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Productivity Growth, Innovation, and Upgrading along Global Value Chains

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Greater exposure to international trade improves productivity by increasing competition, expanding product markets, and improving access to production inputs. Productivity increases at the industry level because competitive pressure leads to a reallocation of resources to more productive firms, while the least productive ones are forced to exit the market (Melitz 2003; Melitz and Ottaviano 2008; Eslava et al. 2013). The productivity of firms can also increase because heightened competition from imported products pushes them to invest in new processes, technologies, and skills to survive (Shu and Steinwender 2019). The possibility to expand into larger export markets also incentivizes firms to improve the production efficiency and the quality of their products (Bustos 2011). And access to a larger range of intermediate production inputs potentially lowers the input costs of firms, improves product quality, and expands product variety (Fieler, Eslava, and Xu 2018; Goldberg et al. 2010; Amiti and Konings 2007). Indeed, a positive and significant causal effect of trade—measured as the sum of exports plus imports to a country's gross domestic product—on aggregate productivity has long been established in the economic literature (Alcalá and Ciccone 2004; Alesina, Spolaore, and Wacziarg 2000; Frankel and Romer 1999).

In today's global economy, 70% of international trade involves global value chains (GVCs) (OECD 2021). GVC trade is characterized by services, raw materials, and parts and components crossing borders, often many times, to be incorporated into final products that are then shipped to consumers all over the world. While countries traded raw materials and components before the advent of GVCs, the scale was nothing like that of today. This complex web of interactions among firms from different countries is the reason why GVC trade offers more opportunities for productivity growth than trade in final goods and services. By outsourcing parts of production to international suppliers, lead firms realize efficiency gains in the form of lower costs or higher quality and so raise productivity (Bøler, Moxnes, and Ulltveit-Moe 2015). When a foreign firm and a local supplier are part of the same supply chain, they need to interact and coordinate to guarantee the chain functions smoothly. That face-to-face communication facilitates the transfer of tacit knowledge and increases domestic innovative capabilities (Hovhannisyan and Keller 2015; Santacreu-Vasut and Teshima 2016). Foreign outsourcing firms have an incentive to transfer the know-how and technology required for the efficient production of outsourced inputs because they will eventually be the consumers of those inputs.

This idea of domestic suppliers accessing new knowledge and resources from foreign markets and buyers is consistent with the so-called learning-by-exporting hypothesis. That said, it is also plausible that only the most productive firms have the resources to integrate themselves into GVCs, which is known as the self-selection hypothesis. Indeed, selling to foreign markets involves various costs, including a substantial upfront investment to customize products to match the standards and requirements of foreign buyers; transportation, distribution, and marketing costs; and the cost of hiring people with the skills to manage export networks. Recent empirical evidence shows that foreign investors carefully target the largest and most productive local firms to invest in and exploit their export networks—in other words, cherry picking (Blonigen et al. 2014; Branstetter and Drev 2014; Guadalupe, Kuzmina and Thomas 2012). So, a superior productivity performance by GVC-integrated firms could be at least partially attributed to the self-selection of originally productive firms into GVCs—and the findings on research and development (R&D) and knowledge spillovers in large private companies may not apply to other firms, industries, or the economy.

This chapter examines the nexus between GVC participation and productivity growth, GVC participation and innovation, and upgrading and innovation along GVCs. Empirically studying these relationships is challenging because it involves disentangling several channels through which GVC participation can potentially drive productivity growth—specialization, access to foreign inputs, knowledge spillovers, and upscaling—that are all at work at the same time. For example, only firms that have unrestricted access to imports of low-cost, high-quality intermediate inputs can afford to specialize in the tasks along the value chain that they perform most efficiently. An investment in technology and the restructuring of internal processes is needed to fully benefit from specialization and higher-quality imported inputs. And firms may need to have initial internal technological capabilities above a certain threshold for access to imported inputs to improve export performance (Torres Mazzi and Foster-McGregor 2021).

This chapter provides diverse perspectives on the concept of innovation from frontier or new-to-the-world innovation to new-to-the-country or new-to-the-firm innovation. Indeed, catch-up innovation, manifested in the successful implementation of new-to-the-country and new-to-the-firm ideas, is as important as frontier innovation for driving productivity growth.

Because no one dataset can capture all the complexity involved in a value chain, the chapter discusses evidence from studies based on different types of data and methodological approaches. For example, case studies based on detailed quantitative and qualitative data on the value chain of one firm or product are very insightful, but do not necessarily apply to other firms, even within the same country and industry. Large, nationally representative enterprise surveys contain granular detail on inputs, output, employment, and other characteristics, but little to no information on upstream and downstream firms, especially across countries. In fact, these surveys are hardly ever harmonized across countries. Datasets tracing cross-border linkages, such as greenfield investments or mergers and acquisitions, tend to be limited to one specific type of linkage along a value chain. It is worth noting that developing economies are noticeably underrepresented in many of these datasets. Input–output tables show the sale and purchase relationships between producers and consumers aggregated by economy sectors. Although they are less detailed than enterprise surveys, they provide a bird's-eye view of all cross-border linkages by economy sectors. And because input–output tables are built on the national account series of gross output, value added, and employment, they are available for many developed and developing economies.

This chapter prominently features the experiences of Asian economies because no other region epitomizes GVC participation as a driver of productivity growth and innovation better than Asia. In 2019, Asia's GVC participation was 67.4%, making it a key player in GVCs (ADB 2021).[1] Asia has seen the rise of economic powerhouses in the span of just a generation, from the export-led industrialization of Japan and the four Asian Tigers during the second half of the 20th century to the People's Republic of China (PRC) becoming the factory of the world and then to Southeast Asian economies successfully using GVCs as a path to participate in global-scale production and to move to higher value-added activities.

The rest of the chapter is organized as follows. The next section examines evidence on the impact of GVC-mediated access to foreign R&D on total factor productivity and innovation at the firm, industry, and economy levels. It identifies knowledge spillovers and access to imported inputs as the main drivers of productivity growth. The section focuses on the role of multinational corporations (MNCs) in facilitating knowledge transfers. This is followed by an analysis on whether GVC-oriented industrialization can boost productivity and employment at the same time and so lead to long-term economic development. This section also shows the key role that specialization and upscaling play in driving income convergence. The following section focuses on functional upgrading along GVCs and presents two case studies from India and the PRC on how firms in emerging economies can leverage the increasing modularization of manufacturing, especially in high-tech sectors, to rapidly catch up with industry leaders in output capabilities. The chapter concludes by drawing lessons from the evidence and findings presented.

1 GVC participation is approximated by the share of value added to gross exports that is used for further processing in cross-border production networks.

Knowledge Spillovers

An economy can benefit from its own R&D as well as the R&D efforts of its trade partners. When a domestic firm invests in R&D, new ideas, intermediate goods, methods to reduce costs, and final consumer products can be developed, allowing firms to become more efficient and profitable. Firms can also benefit from foreign R&D spillovers in embodied and disembodied form. Knowledge in embodied form is transferred through imports of goods and services that embody the skills, factors of production, and technologies used to produce them. Examples of disembodied knowledge transfers are blueprints, patents, and other intangibles and services.

It is harder for firms to draw on a foreign stock of knowledge than a domestic one because even when a technology is non-rival and codified for public use, part of it may be difficult to express or extract and thus harder to transfer. This is known as tacit knowledge, which is often gained from personal and practical experience and is essential for follow-on innovation. Tacit knowledge is often transferred through face-to-face communication, but effective communication between teams working in different locations from different countries and functional backgrounds is generally more challenging. Yet, access to foreign R&D is crucial because it can potentially expose domestic firms to the global frontier.

Evidence is now presented on the impact of GVC-mediated access to foreign R&D on productivity at the firm, industry, and economy levels. Particular focus is given to the relationship between foreign R&D and domestic innovative capabilities, because innovation plays a major role in boosting productivity at all levels of development, but not all productivity increases can be traced back to innovation. For example, the introduction of imported intermediate inputs may boost productivity not because importing countries acquired the knowledge embodied in these goods, but simply because these inputs have higher price-adjusted quality or they enhance the productivity of other factors of production—or both. Because MNCs and their foreign affiliates account for two-thirds of international trade and centrally govern the supply chain, thereby controlling access to distant knowledge and final markets globally, the effect of foreign direct investment by MNCs on the diffusion of knowledge is discussed.

Global Value Chain–Mediated Access to Foreign Research and Development and Productivity

It is well recognized in the economic literature that access to foreign R&D capital through trade increases productivity. The first study on this is based on pooled cross-country data for 22 high-income economies during 1971–1990 (Coe and Helpman 1995). A follow-up study constructing a dataset of 13 manufacturing industries in eight Organisation for Economic Co-operation and Development (OECD) countries during the same period estimated that foreign R&D accounts for roughly 20% of the total effect of R&D investment on productivity (Keller 2002). Nishioka and Ripoll (2012), in an influential study using input–output tables for 32 economies and 13 manufacturing industries for 1995, 2000, and 2005, find that intermediate imports are associated with significant productivity increases.

Imports of intermediate goods improve firm performance. Evidence based on a 1979–1986 census of manufacturing plants in Chile (Kasahara and Rodrigue 2008) and nationally representative panel data of manufacturing firms in Hungary from 1992 to 2003 (Halpern, Koren, and Szeidl 2015) show that importing intermediate goods improves firm performance. Similarly, evidence from a nationally representative survey of 4,000 manufacturing firms in Viet Nam from 2009 to 2012 shows that firms that sourced inputs from foreign affiliates had higher total factor productivity growth, even though they did not receive direct technology transfers (Newman et al. 2015).

The literature emphasizes the importance of absorptive capacity for domestic firms to fully benefit from foreign R&D. Absorptive capacity is the ability of firms to internalize external knowledge, and it is studied at the level of the economy, the firm, and key individuals or groups within a firm (e.g., R&D researchers or management).

Countries where the ease of doing business and the quality of tertiary education are high tend to benefit more from their own R&D efforts, international R&D spillovers, and human capital formation (Coe, Helpman, and Hoffmaister 2009). Strong intellectual property rights are also associated with higher levels of total factor productivity and returns to domestic R&D, and larger international R&D spillovers. Xu (2000), in a study of United States (US) MNCs as a channel of international technology diffusion in 40 countries from 1966 to 1994, finds that only developing economies reaching a minimum human capital threshold benefit from technology transfer provided by US MNCs. Foster-McGregor, Pöschl, and Stehrer (2016) find that foreign R&D spillovers are stronger in countries with greater absorptive capacity measured as average years of secondary schooling and R&D spending.

Global Value Chain–Mediated Access to Foreign Research and Development and Domestic Innovation

That foreign outsourcing firms have an incentive to transfer the know-how and technology to produce an outsourced input suggests that access to foreign R&D through GVC participation could potentially boost domestic innovation. But the high degree of fragmentation of production activities in GVCs implies cross-border applications of very specific areas of parent-company know-how—and parent companies take great care to reduce the dissemination of their know-how into local economies. This cross-border deployment of technology should therefore be thought of more as technology "lending" than technology transfer, meaning that if parent companies decide to relocate specific production tasks to different countries, producers in domestic economies may not be able to continue performing those tasks independently (Baldwin 2014). In that case, access to foreign R&D through GVC participation will not increase domestic innovative capabilities.

