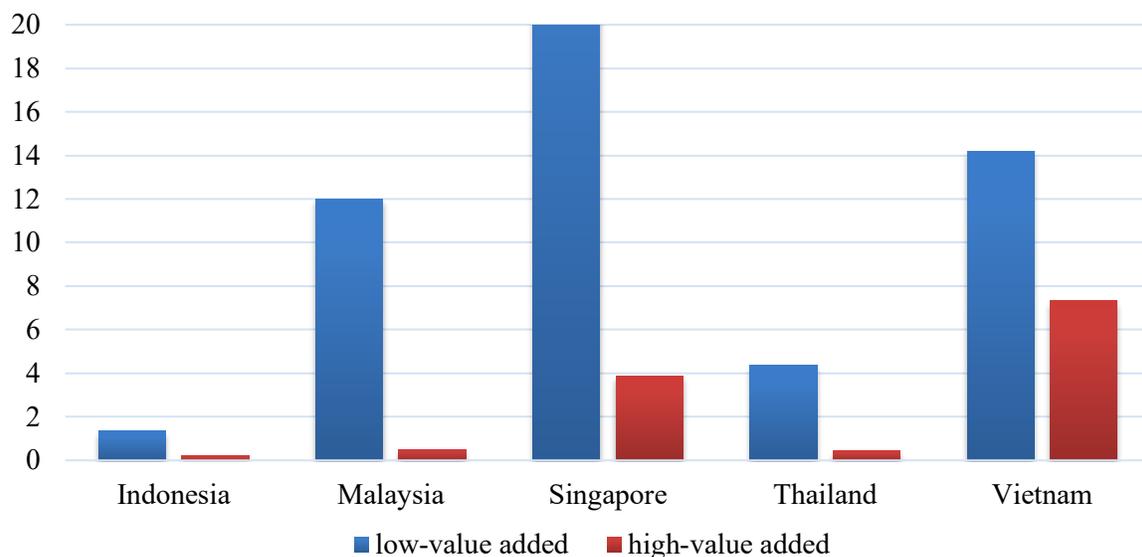
These developments, as well as currency fluctuations, may erode China's desirability in the eyes of MNCs.³⁸

Cost pressures aside, some analysts have observed a trend toward a "China plus one" strategy, whereby firms pair their China investments with investment in a second facility in a nearby Asian economy. This strategy appears to be motivated by a desire to manage supply chain risk as much as by potential cost reductions.³⁹

Increased Global Value Chain Participation by Regional Players

Rising production costs in China have translated into new opportunities for China's fellow EAP countries to deepen their participation in the GVC for electronic products. During 2003–18, capital investments into the region (excluding China) tallied \$139.6 billion, with the majority being directed towards low-value-added activities, such as components manufacturing, packaging, and assembly, in Indonesia, Malaysia, Singapore, and Thailand (figure 5). These investments have translated into 3,411 percent total growth in U.S. imports of intermediate goods from these four countries from 1996 to 2017. U.S. imports of intermediate goods from the rest of the region grew by 772 percent during this same period.⁴⁰

Figure 5. Cumulative capital investments of low-value-added and high-value-added activities for selected East Asia-Pacific countries, 2003–18 (billion \$)



Source: fDI Intelligence, fDI Markets database (accessed August 30, 2018).

³⁸ *Economist*, "China's Share of Global and Asian Exports Is Falling," March 8, 2018.

³⁹ Enderwick, "A 'China-Plus-One' Strategy," 2011.

⁴⁰ World Bank, MC-GVC dataset (accessed August 31, 2018).

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Note: Low-value-added activities included manufacturing goods in the following categories: electronic components; industrial machinery, equipment and tools; semiconductors; rubber; and plastics. High-value-added activities included the following: real estate; software and IT services; and communications.