Piermartini and Rubínová (forthcoming) investigate whether foreign R&D expenditure affects domestic innovation through GVC linkages. They combine data on the number of patent applications filed under the Patent Cooperation Treaty by the residence of inventors with measures of GVC integration from the OECD's Trade in Value Added database and R&D expenditure from the OECD's Research and Development Statistics to construct a panel dataset of 25 economies and seven manufacturing industries, accounting for more than 90% of business R&D spending in manufacturing from 2003 to 2012. Figure 3.1 shows the three main variables in this analysis—domestic R&D expenditure, patent applications, and the foreign R&D pool—by economy. Panel a shows the distribution of R&D expenditure and patent applications is very concentrated: Germany, Japan, and the US are clearly the innovation hubs as they together account for 72.4% of total R&D expenditure and 72.1% of patent applications in the sample. Panel b shows the importance of the foreign R&D pool relative to domestic R&D spending.

Figure 3.1: Main Indicators of Innovative Activity by Economy

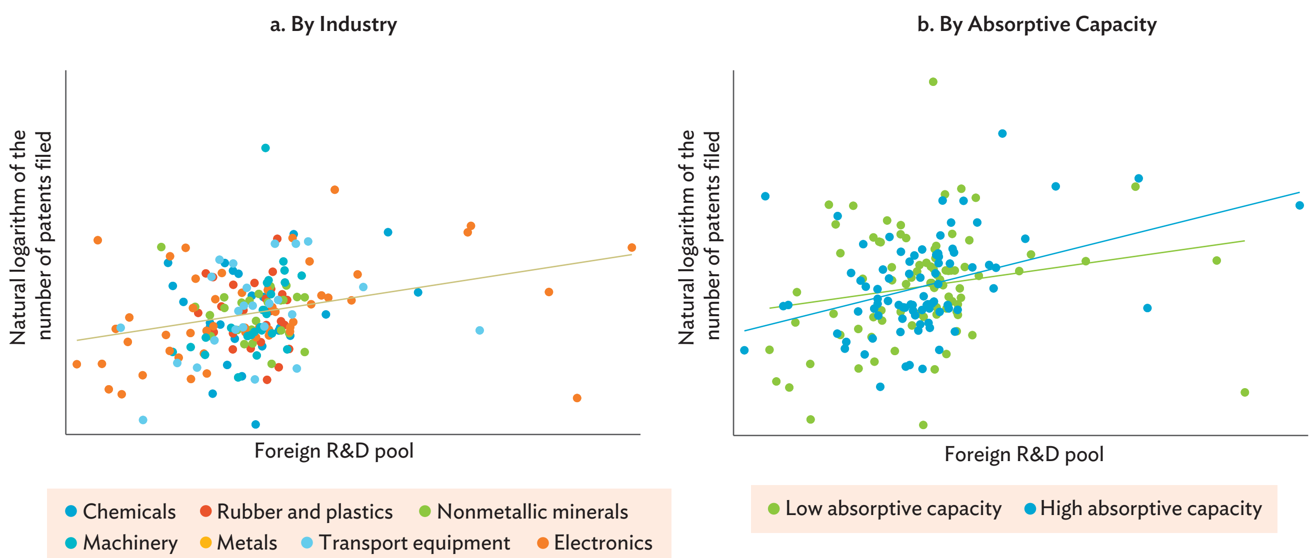
AUS = Australia, AUT = Austria, BEL = Belgium, CAN = Canada, CZE = Czech Republic, FIN = Finland, FRA = France, GER = Germany, HUN = Hungary, IRE = Ireland, ITA = Italy, JPN = Japan, KOR = Republic of Korea, MEX = Mexico, NET = Netherlands, POL = Poland, POR = Portugal, R&D = research and development, ROU = Romania, SPA = Spain, SVK = Slovakia, SVN = Slovenia, TAP = Taipei,China, TUR = Turkey, UKG = United Kingdom, USA = United States.

Source: Authors' adaptation of Roberta Piermartini and Stela Rubínová. Forthcoming. How Much Do Global Value Chains Boost Innovation? *Canadian Journal of Economics.*

The foreign R&D pool matters the most for economies that are highly integrated in the GVCs of the main innovators while having low domestic R&D spending themselves, such as Hungary, Mexico, and Slovakia. The foreign R&D pool as a share of own R&D is low for economies with low GVC participation, such as Romania and Turkey.

Figure 3.2 shows two key results from Piermartini and Rubínová (forthcoming) by using simplified cross-sectional correlations between the average number of patent applications from 2004 to 2012 and the foreign R&D pool in 2000, conditional on economy and industry fixed effects. Panel a shows that access to the foreign R&D pool mediated through GVC integration is positively associated with domestic innovation proxied by the number of patents filed under the Patent Cooperation Treaty. It shows the relationship is especially strong in GVC-intensive industries, such as electronics and transport equipment. In panel b, economy sectors are split into above- and below-median number of researchers per million inhabitants, which is a proxy for absorptive capacity. Consistent with the evidence on total factor productivity presented earlier, panel b shows that a higher absorptive capacity translates into a stronger relationship between the GVC-mediated foreign R&D pool and domestic innovation.

Figure 3.2: Relationship between Global Value Chain–Mediated Foreign Research and Development Pool and Domestic Innovation



R&D = research and development.
Notes: The horizontal axis is access to the foreign R&D pool mediated through global value chain integration; the vertical axis is the natural logarithm of the number of patents filed under the Patent Cooperation Treaty. The trend line is the simple correlation conditional on economy and industry fixed effects.
Source: Authors' adaptation of Roberta Piermartini and Stela Rubínová. Forthcoming. How Much Do Global Value Chains Boost Innovation? *Canadian Journal of Economics*.

Because Piermartini and Rubínová (forthcoming) is based on a sample of mostly OECD and emerging European economies, it does not say much about developing economies and their firms. De Marchi, Giuliani, and Rabellotti (2018) conduct a systematic review of the literature on GVCs in developing economies to investigate whether the linkages between firms in a GVC affect their innovation performance. They identify 50 cases for which information is codified on local innovation taking place and the sources of learning— that is, sources within GVCs or internal to firms or external sources from non-GVC actors. They find that GVC participation is used as a privileged source of knowledge and technologies by firms in developing economies only in a minority of cases. And even then, these firms invested in considerable capacity-building to be able to innovate. In most of the other observed cases, sources of learning within GVCs were exploited only as a complementary source to other channels of knowledge acquisition, the most effective being collective learning, imitation, and learning from non-GVC actors. De Marchi, Giuliani, and Rabellotti (2018) posit that GVC knowledge may be too narrow or specialized and that a certain degree of knowledge variety is needed to innovate, as this chapter shows in detail later.

Another of their findings is the lack of innovation found in about half of the observed cases. Here, local firms displayed poor skills and knowledge creation efforts, along with a lack of interest in both GVC-related and other kinds of knowledge sources. This, again, points to the importance of absorptive capacity at multiple levels—the firm, the cluster, and all the way to the economy itself—in conditioning the extent to which suppliers in developing economies are able to take advantage of GVC-related knowledge.

The Role of Foreign Direct Investment by Multinational Corporations

MNCs can generate knowledge transfers through three channels—through backward spillovers from multinational clients to their local suppliers of intermediate inputs, through forward spillovers from multinational suppliers of intermediate inputs to their local buyers (also known as reverse spillover), and through horizontal spillovers from their foreign affiliates to other domestic firms in the same sector.

MNCs have an incentive to share knowledge and technology, and to encourage the adoption of new practices to get more or better-quality inputs from suppliers, thereby generating backward spillovers. At the same time, MNCs want to prevent technology leakage and horizontal spillovers that would enhance the performance of their local competitors. This can be achieved by paying higher wages to prevent employee turnover, seeking strong intellectual property protection, trade secrecy, and locating in countries or industries where domestic firms have limited imitative capacity to begin with. Local firms sourcing from MNCs can, for their part, potentially learn from the higher quality and greater variety of inputs that they get access to from an MNC entering upstream industry, thus generating forward spillovers.

Empirical evidence supports this basic framework. Two meta-analyses, one based on data from 47 countries and the other from 45 countries (Havránek and Iršová 2011; Iršová and Havránek 2013), find robust evidence of backward spillovers, while forward spillovers are much smaller and horizontal spillovers tend to be nil on average. Even so, these meta-analyses suggest that positive horizontal spillovers exist when foreign firms form joint ventures with domestic firms and that all spillovers are stronger when investors have only a modest technology edge over local firms. Supporting the latter finding and the importance of absorptive capacity are studies based on data from large US firms showing positive spillovers from other technologically close firms and from the presence of foreign affiliates in the same industry (Bloom, Schankerman, and van Reenen 2013; Keller and Yeaple 2009).

MNCs also play an important role in the internationalization of R&D, connecting research teams from around the world and thus facilitating the flow of knowledge across borders. Branstetter, Li, and Veloso (2015), in an analysis of almost 4 million utility patents granted by the US Patent and Trademark Office from 1975 to 2010, identify 7,754 patents with at least one inventor residing in India at the time of invention and 12,419 patents with at least one inventor residing in the PRC.[2] Most of those patents were granted to local inventor teams working for foreign MNCs. A significant share of these patents also incorporated direct intellectual inputs from researchers outside India and the PRC. But spillovers from MNCs to local enterprises outside of MNCs were limited.

In sum, GVC-mediated access to foreign R&D increases total factor productivity and boosts innovation in advanced and emerging economies. Similarly, evidence shows that foreign affiliates of MNCs generate positive local spillovers, especially to their suppliers. Still, the positive effects are conditional on the absorptive capacity of local firms, which depends on human capital, own R&D investment, and broad institutional capabilities. The evidence from developing economies suggests that low absorptive capacity and large distance from the global technology frontier, in addition to the highly specialized nature of the knowledge flowing along a value chain, may prevent local firms from drawing on the knowledge and technology of lead GVC firms. MNCs also have the incentive to support their suppliers' innovation and upgrading in areas that are complementary to them, but to prevent innovation that could challenge their core competency. All in all, the evidence shows that globalization promotes the diffusion of knowledge and technology across borders, but further diffusion within borders—beyond the largest and often multinational firms—is not to be taken for granted.

Global Value Chain–Mediated Productivity Growth as a Driver of Long-Term Development

GVC participation can stimulate productivity growth through multiple channels, as discussed in the previous sections, but for economic development to occur, productivity convergence must be accompanied by sustained employment growth in modern sectors

[2] Inventors from Hong Kong, China and Taipei,China constitute a separate category and are not included in the 12,419 patents with at least one inventor residing in the PRC.

(i.e., manufacturing and, increasingly, services). It remains to be seen, however, whether GVC-oriented industrialization can deliver on that. The global megatrend of automation is increasing productivity, but at the same time reducing relative demand for unskilled labor, thus chipping away at the comparative advantage of developing economies in labor-intensive production (ADB 2018). GVCs have enabled economies to industrialize by specializing in specific production stages, rather than building a whole supply chain at home. That makes industrialization easier and faster, and initially boosts productivity and employment. Yet this kind of industrialization is also less meaningful because it may not induce economies to build the capabilities necessary for long-term development (Baldwin 2014). Finally, the strict product and quality standards that firms producing for global markets must comply with require more automation and reduce the ability of developing economies to substitute unskilled labor for other product inputs (Rodrik 2018).

Pahl and Timmer (2020) investigate the relationship between GVC participation and the long-term growth of employment and labor productivity in manufacturing value chains. They combine national input–output tables with the United Nations Industrial Development Organization's INDSTAT2 dataset of formal manufacturing employment and value added to build an unbalanced panel of 58 economies and 13 industries—a total of 754 combinations—over 1970–2008. Out of the 58, the World Bank classified 38 as developing in 1990, spread across Africa, Asia, Europe, Latin America, and the Middle East. The data are divided into three 10-year periods going backward from 2008, and one 9-year period from 1970 to 1978. They find two meaningful results: first, a strong positive association of GVC participation with labor productivity growth in the export chain, which becomes stronger the further an economy is from the productivity frontier. This is consistent with the abundant literature on the impact of trade on total factor productivity. The second result is no significant association of GVC participation with manufacturing employment growth, except for economies close to the productivity frontier, where the association is negative. These results lend support to the so-called mixed-blessing hypothesis, according to which firms that participate in GVCs might be successful at absorbing advanced technologies, but less so in employing labor.

Gentile and de Vries (2021) use a task-based GVC accounting approach to examine how the scale of participation, the productivity level of the activities performed, and the types of activities carried out along the value chain drive income convergence. The study focuses on developing Asia, a region that has been successful in increasing employment in labor-intensive production activities.[3] While Pahl and Timmer (2020) study GVC employment, Gentile and de Vries (2021) distinguish between production and knowledge jobs.

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3 Developing Asia refers collectively to the 47 ADB regional members (excluding Australia and New Zealand) listed at https://www.adb.org/who-we-are/about#members.

Gentile and de Vries (2021) use the Multiregional Input–Output Database of the Asian Development Bank (ADB) and labor force survey data for a sample of 15 developing Asian economies—representing over 90% of total employment in the region—and 29 OECD countries from 2000 to 2018. They focus on the tasks carried out in developing Asian economies for final manufactured products produced anywhere in the world.[4] In this context, "income" is not the classic gross domestic product, but rather the value added generated within an economy for the worldwide production of manufactured goods. This includes value added from nonmanufacturing activities, such as business services, transport, finance, and the production of raw materials. This is the concept of "manufactures GVC income" or simply GVC income, introduced by Timmer et al. (2013). This approach implies a broad definition of GVCs that includes domestic producers delivering value added to domestic final production. Because manufacturing products are internationally highly contestable, it is reasonable to expect that most final manufactured products, even if they are produced and sold domestically, involve some imported intermediate inputs. Furthermore, firms selling final manufacturing products compete in foreign as well as domestic markets.

Similarly, GVC jobs are defined as jobs related to activities that are directly and indirectly involved in the production of final manufactured goods. This is not the classic definition of manufacturing jobs, because it includes jobs in nonmanufacturing activities if they contribute to final manufacturing output. The outsourcing of business services that were previously done in-house creates the impression of shrinking manufacturing employment when it is simply a reallocation of tasks to domestic services firms. One of the main advantages of the concept of GVC jobs is that it "recovers" those outsourced jobs.

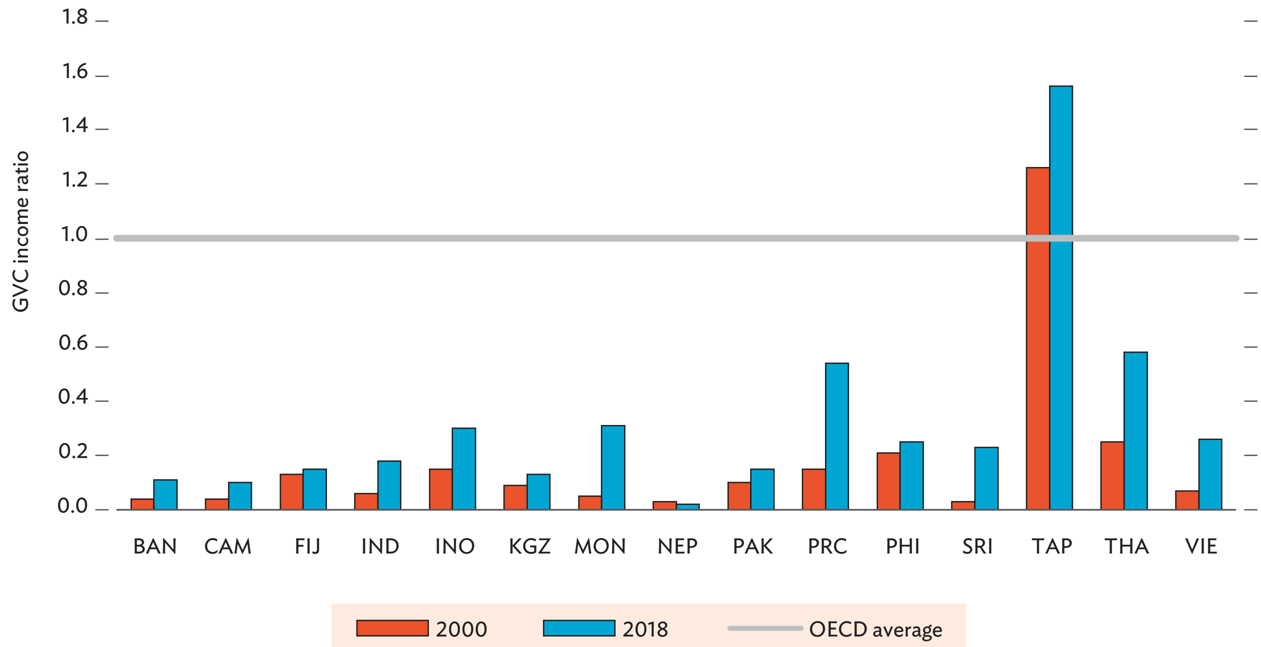
Figure 3.3 shows the GVC income ratio—that is, GVC income per capita for the sample of 15 developing Asian economies relative to the OECD comparison-group average in 2000 and 2018. In 2000, with the exception of Taipei,China, all economies had per capita GVC incomes that were less than 25% of the OECD's average. In 2018, the developing Asian economies increased their competitive position in manufacturing GVCs, and GVC income per capita in the region increased faster than the OECD average. All 15 managed to reduce the GVC income gap except Nepal. GVC income rose rapidly in several of the large economies. The PRC's GVC income ratio rose from 0.15 in 2000 to 0.54 in 2018, Thailand's from 0.25 to 0.58, and Viet Nam's from 0.07 to 0.26.

Figure 3.4 shows GVC income per capita for the aggregate of the 15 developing Asian economies relative to the OECD average from 2000 to 2018. The line markers represent the years for which input-output tables are available in ADB's Multiregional Input–Output Database. GVC income convergence appears faster before 2010, but it continues during the 2010s. Levels are affected by excluding the PRC, but trends are qualitatively similar. The average income ratio for the 15 rose from 12% in 2000 to 34% by 2018.[5] Although impressive, this is still only one-third the OECD average.

4 A similar analysis of services GVCs is not possible because input–output tables do not capture the cross-border flow of services in sufficient detail.

5 Excluding the PRC, it rose from 10% in 2000 to 22% by 2018.

Figure 3.3: Global Value Chain Income Ratio in 15 Developing Asian Economies Relative to the Organisation for Economic Co-operation and Development Average, 2000 and 2018



BAN = Bangladesh, CAM = Cambodia, FIJ = Fiji, GVC = global value chain, IND = India, INO = Indonesia, KGZ = Kyrgyz Republic, MON = Mongolia, NEP = Nepal, OECD = Organisation for Economic Co-operation and Development, PAK = Pakistan, PRC = People's Republic of China, PHI = Philippines, SRI = Sri Lanka, TAP = Taipei,China, THA = Thailand, VIE = Viet Nam.

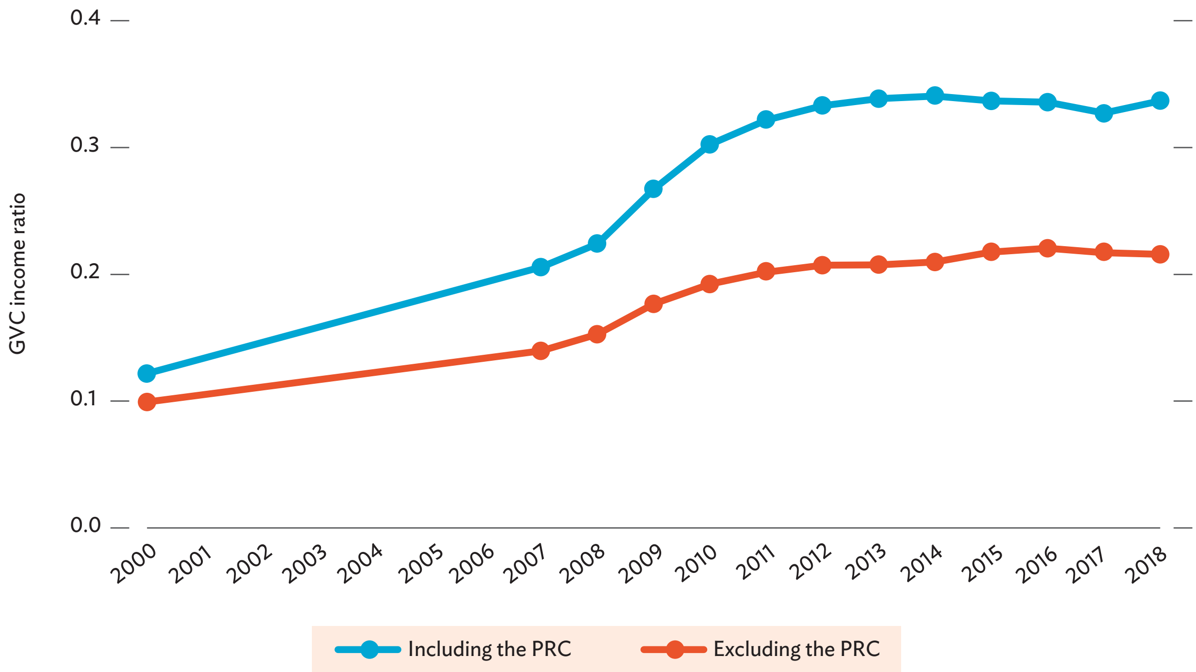
Notes:

1. GVC income ratio calculated as real GVC income in final manufacturing products, expressed per capita and at 2011 constant purchasing power parity relative to the (unweighted) average of 29 OECD countries.
2. The 29 OECD countries are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, Poland, Portugal, the Republic of Korea, Slovenia, Spain, Sweden, Turkey, the United Kingdom, and the United States.

Source: Elisabetta Gentile and Gaaitzen J. de Vries. 2021. Is Participation in Global Value Chains Driving Income Convergence in Developing Asia? A Task-Based Accounting Approach. Unpublished.

In the framework adopted by Gentile and de Vries (2021), an economy can increase GVC income through three main drivers. The first is an increase in the scale of activities carried out for GVCs of final manufactured products (i.e., the number of jobs involved in those activities). The second is increasing the productivity levels of those activities through either process upgrading (better organization of the production process or using improved technology) or product upgrading (improving quality or design or adding new features). The third is functional upgrading; this is the reallocation of jobs from low to high value-added activities within GVCs. The highest value creation generally occurs in more upstream processes (e.g., R&D and design) or more downstream processes (e.g., marketing) rather than in the middle (e.g., assembly) (Shih 1996). Most of this value added stems from intangibles, such as brands, basic R&D, design, and the digitalization of organizational processes, as discussed in Chapter 2.