Among the likely reasons for these investments are the opportunity to gain access to cost efficiencies (lower labor costs that afford lower marginal costs of production); financial incentives (e.g., special economic zones offering tax breaks) from the destination country; and burgeoning regional markets.⁴¹ In 2003, for example, a Swiss-headquartered semiconductor company (STMicroelectronics) noted that Singapore's favorable labor and energy costs, access to water (which is critical in the production of semiconductors), and local government policies contributed to the decision to increase their capital investments into the country.⁴²

The OECD's Trade in Value Added database demonstrates how this influx of FDI changed the composition of exports in the EAP, altering the region's electronic products value chain. Between 1995 and 2011, the first and last years for which data are available, foreign value-added content as a share of gross exports for computers, electronics, and optical equipment grew by 20 percent in Malaysia and Thailand and 13 percent in Vietnam while registering a decline of 12 percent in Singapore. At the same time, China's foreign value-added content as a share of gross exports for these electronic products declined from 75 percent to 55 percent, indicating that China is adding more value to electronic products.⁴³

The Semiconductor Global Value Chain

Semiconductors, also known as integrated circuits or “chips,” are the enabling hardware for all modern electronic products. In addition to their widespread use in information and communications technology goods (e.g., computers, smartphones, and televisions), semiconductors are increasingly consumed in the automotive, aerospace, and medical device industries. The semiconductor production process consists of several modular steps: research and development (R&D), design, manufacturing, and the “ATP” triad—assembly, testing, and packaging. This modularity has resulted in a global value chain characterized by MNCs offshoring and/or outsourcing one or more of these value-added steps to different countries. As the EAP, and China in particular, has become responsible for a greater percentage of the world's chip consumption, MNCs have chosen to conduct parts of the semiconductor production process in the region, taking advantage of proximity to end users as well as lower labor costs.

Semiconductor Production

As noted above, the production of a semiconductor consists of four general steps: R&D, design, manufacturing, and ATP (figure 6). These steps can all be conducted by one company, known as

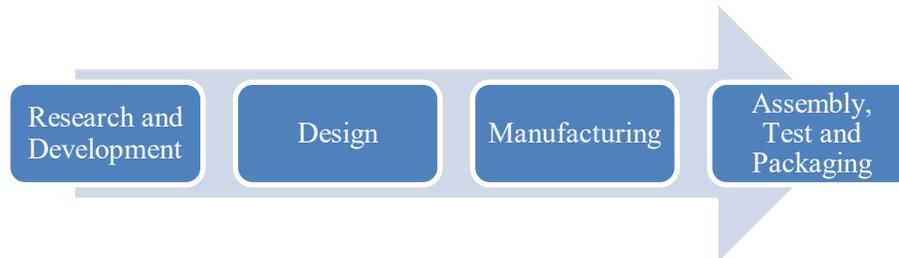
⁴¹ *Economist*, “The Problem with Made in China,” January 11, 2007; UN ESCAP, *Asia-Pacific Trade and Investment Report 2015*, 2015.

⁴² fDI Intelligence, fDI Markets database, (accessed August 29, 2018).

⁴³ OECD, Trade in Value Added database (accessed October 4, 2018).

an integrated device manufacturer (IDM), such as Intel or Samsung. However, the industry increasingly features firms that specialize in design only (known as fabless firms), manufacturing only (known as foundries), or ATP. The value of a chip can be roughly broken into three parts, with 45 percent of a chip's value realized in the R&D/design steps, another 45 percent during manufacturing, and the final 10 percent during ATP.⁴⁴

Figure 6. The semiconductor production process



Source: Compiled by authors.

Semiconductor firms are perpetually investing a large amount of their profits in research and development in an effort to keep up with Moore's Law, developing chips with better performance at lower costs. The complexity of the semiconductor manufacturing process adds to these cost pressures. Developing a state-of-the-art semiconductor manufacturing facility, which requires everything from an advanced clean room to highly specialized manufacturing equipment, can cost over \$10 billion dollars.⁴⁵ One U.S. semiconductor MNC reported using over 16,000 suppliers, only half of whom are located in the United States.⁴⁶

The Development of the Semiconductor Global Value Chain

Increasing production costs and expansive supply chains have prompted firms to focus on their competitive advantages while outsourcing or offshoring other segments of the value chain to subsidiaries and other companies. In practice, this means that an IDM will retain its high-value-added R&D, design, and manufacturing work in countries with a correspondingly high-skilled workforce while locating the low-value-added ATP in a country with cheaper labor. For example, Intel conducts semiconductor research and development, design, and manufacturing in the United States and then exports these high-value wafers to the company's Chinese subsidiaries, where they are "cut to individual units, packaged, and tested to ensure that each . . . product is ready for commercial sale."⁴⁷ "Fabless" firms take this a step further by solely engaging in chip design and then sending those designs to a contract manufacturer (foundry), before the nearly complete wafers are passed along to an ATP firm. A finished chip conceivably

⁴⁴ SIA, "In the Matter of Executive Order 13786," 2017, 2.