Figure 3.4: Global Value Chain Income Ratio Aggregate in 15 Developing Asian Economies Relative to the Organisation for Economic Co-operation and Development Average, 2000–2018



GVC = global value chain, PRC = People's Republic of China.

Notes:

1. GVC income ratio calculated as real GVC income in final manufacturing products, expressed per capita and at 2011 constant purchasing power parity for the aggregate of the 15 developing Asian economies relative to the (unweighted) average of Organisation for Economic Co-operation and Development (OECD) countries.
2. The 15 are Bangladesh, Cambodia, Fiji, India, Indonesia, the Kyrgyz Republic, Mongolia, Nepal, Pakistan, the People's Republic of China, the Philippines, Sri Lanka, Taipei,China, Thailand, and Viet Nam. The 29 OECD countries are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, Poland, Portugal, the Republic of Korea, Slovenia, Spain, Sweden, Turkey, the United Kingdom, and the United States.
3. Line markers represent the years where input–output tables are available in the Asian Development Bank's Multiregional Input–Output Database.

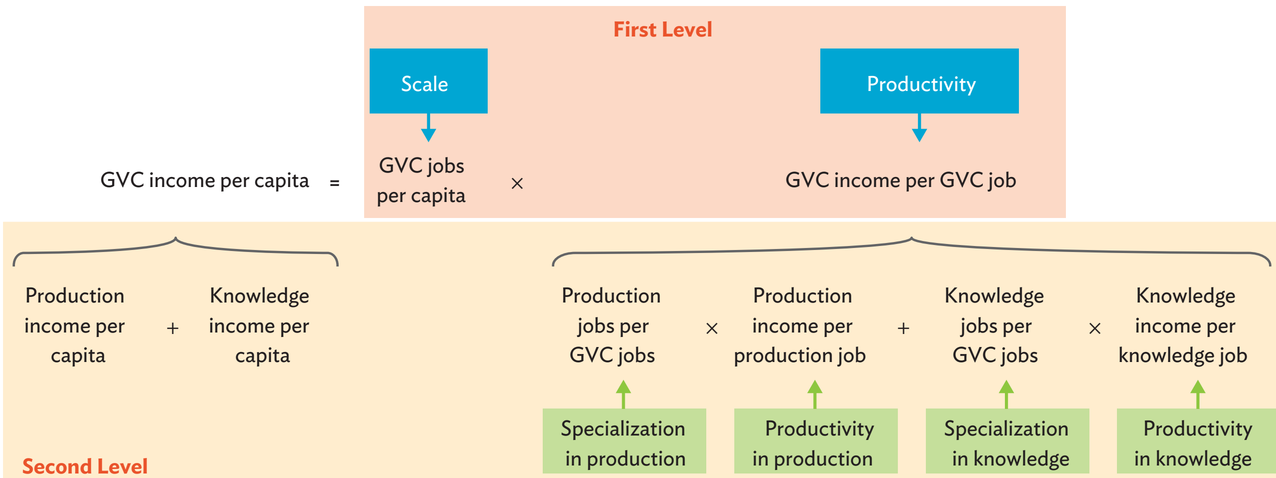
Source: Elisabetta Gentile and Gaaitzen J. de Vries. 2021. Is Participation in Global Value Chains Driving Income Convergence in Developing Asia? A Task-Based Accounting Approach. Unpublished.

GVC income per capita can be disaggregated at two levels (Figure 3.5). In the first, GVC income per capita is expressed as the product of scale (GVC jobs per capita) and productivity (GVC income per GVC job). An increase in scale means that a rising share of the population is involved in GVCs; an increase in GVC income per GVC jobs means that workers performing those jobs are getting more productive.

The second level of disaggregation sheds light on functional upgrading (Figure 3.5). Activities along a GVC are broken down into two categories: production activities, which are all the activities in the physical transformation process, such as assembly and parts and components manufacturing; and knowledge-intensive activities, which are all the activities involved in pre- and postproduction processes, such as R&D, design, marketing, and after-sales services. Because knowledge-intensive activities capture most of the value added embedded in final output, and a shift toward knowledge-intensive activities is an indication of functional upgrading, GVC income per capita can be disaggregated into the sum of production income per capita and knowledge income per capita.

Productivity can be disaggregated into the weighted sum of production income per production job (productivity in production) and knowledge income per knowledge job (productivity in knowledge). The weights are the share of production jobs to total GVC jobs (specialization in production) and the share of knowledge jobs to total GVC jobs (specialization in knowledge). An increase in the share of knowledge jobs to total GVC jobs is an indication that the economy is specializing in knowledge-intensive activities. Similarly, an increase in the share of production jobs to total GVC jobs would be an indication that the economy is specializing in production activities.

Figure 3.5: Disaggregating Global Value Chain Income per Capita

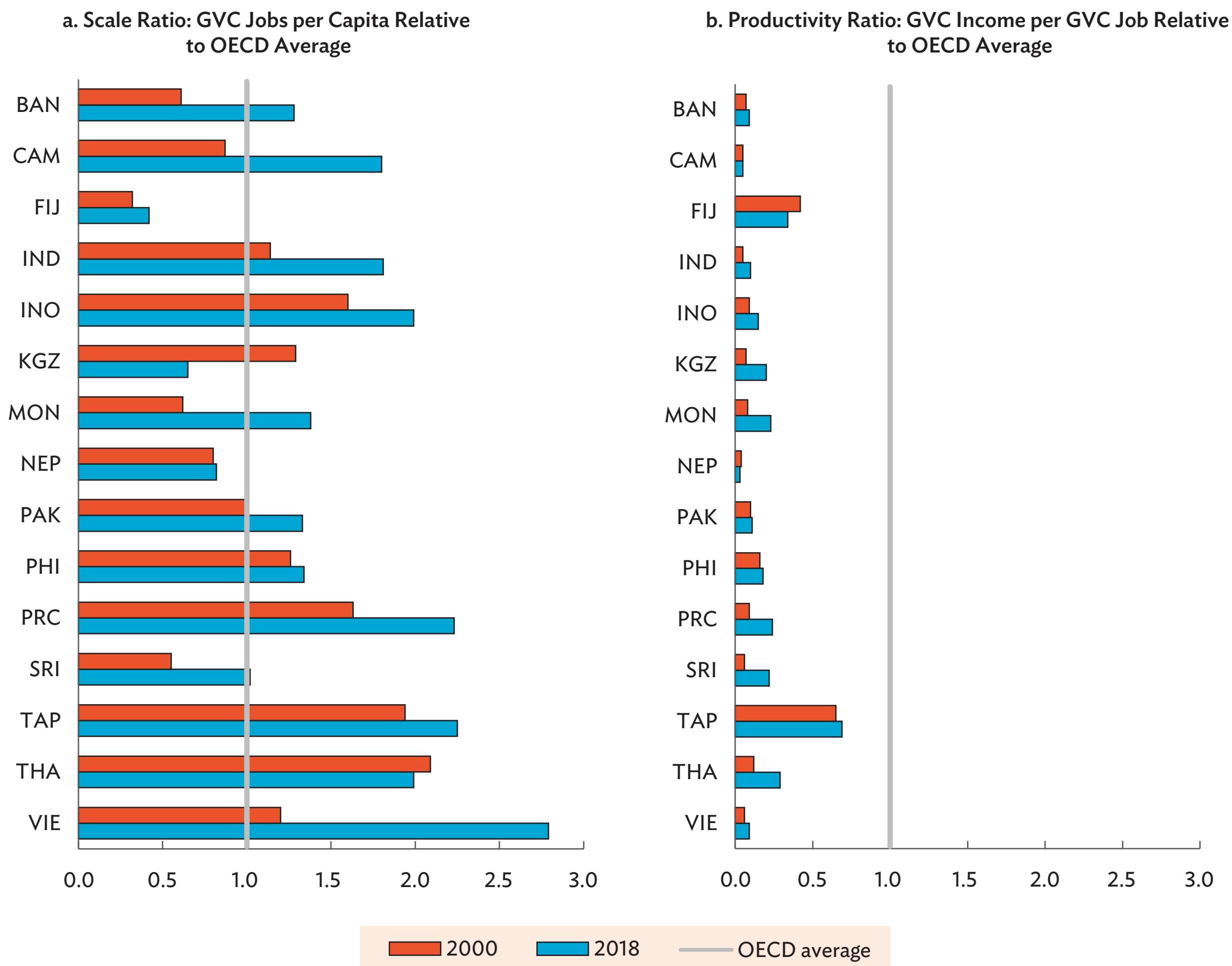


Source: Authors based on Elisabetta Gentile and Gaaitzen J. de Vries. 2021. Is Participation in Global Value Chains Driving Income Convergence in Developing Asia? A Task-Based Accounting Approach. Unpublished.

Figure 3.6 shows the results of the first-level disaggregation, where scale and productivity are divided by the OECD average. Panel a shows that in 2000, nine out of the 15 developing Asian economies had a scale ratio above 1, implying they had more GVC jobs per capita than the OECD average. That increased to 12 in 2018—and the ratio for India, Indonesia, the PRC, Taipei,China, and Thailand was above 2, which highlights the active involvement of workers from Asia in manufacturing GVCs. The scale ratio for the aggregate of the 15 economies was 1.34 in 2000 and 2.10 in 2018. This suggests the GVC income gap between developing Asia and the OECD is not due to the overall scale of their involvement in GVCs.[6] Panel b shows the gap in GVC income between developing Asia and the OECD shown in Figure 3.4 is mainly accounted for by differences in productivity. In 2000, developing Asia's productivity ratio was about 9% of the OECD's average. Although productivity has increased rapidly since then, it started from a low level, such that it was still at only 16% of the OECD average in 2018.

6 Structural transformation in OECD countries has been such that the output and employment share of services activities not related to manufactured products increased. This affects the observed changes in the ratios.

Figure 3.6: First-Level Disaggregation of Global Value Chain Income per Capita in 15 Developing Asian Economies, 2000 and 2018



BAN = Bangladesh, CAM = Cambodia, FIJ = Fiji, GVC = global value chain, IND = India, INO = Indonesia, KGZ = Kyrgyz Republic, MON = Mongolia, NEP = Nepal, OECD = Organisation for Economic Co-operation and Development, PAK = Pakistan, PRC = People's Republic of China, PHI = Philippines, SRI = Sri Lanka, TAP = Taipei,China, THA = Thailand, VIE = Viet Nam.

Notes:

1. In panel a, the scale ratio is calculated as GVC jobs in final manufacturing products per capita relative to the OECD average. In panel b, the productivity ratio is calculated as real GVC income in final manufacturing products, expressed at 2011 constant purchasing power parity and divided by GVC jobs in final manufacturing products, relative to the (unweighted) average of 29 OECD countries.
2. The 29 OECD countries are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, Poland, Portugal, the Republic of Korea, Slovenia, Spain, Sweden, Turkey, the United Kingdom, and the United States.