⁴⁵ Intel Corporation, "Public Comment Concerning Proposed Determination of Action," 2018, 3.

⁴⁶ SIA, "Beyond Borders: The Semiconductor Global Value Chain," 2016, 3.

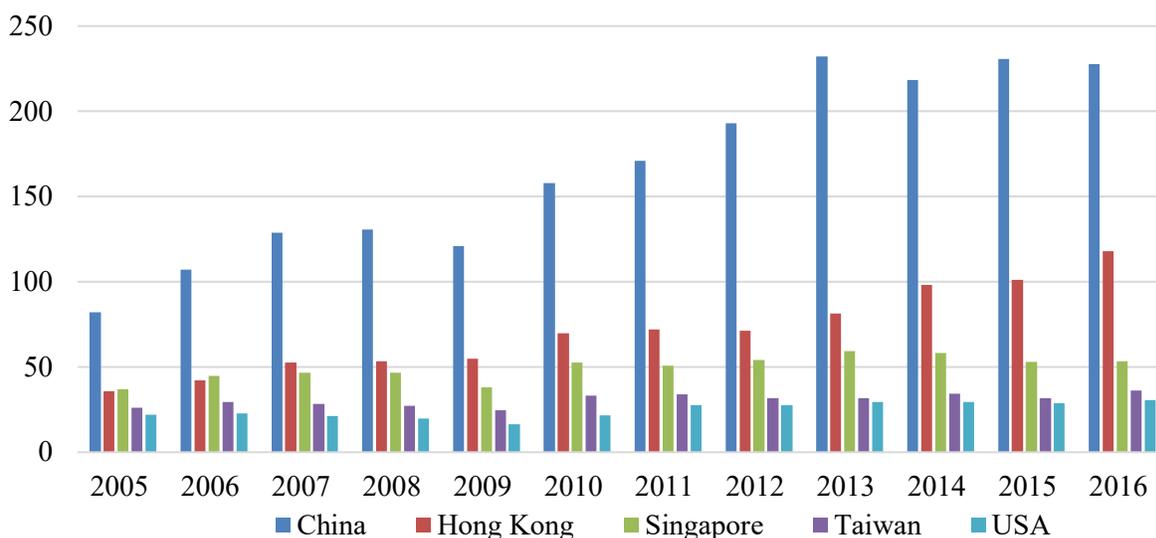
⁴⁷ Intel Corporation, "Public Comment Concerning Proposed Determination of Action," 2018, 3.

crosses multiple geographic borders as value is added by different firms throughout the production process.

The concentration of ATP firms in Asia began decades ago. Fairchild Semiconductor's decision in 1961 to open an ATP facility in Hong Kong precipitated a broader trend in the industry to locate ATP facilities in Asia. As ATP is "labor-intensive, highly routine, and highly cost-sensitive," firms offshored this part of the production process to take advantage of lower wages and tax incentives.⁴⁸ Since the 1970s, most major MNCs engaged in chip production have operated ATP facilities in EAP, where semi-finished semiconductors that have already undergone design and manufacturing are imported for the last and lowest-value-added step of the process.⁴⁹

One of the first major destinations for ATP facilities was Malaysia, which was home to Intel, AMD, Hewlett-Packard, Hitachi, and National Semiconductor (now ON Semi) by the mid-1970s.⁵⁰ A 2015 study by the Malaysian government found that the number of firms in Malaysia's electronics industry grew from 4 to 1,695 between 1970 and 2006, with employment in the sector rising from 577 to 596,270 over the same period. This trend has remained steady over time as Malaysia and other EAP countries have become home to an important part of the semiconductor GVC. Firms have had further incentive to locate ATP facilities in the region as China, which has 22 percent of worldwide ATP facilities, has eclipsed the United States as the world's largest consumer of semiconductors (figure 7).⁵¹

Figure 7. Leading importers of semiconductors, 2005–16 (billion \$)



Source: IHS Markit, GTA database (HS heading 8542; accessed September 30, 2018).

⁴⁸ SIA, "Beyond Borders: The Semiconductor Global Value Chain," 2016, 1.

⁴⁹ SIA, "In the Matter of Executive Order 13786," 2017, 6.

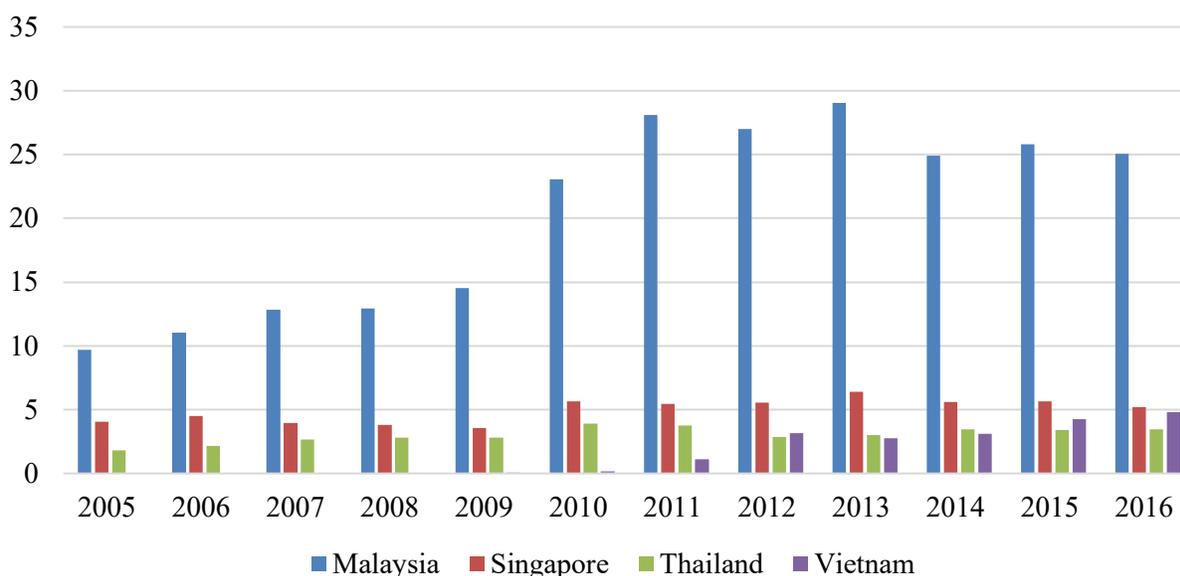
⁵⁰ Abad et al., "Malaysian Semiconductor Cluster," 2015, 19.

⁵¹ SIA, "Public Comment Concerning Proposed Determination of Action," 2018, 8.

The Semiconductor Global Value Chain in Asia

China remains the largest consumer of chips; indeed, as it moves up the value chain in its production of final goods that incorporate semiconductors (computers, automobiles, etc.), its demand for chips has consistently grown, with only minor fluctuations.⁵² Between 2005 and 2016 Southeast Asian countries saw their exports of semiconductors to China grow. This increase is most notable in Malaysia, with exports of integrated circuits (a type of semiconductor) increasing from \$970 million in 2005 to \$2.5 billion in 2016 (figure 8).⁵³

Figure 8. China's imports of integrated circuits from Southeast Asia, 2005–16 (million \$)



Source: IHS Markit, GTA database (HS heading 8542; accessed September 30, 2018).

Some changes in the East Asia GVC for semiconductors, though not captured by gross export figures, are indicative of larger trends in the electronics GVC in the region. While China's increasing consumption of semiconductors ensures that it remains a hub for both the chip and electronics GVC in East Asia, this centrality has had positive spillovers for some of its regional neighbors as MNCs have chosen to locate facilities in adjacent countries.

U.S. Census Department data on related-party trade, which catalogue trade by U.S. companies with their subsidiaries abroad, shows how this increase in demand for chips has directly and indirectly benefited China's neighbors as U.S. firms have expanded operations in the region (figure 9). Between 2005 and 2016, the last year for which data are available, an average of 75 percent of U.S. imports of semiconductors from Malaysia, Vietnam, Singapore, and Thailand