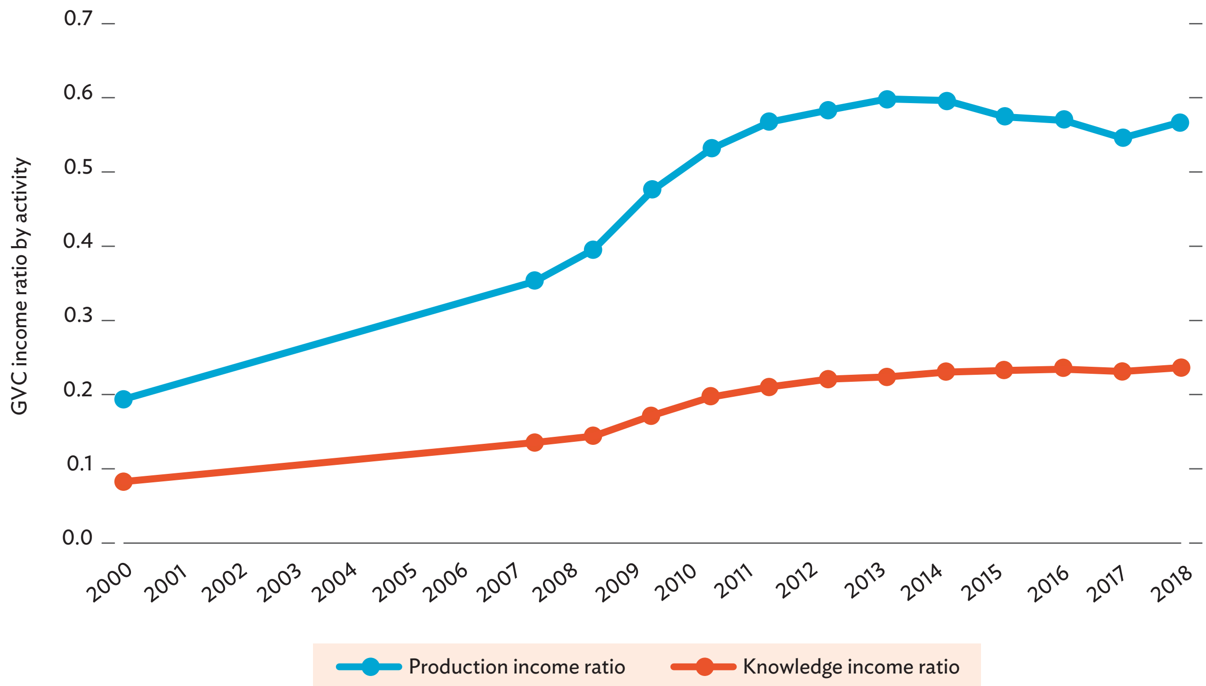
Source: Elisabetta Gentile and Gaaitzen J. de Vries. 2021. Is Participation in Global Value Chains Driving Income Convergence in Developing Asia? A Task-Based Accounting Approach. Unpublished.

Figure 3.7 shows the further disaggregation of the GVC income ratio in Figure 3.4 into the knowledge income ratio, defined as GVC income per capita accruing from knowledge-intensive activities relative to the OECD average, and production income ratio, similarly defined but for production activities. The figure shows a clear difference in convergence rates between production and knowledge-intensive activities. Here, developing Asia has been catching up much faster in production.[7] In 2018, GVC income from production activities was 57% of the OECD average and 24% for

[7] This pattern is qualitatively similar if the PRC is excluded.

knowledge-intensive activities. This indicates a convergence in income from knowledge-intensive activities, but from low levels such that there was still a major gap in 2018.

Figure 3.7: Global Value Chain Income Ratio Aggregate by Activity in 15 Developing Asian Economies Relative to the Organisation for Economic Co-operation and Development Average, 2000–2018



GVC = global value chain, OECD = Organisation for Economic Co-operation and Development.

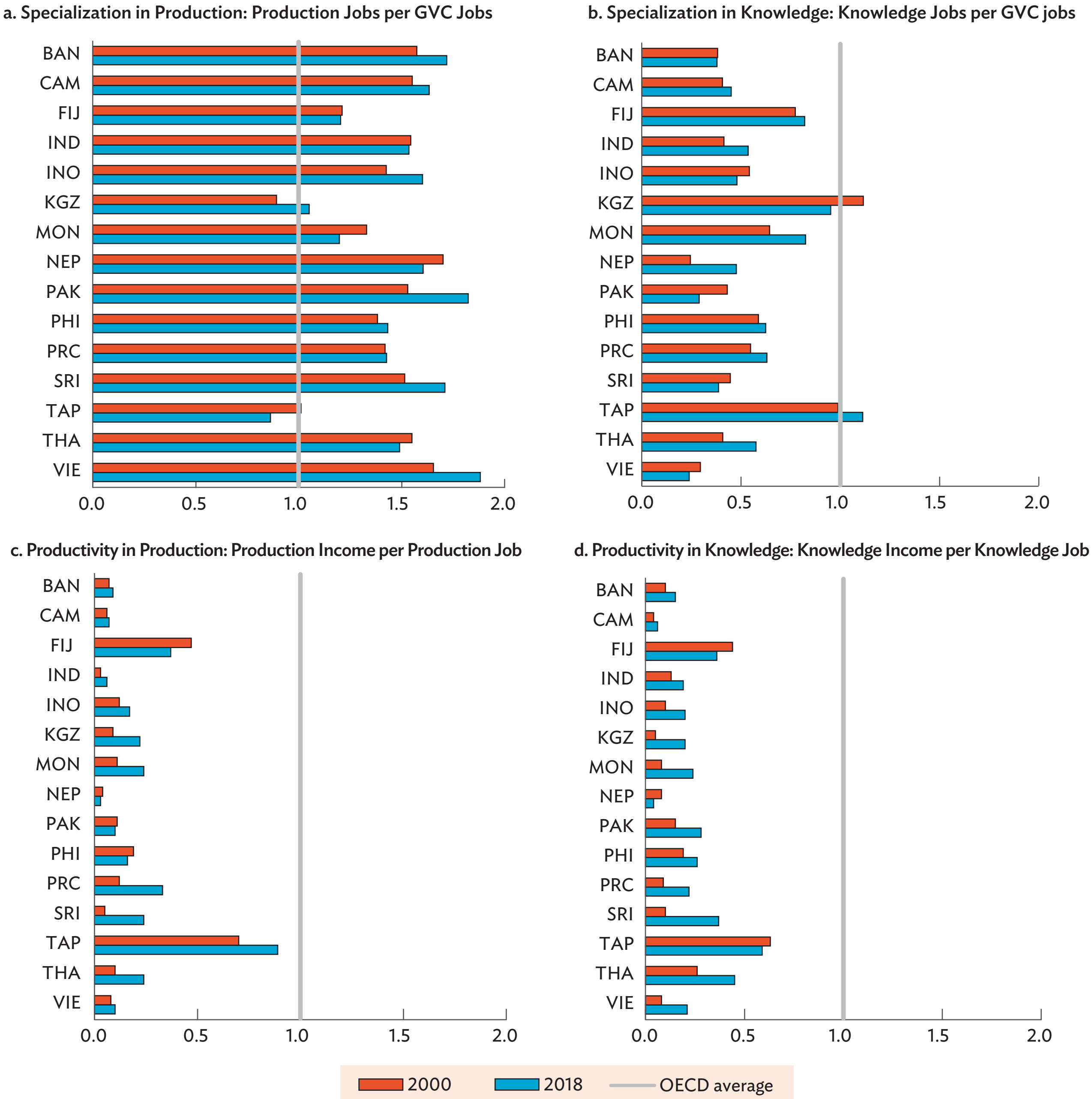
Notes:

1. GVC income ratio calculated as real GVC income in final manufacturing products, expressed per capita and at 2011 constant purchasing power parity for the aggregate of 15 developing Asian economies and disaggregated into the sum of production income per capita and knowledge income per capita relative to the (unweighted) average 29 of OECD countries.
2. The 15 are Bangladesh, Cambodia, Fiji, India, Indonesia, the Kyrgyz Republic, Mongolia, Nepal, Pakistan, the People's Republic of China, the Philippines, Sri Lanka, Taipei,China, Thailand, and Viet Nam. The 29 OECD countries are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, Poland, Portugal, the Republic of Korea, Slovenia, Spain, Sweden, Turkey, the United Kingdom, and the United States.
3. Line markers represent the years where input–output tables are available in the Asian Development Bank's Multiregional Input–output Database.

Source: Elisabetta Gentile and Gaaitzen J. de Vries. 2021. Is Participation in Global Value Chains Driving Income Convergence in Developing Asia? A Task-Based Accounting Approach. Unpublished.

Figure 3.8 presents the results of the second-level disaggregation of the productivity ratio shown in Figure 3.5 into the specialization-in-production ratio, the productivity in production ratio, the specialization-in-knowledge ratio, and the productivity in knowledge ratio. Panel a clearly shows that GVC income convergence was mainly driven by an expansion of GVC jobs in production, whereas the share of knowledge-intensive jobs is roughly 50% of the OECD average, with the exception of Fiji and Taipei,China. These reflect a global division of labor whereby more knowledge-intensive jobs are in advanced economies and more production jobs are in developing Asia. Yet knowledge-intensive jobs increased in developing Asia from 2000 to 2018. Panels c and d show that most developing Asian economies in the sample increased productivity in both production and knowledge-intensive activities from 2000 to 2018.

Figure 3.8: Second-Level Disaggregation of Productivity in 15 Developing Asian Economies, 2000 and 2018



BAN = Bangladesh, CAM = Cambodia, FIJ = Fiji, GVC = global value chain IND = India, INO = Indonesia, KGZ = Kyrgyz Republic, MON = Mongolia, NEP = Nepal, PAK = Pakistan, OECD = Organisation for Economic Co-operation and Development, PRC = People's Republic of China, PHI = Philippines, SRI = Sri Lanka, TAP = Taipei,China, THA = Thailand, VIE = Viet Nam.

Notes:

1. In panels a and b, the specialization in production (knowledge) ratio is calculated as GVC jobs in production (knowledge-intensive) activities in final manufacturing products divided by total GVC jobs, relative to the (unweighted) average of 29 OECD countries. In panels c and d, the productivity in production (knowledge) ratio by activity is calculated as real GVC income of production (knowledge-intensive) activities in final manufacturing products, expressed at 2011 constant purchasing power parity and divided by GVC jobs in production (knowledge-intensive) activities, relative to the (unweighted) average of 29 OECD countries.
2. The 29 OECD economies are Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, Poland, Portugal, the Republic of Korea, Slovenia, Spain, Sweden, Turkey, the United Kingdom, and the United States.

Source: Elisabetta Gentile and Gaaitzen J. de Vries. 2021. Is Participation in Global Value Chains Driving Income Convergence in Developing Asia? A Task-Based Accounting Approach. Unpublished.

However, all but Fiji, the PRC, and Taipei,China were below 25% of the OECD's average level of productivity for production activities, and productivity in knowledge is not much different. These findings suggest that the increased involvement of Asian workers in manufacturing GVCs, particularly in production activities, is driving income convergence in developing Asia. Productivity has increased, but this is from a low starting point. Thus, the region still has a long way to go before its productivity convergence is complete.

In sum, while exporting through GVCs is often seen as a panacea for weak industrialization trends in developing economies, the reality is more complex. Productivity growth is not necessarily associated with employment growth in developing economies, and the association even turns negative as economies get closer to the productivity frontier in manufacturing, possibly due to the labor-substituting effect of automation. Even in developing Asia, which has seen a massive increase in the scale of production activities, productivity convergence and functional upgrading have been slow and far from guaranteed, as shown by the diversity of outcomes across the 15 economies examined by Gentile and de Vries (2021). That study, however, also shows the importance of upscaling in driving income convergence and that the volume of the activity matters just as much as the domestic share of the value of the product in driving income convergence.