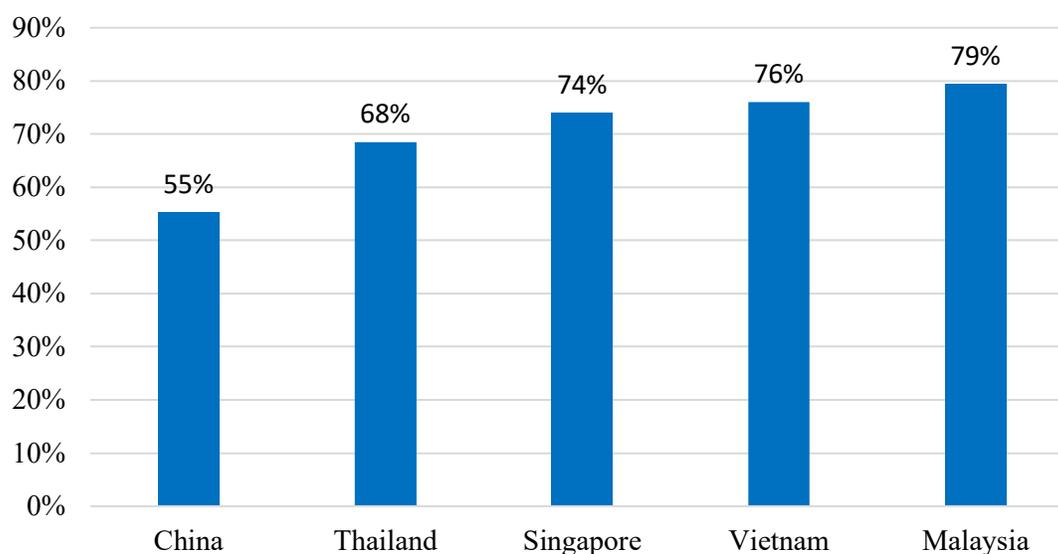
⁵² SIA, *Factbook 2018*, June 5, 2018, 3–14.

⁵³ Part of this increase is likely due to the presence of the German companies Infineon and X-Fab in Malaysia. Both firms operate semiconductor fabrication facilities there that began volume operations in the mid-2000s.

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came from U.S. firm subsidiaries in those countries.⁵⁴ The presence of U.S. MNCs in each of these four countries is not reflected in gross trade data, which shows that the U.S. runs bilateral trade deficits in semiconductors with each of these four countries. This trade is largely intra-firm trade between U.S. parent companies and their subsidiaries.⁵⁵

Figure 9. Average percent of U.S. semiconductor imports from U.S. firm subsidiaries in Southeast Asia, 2005–16



Source: U.S. Census Bureau (accessed September 25–27, 2018).

During this same period, an average of 55 percent of U.S. imports of semiconductors from China came from U.S.-headquartered firm subsidiaries in China. However, because Chinese firms maintain less than 5 percent of worldwide market share in semiconductor sales, the remaining imports were not made up of chips produced by Chinese firms but rather consisted of imports of chips from non-U.S. semiconductor firms operating subsidiaries in China.⁵⁶ When juxtaposed with the growth in Chinese imports of chips from Southeast Asia (as shown above in figure 8), this indicates that U.S. firm subsidiaries in Southeast Asia are not only selling chips to the U.S.-headquartered parent company; they are also directly exporting some of their product to Chinese consumers.

This information suggests that the aforementioned growth in Chinese imports of semiconductors from Southeast Asia primarily benefits U.S.-headquartered semiconductor firms, who have chosen to locate their “back-end” ATP facilities in the region. They have done so not only to take

⁵⁴ U.S. Census Bureau, NAICS Related Party Database (accessed September 28, 2018).

⁵⁵ VerWey, “Explaining U.S. Bilateral Trade Deficits,” 2018.

⁵⁶ In fact, Intel Corporation indicates that they are not aware of any microprocessors manufactured by a Chinese-controlled company currently sold in the United States. Intel, “Public Comment Concerning Proposed Determination,” 2018, 3.

advantage of low labor costs in the region, but also to ship their chips directly to nearby consumers in China, where they are incorporated by US-firm subsidiaries into electronic goods that are then exported to consumers. This GVC ensures the ongoing competitiveness of the U.S.-headquartered industry, which maintains 46 percent of global market share. Moreover, it allows the U.S.-headquartered industry to reinvest profits in R&D spending, which in 2017 totaled \$60.8 billion.⁵⁷

Conclusion and Future Directions

For more than 20 years, the EAP region has been the principal driver of GVCs for electronic products, as measured by the trade in intermediate goods. FDI has been instrumental in developing these multinational networks, with the majority of capital investments being directed at China. However, China's gradual transition into higher-value-added activities and associated production cost increases have led foreign MNCs to invest in other countries within the region. In particular, Malaysia, Thailand, Vietnam, and Singapore have attracted substantial sums of capital investment, the bulk of which has been directed towards low-value-added activities. FDI into these countries has increased their GVC participation dramatically, as evidenced by the substantial growth in imported intermediate goods over this period.