Upgrading and Innovation along Global Value Chains

Firms from developing economies typically face two challenges when entering international markets, particularly newly emerged high-tech markets: a technology gap and a marketing gap. The technology gap—difficulty in accessing needed technologies—is associated with weak technology and innovation capabilities. The marketing gap is the high barriers to entry into increasingly concentrated global markets, such as heavy information costs and investments to establish a brand (Schmitz 2007).

The modularization of manufacturing—the building of complex products from smaller subsystems that can be designed independently yet function together as a whole—has reduced the production complexity of high-tech products. This is because potential market entrants can source core technologies from international suppliers (or acquire the firms that own those technologies) and concentrate on noncore technology activities, such as assembly and brand development. In other words, the international division of labor along GVCs has solved the technological bottlenecks of manufacturing sophisticated products (Xing 2021a).

Two case studies are now presented on emerging economy MNCs that have caught up with and eroded the market share of established MNCs based in advanced economies. In both cases, the new market entrants overcame the technology gap by taking advantage of modularity in manufacturing, albeit by pursuing two different strategies. They also overcame the marketing gap by using their knowledge of their domestic markets to create a competitive advantage and then gradually growing their presence in foreign markets.

It is worth noting that catching up in output capabilities means acquiring the technologies and skills relating directly to a product or service; this does not necessarily include the ability to enhance or develop that product (Awate, Larsen, and Mudambi 2012). The process, however, still involves new-to-the-country and new-to-the-firm innovation. The two case studies also emphasize the importance of marketing innovation in product design, packaging, placement, promotion, and pricing, as well as organizational innovation to be able to compete globally. In other words, the ability to develop the next-generation product is not the only way for a firm to be innovative.

Acquiring Technology through Outward Foreign Direct Investment in India's Wind Turbine Industry

Suzlon Energy Ltd., an Indian wind turbine manufacturer, entered the industry in 1995 as a start-up. Within 12 years, Suzlon had caught up with the industry technology frontier in its output capability. The combined worldwide market share of Suzlon and its subsidiaries was about 10% in 2009, making it the world's third largest wind turbine manufacturer.[8]

Suzlon's trajectory is a classic example of a successful springboard strategy in which emerging economy MNCs overcome their latecomer disadvantage in the global stage by aggressively acquiring strategic assets from mature MNCs to fortify capabilities and better compete against larger global players (Luo and Tung 2007). The process begins with an "inward internationalization" stage in which local firms acquire basic skills and capabilities from foreign firms. This stage is followed by outward foreign direct investment aimed at improving output capabilities. The newly acquired assets and knowledge are then transferred back to the home market and used to improve and upgrade these capabilities. The reinvigorated home base and strengthened capabilities are then used to compete globally (Luo and Tung 2018).

Table 3.1 summarizes Suzlon's springboard strategy in the early years. The sales agreement followed by a licensing agreement with German company Südwind Energy GmbH represents the inward internationalization stage. By combining operational knowledge of foreign technologies with knowledge of its domestic market, Suzlon deployed a strategy of selling locally manufactured turbines of technological sophistication comparable to its competitors at considerably lower prices—and became the clear leader in India's wind energy market in just 4 years.

8 The case study is drawn from Awate, Larsen, Mudambi (2012, 2015).

It is interesting to note how Suzlon pursued expertise in each of the core technological modules that a wind turbine is made of from different firms (Figure 3.9). This was possible because under a modular production system, the product can be broken down into functional modules according to given design rules that define the function of each module; how the modules interact, connect, and communicate with each other; and the standards for testing the performance of each module and its compliance with the design rules (Baldwin and Clark 1997, 2000). Producers can mix and match different modules to produce final products catering to diverse consumer preferences by following the design rules, and the decomposability of the production process is thus greatly enhanced.

Table 3.1: Suzlon Energy's Early Knowledge Acquisition Strategy to Become a Wind Turbine Leader

Year	Action	Objective
1995	Sales contract with German company Südwind Energiesysteme	To handle low-tech sales activities for Südwind in India and gain valuable industry experience
1996	Licensing agreement with Südwind	To gather the engineering and manufacturing expertise in wind turbine technology
2001	Acquisition of Dutch company AE-Rotor Techniek	To acquire specialized knowledge in the design and manufacture of rotor blades
2001	Licensing agreement with Dutch company Aerpac	To acquire expert knowledge in rotor blade design
2001	Acquisition of manufacturing and marketing rights from Enron Wind Rotor Production, the Dutch subsidiary of United States company Enron Wind	To acquire the molds, production line, and technical support and assistance for rotor blade manufacturing
2002	Acquisition of German company 215 Verwaltungs	To establish an research and development unit in Germany
2004	Joint venture with Austrian company Elin Motoren	To manufacture wind turbine generators in India
2006	Acquisition of Belgian company Hansen Transmission International	To acquire sophisticated technology for gearboxes and drive trains for wind turbines
2007	Acquisition of German company REpower Systems	To broaden the product portfolio to include the largest offshore wind turbines

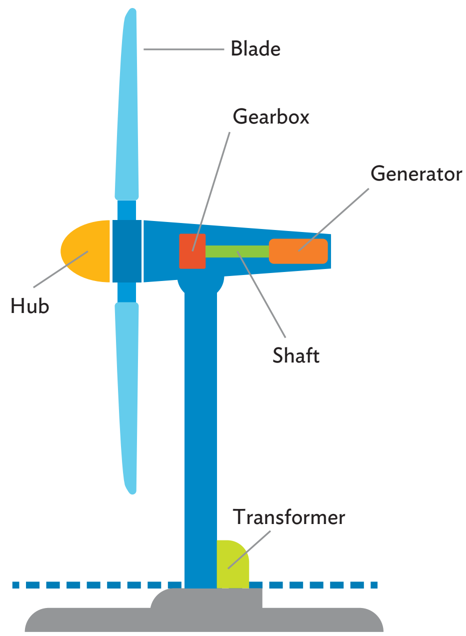
Sources: Authors' adaptation of Snehal Awate, Marcus M. Larsen, and Ram Mudambi. 2012. EMNE Catch-Up Strategies in the Wind Turbine Industry: Is There a Trade-Off between Output and Innovation Capabilities? *Global Strategy Journal*. 2 (3). pp. 205–223; Snehal Awate, Marcus M. Larsen, and Ram Mudambi. 2015. Accessing vs Sourcing Knowledge: A Comparative Study of R&D Internationalization between Emerging and Advanced Economy Firms. *Journal of International Business Studies*. 46 (1). pp. 63–86.

Next, is the outward foreign direct investment stage that corresponds to the technical agreements and acquisitions in 2001 and 2002. These early acquisitions were still output oriented—that is, they were aimed at getting skilled workers and the technologies required to catch up in output capabilities. Suzlon then targeted for acquisition firms that possessed significant R&D knowledge in different technologies and were active innovators. The joint venture with Elin Motoren GmbH in 2004 and the acquisitions of Hansen Transmission International AV in 2006 and REpower Systems AG in 2007 were aimed at building a knowledge portfolio in key technology areas.

In 2005, Suzlon started setting up R&D units in Europe, mainly in Denmark and Germany. As of 2015, the higher end of Suzlon's R&D knowledge still resided in its foreign subsidiaries, whereas the Indian operations had not generated a single patent.

To determine whether Suzlon's rapid output catch-up also facilitated catch-up in innovation capabilities, Suzlon's knowledge base is compared with the knowledge base of industry leader Vestas Wind Systems A/S, representing the technology frontier. Vestas is a Danish company that began manufacturing wind turbines in 1979 and was industry leader by 2009. Being the industry's pioneer, Vestas pursued a strategy of global in-house R&D, actively searching for new knowledge and competences.

Figure 3.9 Main Parts of a Wind Turbine



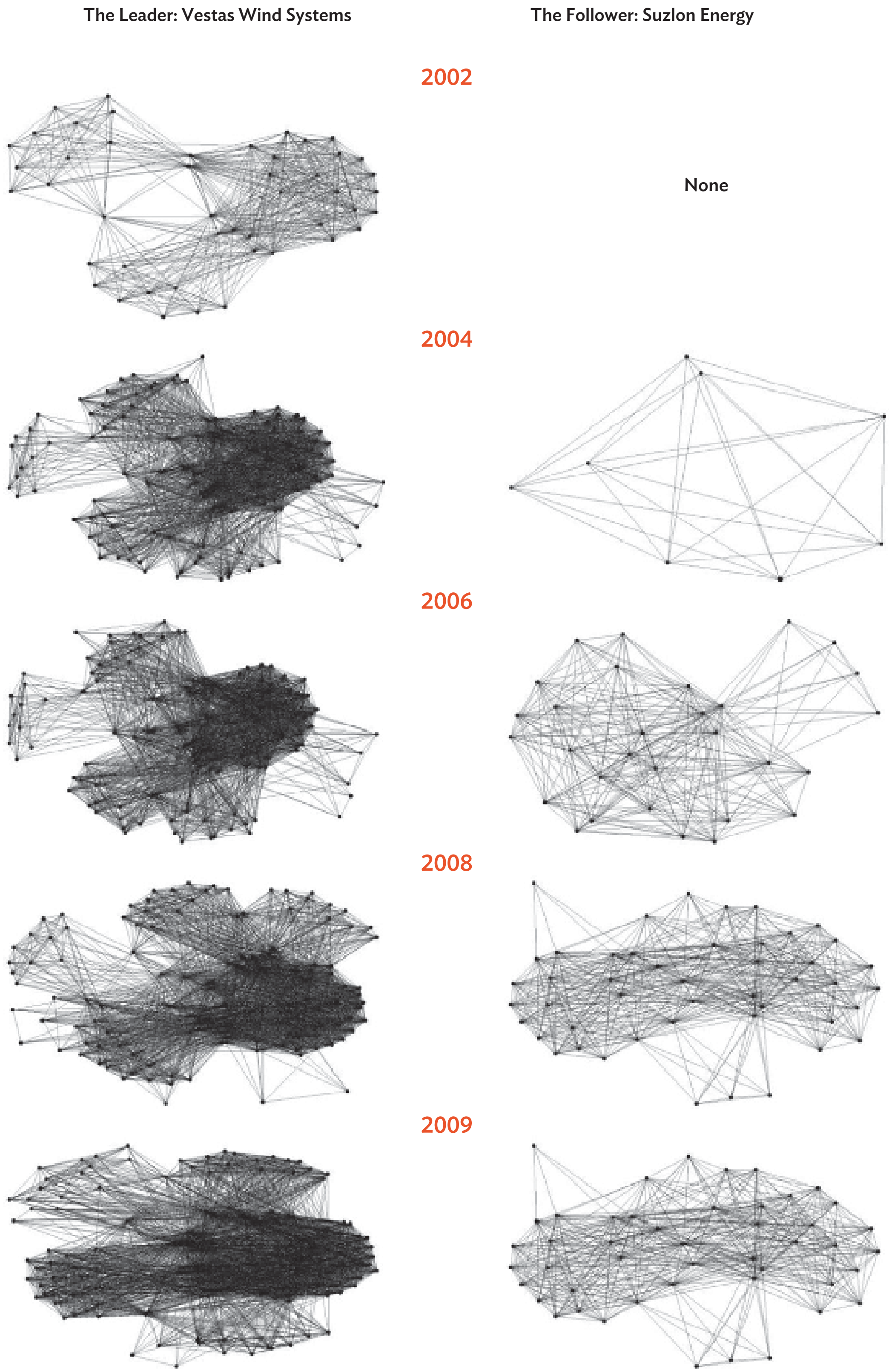
Source: Authors.

Figure 3.10 is a visual representation of the two firms' knowledge bases measured as the yearly networks of technology classes of backward-cited patents.[9] The knowledge bases are depicted as networks of technological domains from where each firm draws its knowledge. These are the technological classifications defined by the US Patent and Trademarks Office that appear in each firm's patent citations. The nodes in the network represent the various classes of technologies, and the links or connections between these classes show that each firm combined them to generate their patented innovations.

As the figure shows, industry leader Vestas's technology network got larger (more nodes) and denser (more connections among nodes) from 2000 to 2009, implying that the company draws knowledge from a larger number of technological domains. The dense networks also show that Vestas's deep technological knowledge enables the company to understand in what ways the different technologies are interrelated and to combine them in useful ways. Thus, Vestas's knowledge base is both deep and broad.

9 Backward citations reference work that is considered relevant to a current patent application, and they are a primary component of proving inventiveness in new patent applications. How many patents are cited and from which categories is a proxy for how deep a firm's knowledge base is.

Figure 3.10: Evolution of the Source Networks of Vestas and Suzlon



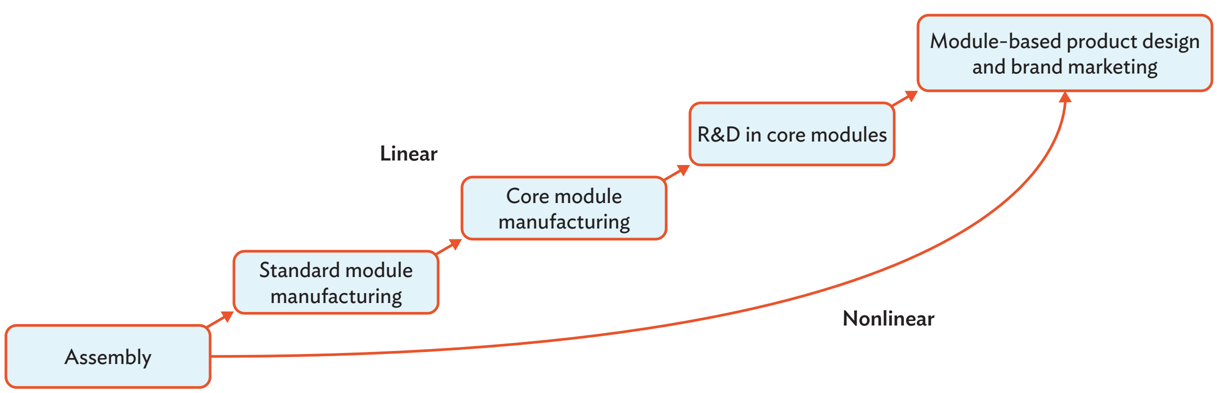
Source: Snehal Awate, Marcus M. Larsen, and Ram Mudambi. 2012. EMNE Catch-Up Strategies in the Wind Turbine Industry: Is There a Trade-Off between Output and Innovation Capabilities? *Global Strategy Journal*. 2 (3). pp. 205–223.

The figure clearly shows the effect of Suzlon's springboard strategy on its knowledge base. Its technology network barely had any nodes and links before its acquisition sprees in 2001–2002 and 2006–2007. But with every acquisition, Suzlon's knowledge base got larger, albeit much smaller and thinner than Vestas's. The drawback of such a knowledge base is evident in Suzlon's insignificant patent output. In other words, the springboard strategy certainly helped Suzlon to catch up in output capabilities. But the lesson here is that simply buying knowledge may not help generate new knowledge, an area in which firms in several emerging economies struggle.

Nonlinear Upgrading and the Rise of Local Smartphone Brands in the People's Republic of China

Firms can upgrade along GVCs by following two dynamic paths: linear and nonlinear (Figure 3.11). Upgrading along value chains step by step from low to high value-added tasks is a linear upgrading path. For instance, a firm starts with assembling mobile phones, then manufactures increasingly complex mobile phone components, and eventually produces its own brand of mobile phones. A nonlinear path is sourcing core technologies and jumping directly to brand building (Xing 2021b).

Figure 3.11: Linear and Nonlinear Upgrading Paths along Global Value Chains



R&D = research and development.
Source: Authors.

The unprecedented success of the PRC's smartphone industry is a classic case of nonlinear upgrading along GVCs. In the global smartphone market, homegrown PRC brands Huawei Technologies Co. Ltd., OPPO Co. Ltd., and Xiaomi Corp. are now three of the top five global smartphone brands.[10] PRC smartphone makers entered the industry by sourcing core technological components from foreign MNCs because they had limited technological capabilities themselves in core components. Because of

10 Counterpoint. Global Smartphone Market Share: By Quarter. https://www.counterpointresearch.com/global-smartphone-share/ (accessed on 23 August 2021).

this, they also focused on incremental innovations, marketing, and brand building. By taking advantage of the modularization of smartphone production and standard mobile platforms, the three firms successfully broke the monopoly of foreign rivals in domestic and international markets.

To show the dependence of PRC smartphones on foreign technology platforms, Table 3.2 lists the operating systems and core components used by the Huawei P30 Pro, OPPO R11s, and Xiaomi Mi MIX 2 smartphones, all of which were launched after 2018. All three models run on the Android operating system. All core components used in the OPPO R11s and Xiaomi MIX2 are sourced from companies in Japan, the Republic of Korea, and the US. It is those core components that determine the technological functions of the OPPO R11s and Xiaomi MIX2 and power them to compete with the smartphones of Apple Inc. and Samsung Electronics Co. Ltd. The foreign value added accounts for 84.5% of the manufacturing cost of the Xiaomi Mi MIX2 and 83.3% of the OPPO R11s (Xing and Huang 2021).

Table 3.2 Dependence of Huawei, OPPO, and Xiaomi Smartphones on Foreign Technology

Core component	Huawei P30 Pro	OPPO R11s	Xiaomi Mi MIX 2
Operating system	Android (USA)	Android (USA)	Android (USA)
CPU	HiSilicon (PRC)	Qualcomm (USA)	Qualcomm (USA)
Flash memory	Samsung (KOR)	Samsung (KOR)	Hynix (KOR)
DRAM	Micron Technology (USA)	Samsung (KOR)	Samsung (KOR)
Display	BOE Technology (PRC)	Samsung (KOR)	JDI (JPN)

CPU = central processing unit, DRAM = dynamic random-access memory, JPN = Japan, KOR = Republic of Korea, PRC = People's Republic of China, USA = United States.
Source: Yuqing Xing. 2021. Decoding China's Export Miracle: A Global Value Chain Analysis. Singapore: World Scientific.

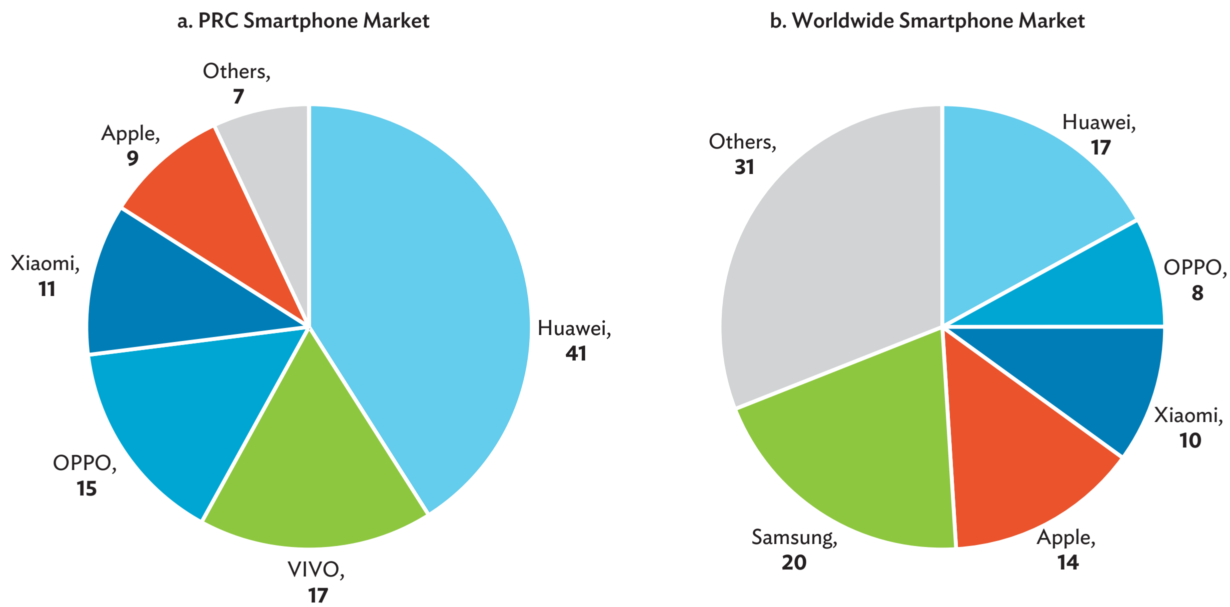
Huawei is regarded as the most innovative PRC company. In 2018, it invested $15.3 billion in R&D, outspending Apple (Bloomberg 2019). But besides the operating system, the Huawei P30 Pro uses dynamic random-access memory from US firm Micro Technology Co. Ltd. and flash memory from Samsung. In all, foreign parts and components account for 61.9% of the manufacturing cost of the Huawei P30 Pro.

Using foreign technology modules and platforms takes much less time and investment than developing core technology, such as chipsets and operating systems. The huge PRC market is conducive to marketing-focused strategies drawing on borrowed technology. By concentrating on marketing and product differentiation, PRC smartphone makers have capitalized on their advantage in understanding the preferences of Chinese consumers. Take OPPO: by positioning its product as the smartphone with the best camera capabilities in its marketing, the company successfully differentiated itself from its rivals.

The nonlinear upgrading strategy has been highly successful. PRC smartphone makers have reversed the dominance of foreign brands completely in the domestic market.

Panel a in Figure 3.12 shows that, in the first quarter of 2020, PRC brands accounted for more than 90% of the PRC's smartphone market, up from 10.4% in 2000 (Imai and Shiu 2007). The top four brands in terms of shipments—Huawei, OPPO, Vivo Mobile Communications Co. Ltd., and Xiaomi—are all local brands, accounting for 84% of the market.[11] Apple has a modest 9% market share in the PRC, while Samsung, the world's largest mobile phone maker, has almost disappeared from the PRC market.

Figure 3.12: Share of Smartphone Market by Brand, Q1 2020
(%)



Sources: Panel a: Counterpoint. China Smartphone Market Share: By Quarter. https://www.counterpointresearch.com/china-smartphone-share/; panel b: Counterpoint. Global Smartphone Market Share: By Quarter. https://www.counterpointresearch.com/global-smartphone-share/ (both accessed 23 August 2021).