It is important to note that despite the emergence of these regional producers, China will likely remain the central player within the sector's GVC. First, the country's large market, rising productivity, and deeply integrated supply chain (as reflected in the abundance of reliable local suppliers) are likely to prove sufficient to overcome China's rising production costs. In addition, China has announced ambitious industrial development plans for everything from automobiles to semiconductors under the auspices of Made in China 2025, although the success of this initiative remains to be seen.

Several additional questions for future research are worth considering: is China simply moving low-value-added production to lower-cost regions in the country for internal consumption? As low-value-added production increases elsewhere in the region, are MNCs opening new higher-value-added facilities (such as engineering offices) in China? Finally, what role does automation play in motivating the shift of low-value added-activities out of China?

⁵⁷ SIA, *Factbook 2018*, June 5, 2018. 3–14.

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Appendix A

Backward and Forward Linkages in Global Value Chains

A country's GVC participation can be categorized based on the relative shares of foreign or domestic value added that contribute to their exports. A country whose exports reflect high foreign value-added content is said to have high "backward linkages" in the GVC, while a country with a high domestic value-added contribution to exports that are destined for third countries for further processing is said to participate via "forward linkages." In general, the majority of foreign content that is included in a country's exports is sourced regionally. For example, Asia contributed roughly 14 percent of the content to China's exports, in contrast to just 4 percent from the United States in recent years.⁵⁸ Moreover, between 1 and 2 percent of some regional partners' entire GDP is embedded in China's manufacturing exports to America.⁵⁹

For some sectors, it is common for "factory" economies in developing regions to have exports with higher shares of foreign value-added content (backward linkages) and for developed countries to have more domestic content embedded in their exports (forward linkages). This is the case in the semiconductor sector, where countries like the United States that add substantial value in the production process can be said to have high forward linkages, while Malaysia, Vietnam, Singapore, and Thailand have high backward linkages, given the large share of foreign value-added content present in their semiconductor exports.

In the global manufacturing sector, China's backward linkages are as high as rates observed across the rest of Asia—or higher, in some cases⁶⁰—but remain lower than what is estimated for developed economies, such as the United States, Great Britain, Germany, and France (figure A-1). Typically, higher domestic value-added content in trade is associated with higher manufacturing competitiveness, with local production supplanting foreign inputs.⁶¹ It should be noted, however, that countries with high endowments of natural resources register as having high domestic content embedded in their exports, which would not necessarily suggest a developed manufacturing sector. For example, Russian exports have the highest domestic content (93 percent) of all countries. This high domestic share reflects Russia's substantial natural resources, which are harnessed and processed before eventually being converted into finished products.

⁵⁸ Kowalski, *Participation of Developing Countries in Global Value Chains*, 2015.

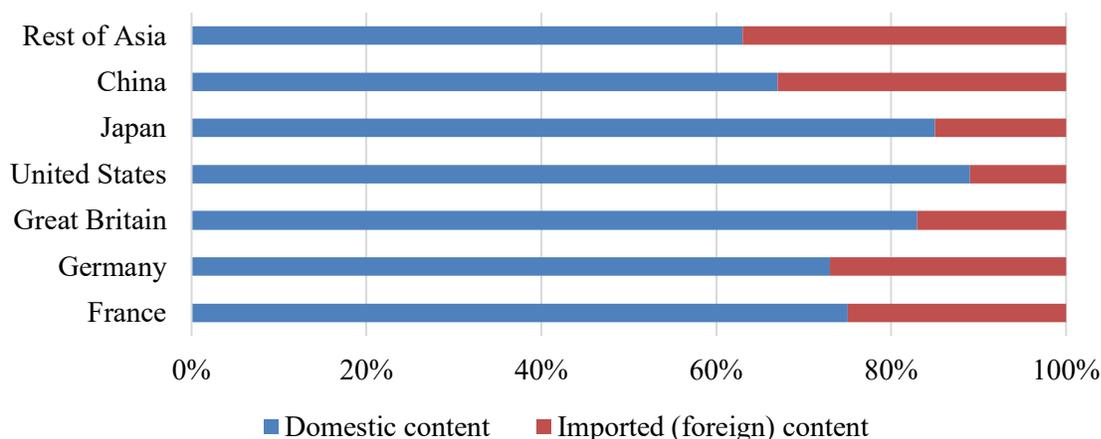
⁵⁹ *Economist*, "Tumbling Down," March 31, 2018.