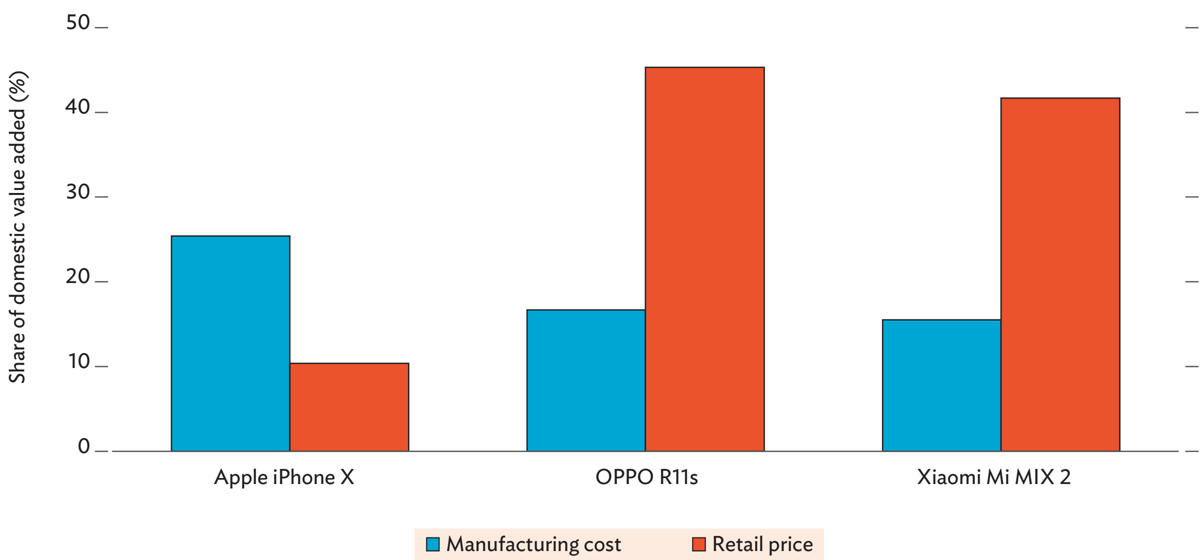
PRC original brand manufacturers, riding on their domestic success, began selling smartphones globally. Their presence and market shares in geographically dispersed foreign markets have grown, particularly in emerging markets, where affordable PRC-brand smartphones continue to be attractive to low- and middle-income consumers, who make up the majority of smartphone users in these markets. In India's smartphone market, for example, PRC brands had a 66% market share in the first quarter of 2019. Here, Xiaomi surpassed Samsung to become the biggest brand in India.[12] Panel b in Figure 3.12 shows that globally by the first quarter of 2020, Huawei, OPPO, and Xiaomi had taken three of the top five positions in smartphone shipments.

11 Huawei's 41% market share in the first quarter of 2020 includes Honor, a PRC smartphone brand founded in 2013 and owned by Huawei until 2020, when Huawei sold it to Shenzhen Zhixin New Information Technology Co.

12 Counterpoint. India Smartphone Market Share: By Quarter. https://www.counterpointresearch.com/india-smartphone-share/ (accessed on 23 August 2021).

As noted earlier, the potential for value creation is distributed unevenly across different stages of the value chain, and the bulk of this value added stems from intangibles, such as brands (Mudambi 2008). By pursuing a nonlinear upgrading strategy, firms can increase their value added in high-tech products even if they lack the technological capability. Figure 3.13 demonstrates this point by comparing the value added accruing to the PRC for three smartphones: the Apple iPhone X, the OPPO R11s, and the Xiaomi Mi MIX 2. All three are assembled in the PRC, but while Oppo and Xiaomi are local brands, Apple is of course a US brand. When value added is measured on the basis of manufacturing cost, the share accruing to the PRC is 25.4% for the Apple iPhone X, and less than 20.0% for both the OPPO R11s and the Xiaomi Mi MIX 2. But when the retail price, a proxy of the whole value added of a good, is used as a yardstick, the domestic value added of the OPPO R11s is 45.3% and 41.7% for the Xiaomi Mi MIX 2, much higher than that of the Apple iPhone X, at 10.4%. Brand ownership clearly contributes most to the increase in domestic value added of the two PRC smartphones.

Figure 3.13: Domestic Value Added of Three Smartphones Assembled in the People's Republic of China



Source: Authors' adaptation of Yuqing Xing and Shaopeng Huang. 2021. Value Captured by China in the Smartphone GVC: A Tale of Three Smartphone Handsets. *Structural Change and Economic Dynamics*. 58. pp. 256–266.

MNCs have evolved into factoryless manufacturers and derived income from intangible assets, including brands, as shown in Chapter 2. Xiaomi is factoryless but controls its large distribution network, as Apple does. Mi MIX 2 teardown data show that Xiaomi's gross profit and retail services, primarily provided through its online channels or offline Xiaomi Mi Stores, jointly account for 31.7% of the total value added, which is by far the largest contribution (Xing and Huang 2021). Hence, Xiaomi's brand ownership significantly enhances the value-added captured by the PRC.

The feasibility of a nonlinear upgrading strategy is critically dependent on the absence of political intervention in free and fair international transactions, allowing firms to source freely parts and core technologies without being discriminated based on nationality. Geopolitical tensions and trade frictions can disrupt the smooth operation of firms relying on a nonlinear upgrading strategy. While Chapter 5 gives a comprehensive analysis on the risks of GVC participation, Box 3.1 presents the case of Huawei to illustrate the risks of pursuing a nonlinear upgrading strategy in a high-tech industry.

Box 3.1: The Risks of a Nonlinear Upgrading Strategy: The Case of Huawei

Huawei Technologies Co. Ltd., a multinational technology company from the People's Republic of China (PRC), lost its position as the world's second largest smartphone brand in 2018, when the Government of the United States (US) imposed increasingly stringent export controls and market access restrictions on Huawei on national security grounds (McCabe 2021). Out of the $70 billion Huawei spent on component procurement in 2018, some $11 billion went to US firms, including Intel Corp., Micron Technology Inc., and Qualcomm Inc. (Jiang and Martina 2019).

From May to August 2019, the US Department of Commerce's Bureau of Industry and Security added Huawei and its numerous subsidiaries to its export control entity list, which requires US companies to obtain a US government license before exporting parts and technology to Huawei (BIS 2019a and 2019b).

In May 2020, the bureau announced an expansion of US export controls on Huawei that further limited the company's ability to produce or develop products using US software and technology, as well as acquiring foreign-produced semiconductors manufactured using US-developed technology (BIS 2020). Under the new regime, even non-US suppliers, such as TSMC Ltd., are barred from supplying chips to Huawei and its affiliates, such as HiSilicon Semiconductor Co. Ltd, if the chips are manufactured using US-developed technology.

These restrictions have had a significant impact on Huawei, particularly on its ability to source hardware and software. For example, after being added to the entity list in May 2019, Huawei's smartphones were prohibited from using Google LLC's Android-based software suite Google Mobile Services, which had a direct impact on its overseas sales.

Huawei's ability to source high-end chips made in the US was also severely hampered. According to *Nikkei Asia* (2020), the company's purchases from the US were halted after the imposition of export controls in 2018, and the share of US-made components in Huawei phones dropped dramatically. In Huawei's top-end MATE30 5G, for example, the total value of components made in the PRC increased from 25% to 42%, while US components dropped from 11% to about 1%.

The impact of these restrictions is most evident when seen in terms of Huawei's global market share. In the first quarter of 2019, it had a 17% share in the global smartphone market, shipping 59.1 million handsets worldwide. By the first quarter of 2021, this had fallen to 4% (15.0 million shipped handsets). This market share does not include Huawei's sub-brand Honor, which was sold in 2020 to ensure its survival in the face of US sanctions (McMorrow 2020).

The rise and fall of Huawei in the global mobile phone market show not only the excessive dependence of the most innovative high-tech company in the People's Republic of China on foreign technologies, but also the risks of pursuing a nonlinear upgrading strategy along global value chains.

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Overall, the case studies from India and the PRC imply that moving up a value chain in high-tech sectors is not necessarily a linear process. Apart from participating in increasingly more technologically sophisticated production tasks, firms in developing economies can leverage their competitive advantage to target high value-added functional segments. The firms in these case studies used their large domestic market to build their brands before expanding into foreign markets and, as such, can be seen as exceptional cases. While a large domestic market certainly helps to achieve scale at the early stages of integration into GVCs, the key to both success stories is that these firms leveraged their knowledge of the local context to create competitive advantage. The rising regionalism in GVCs discussed in Chapter 1 means that firms from small developing economies can leverage their regional markets for scale if there are no disruptions to trade and investment flows.

Conclusions

This chapter provides answers to three questions. First, what is the relationship between GVC participation and productivity growth, and how do GVCs affect the innovative performance of participating firms? It is important to understand these relationships because productivity is a critical factor in determining the standard of living in an economy. The evidence shows that GVC-mediated access to foreign R&D increases total factor productivity and, in advanced and emerging economies, boosts innovation. Conversely, low absorptive capacity and large distances from the global technology frontier, as well as the highly specialized nature of the knowledge flowing along a value chain, may prevent firms in developing economies from drawing on the knowledge and technology of lead GVC firms. Precisely because lead firms tend to work closely with their suppliers, the consequence of this may be that these end up being overly specialized and dependent on the lead firms. As De Marchi, Giuliani, and Rabellotti (2018) note, imitation is one of the most effective channels of knowledge acquisition, along with collective learning and learning from non-GVC actors.

The second question is whether GVC-mediated productivity growth is associated with sustained employment growth in high-productivity sectors. This is a necessary condition for economic development to occur. The chapter shows that GVC-mediated productivity growth is not necessarily associated with employment growth in developing economies, and that the association even turns negative as economies get closer to the productivity frontier in manufacturing, possibly due to the labor-substituting effect of automation. Similarly, Gentile and de Vries (2021) show that in developing Asia employment and productivity along value chains do not necessarily go hand in hand. That study also shows that, while there has been a lot of emphasis on functional upgrading as a driver of income convergence, in developing Asia the volume of activity matters just as much as the domestic share of the value of a product. As Kowalski et al. (2015) note, “important benefits can be derived from specializing in assembly activities and performing them on a large scale.”

The third question is whether firms in emerging economies can leverage the fragmentation of production underpinning manufacturing GVCs to catch up with industry leaders and successfully compete on a global stage. Indeed, moving up the value chain ladder is no longer necessarily a linear process. The increasing modularization of manufacturing, especially in high-tech industries, makes it possible even for firms with relatively limited technological capabilities to become industry leaders. This can be done by firms sourcing core technological components from foreign MNCs or using international expansion as a springboard to acquire strategic resources and reduce their institutional and market constraints at home. While a rapid catch-up in output capabilities is not sufficient to put the firms at the innovation frontier, the process still involves new-to-the country and new-to-the-firm innovation, which are as important as frontier innovation for driving productivity growth.

The case studies on India and the PRC could be perceived as outliers because they both have a large domestic market. While that certainly helps with achieving scale at the early stages of integration into GVCs, the key to both success stories is that those firms leveraged their knowledge of their domestic markets to create competitive advantage. With the rising regionalism in GVCs discussed in Chapter 1, even economies with relatively small domestic markets can successfully pursue these strategies by leveraging their regional markets for scale.

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