⁶⁰ Within EAP countries, there is substantial variation in the relative contribution of domestic content to a country's exports. For example, domestic value added in exports as a share of GDP for selected countries was 10 percent (Vietnam), 43 percent (Thailand), 51 percent (Singapore), and 62 percent (Malaysia). ASEAN-Japan Centre, *Global Value Chains in ASEAN*, September 2017.

⁶¹ ASEAN-Japan Centre, *Global Value Chains in ASEAN*, September 2017.

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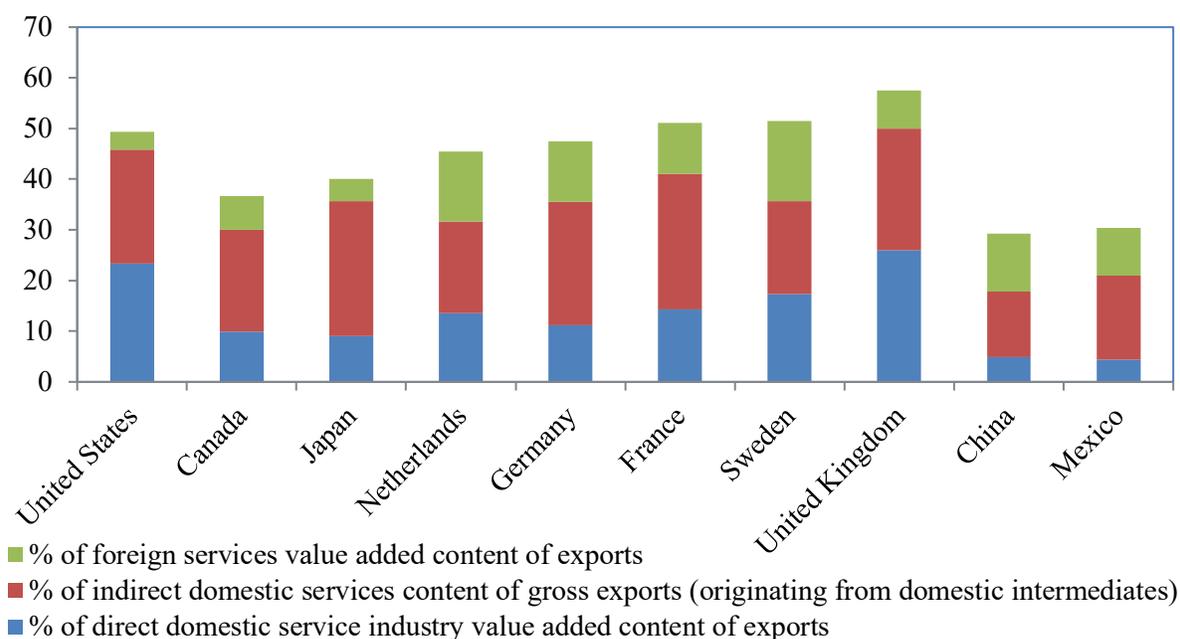
Figure A-1. Origin of value added in exports (backward participation), 2009 (percent)



Source: Kowalski et al., *Participation of Developing Countries in Global Value Chains*, 2015.

The relatively high domestic value-added contributions of developed countries largely reflects the strong contributions of services to GVCs. For example, the OECD estimated in 2016 that services represented roughly half the value of U.S. exports of goods (figure A-2). In sharp contrast, services in the emerging economies of China and Mexico contributed less than 5 percent. As earlier observed in figure 1, services such as research and design, distribution, marketing, and post-sales services are all considered high-value-added activities.

Figure A-2. Value added of total domestic services in gross exports as a share of gross exports, 2016 (percent)



Source: Moran and Oldenski, "How Offshoring and Global Supply Chains Enhance," April 2016.