Enabling an Innovation Ecosystem and Participation at the Higher End of Global Value Chains

MINSOO LEE, RAYMOND GASPAR, AND HUIYAN DU*

Moving up the global value chain requires an enabling innovation ecosystem alongside economy-specific endowments, a mix of supportive policies in broad areas of infrastructure and institutions, and other enabling factors. Examining sample economies globally and in developing Asia, the empirical results suggest that during the transition from a low level of upgrading in a global value chain to a medium-level one, efforts should focus on increasing the scale of innovation inputs, allowing firms to improve in many areas of their capacity to innovate. To move higher up a global value chain, the design of innovation policies should gradually emphasize the production of technological, knowledge, and creative outputs.

Keywords: developing Asia, global value chain upgrading, innovation efficiency

JEL codes: F10, F14, F15

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I. Introduction

The rapid technological advances being made alongside stronger and broader regional cooperation and integration have helped boost cross-border transactions through trade and investment. Efficiency improvements for moving goods, delivering services, and exchanging information have substantially reduced costs in globalized transactions. This process has fostered the formation of global value chains (GVCs), which have transformed international trade and production patterns. The World Bank (2017) estimated that GVCs account for 60% of international trade and employ 17 million people.

In a GVC, the stages involved in producing a single product are dispersed across countries, particularly those where the right skills and input requirements are available at a competitive cost and quality. Despite the complexity of GVCs, evidence suggests that participating in them is beneficial, although to varying degrees. The granular division of production and task specialization enables countries to find their niches and benefit from economies of scale and scope (Cheng et al. 2015). Baldwin and Yan (2014) found that participating in GVCs results in significant productivity gains. They found an 8%–9% productivity differential between GVC and non-GVC firms, identified by their export and import transactions. GVCs help small and medium-sized enterprises get into global markets, particularly by finding their niches (UNCTAD 2010). Industrialization in developing countries can make it possible for them to participate in GVCs by obviating the need to build in-house production capacity.

Although emerging economies are fairly integrated in supply chains, there are concerns that GVCs tend to favor advanced economies. This argument stems from the limited ability of developing economies to upgrade to higher value-added activities. Milberg (2004), in his theory of endogenous asymmetric market structure in GVCs, posited that lead firms retain higher value-added activities (characterized as oligopolistic with high entry barriers) in their home countries, while offshoring lower value-added activities (highly competitive with low barriers to entry). This pattern can be seen in Apple products, with lower value-adding activities largely outsourced to East Asia, while higher value-adding activities in research and development (R&D), product design, and marketing are done from their United States headquarters.1 Relatedly, Heintz (2006) developed a model of the distributive dynamics of GVCs that shows an unequal distribution of gains from global production networks.

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1This assessment is based on a study by Linden, Kraemer, and Dedrick (2009) that examined which countries capture more value in the case of Apple’s iPod.
Moving up the GVC—for example, by capturing more technologically sophisticated functions—is a challenge for many developing economies. It is not, however, an insurmountable one, as some developing economies in Asia have shown. Firms in Taipei, China have made the transition from largely simple production tasks in the 1980s to the more complex tasks of product design and logistics (Kishimoto 2004). This upgrading can also be seen in the People’s Republic of China (PRC) (Kee and Tang 2016, Organisation for Economic Co-operation and Development [OECD] 2007). Taglioni and Winkler (2016) observed that Southeast Asia is increasingly becoming a hub for knowledge-intensive goods and services.

Much of the literature studying how GVC players from developing countries can move up the value chain involves the crucial role of innovation. Upgrading the technological sophistication of production or offering knowledge-intensive activities within a value chain requires an enabling innovation ecosystem. For a GVC, this should “shape the ability of actors to master and use existing technologies to carry out routine tasks and to create new products and processes” (Sampath and Vallejo 2018, 486). A conducive innovation ecosystem for GVCs should involve improvements in education and supportive policies that foster technological capabilities (e.g., sustained public R&D and building domestic knowledge and technological absorptive capacity).

This paper aims to characterize an enabling innovation ecosystem that corresponds to participation at the higher end of GVCs. It is important to understand the intersection of different levels of GVC upgrading with several dimensions of the innovation ecosystem. From a policy perspective, more value can be created from GVCs through upgrading (Humphrey and Schmitz 2002, Kowalski et al. 2015).

Empirical exercises examine the key factors that affect how economies benefit from GVCs, shedding light on which element of an innovation ecosystem enables developing economies to catch up and thereby capture a higher portion of the value chain. These exercises are conducted on both global and developing Asia samples. The extent of participation in the higher end of the value chain is derived from the Asian Development Bank (ADB)’s multiregional input–output based GVC statistics. Among GVC components, we focus on the foreign value-added embedded in intermediate exports, the increasing share of which suggests that industries are

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2Developing Asia comprises Bangladesh; Bhutan; Brunei Darussalam; Cambodia; Fiji; Hong Kong, China; India; Indonesia; Kazakhstan; the Kyrgyz Republic; the Lao People’s Democratic Republic; Malaysia; Maldives; Mongolia; Nepal; Pakistan; the Philippines; the PRC; the Republic of Korea; Singapore; Sri Lanka; Taipei, China; Thailand; and Viet Nam.

3These provide a detailed picture of an economy through which mutual interrelationships among producers and consumers in the economy can be systematically quantified (the tables are discussed further in a later section). Input–output tables have become a widely used tool for national accounting, economic planning, and policy analysis.
upgrading—that is, shifting more toward producing products required in other economies’ final production or exports. For the innovation ecosystem, the paper uses the Global Innovation Index indicators that assess the innovation performance in both input and output dimensions, and the economy- and firm-level innovation capacity indicators from the World Economic Forum’s *Global Competitiveness Report.*

The paper generally finds that the transition to higher levels of GVC upgrading requires an enabling innovation ecosystem alongside economy-specific endowments, a mix of supportive policies in broad areas of infrastructure and institutions, and other enabling factors. Policies that promote innovation are needed to create this ecosystem. Efforts should focus on increasing the scale in innovation inputs during the transition from a low level of upgrading to a medium one, allowing firms to improve in many areas of their capacity to innovate. To move higher up a global value chain, the design of innovation policies should gradually emphasize the production of technology, knowledge, and creative outputs.

The rest of the paper is structured as follows. Section II discusses the intersection of GVCs and innovation, focusing on the trends observed in developing Asia’s participation in GVCs. Section III elaborates on the empirical analysis determining the vital factors that affect how economies benefit from GVCs, with a particular focus on which elements of the innovation ecosystem help economies capture more value from GVCs, specifically in developing Asia. Section IV discusses the policy implications of the paper’s findings.

II. Upgrading Value Chain Participation through Innovation

GVCs are a prominent feature of international trade. Policies that try to leverage economic growth and development from international production networks have thus far been informed by efforts to better understand how these networks operate. This takes its cue from the notion that this pattern of trade not only promotes the production of exports of goods and services but also facilitates the movement of know-how, technologies, and human capital.

With this in mind, governments in developing economies are trying to move up the value chain by promoting the production of high value-added exports in GVCs.

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4The Global Innovation Index measures innovation performance not only in human capital and research but also in institutions, infrastructure, and market and business sophistication, among other areas. It also measures the ability to produce knowledge, technology, and creative outputs. The index is compiled by Cornell University, INSEAD, and the World Intellectual Property Organization.
Upgrading a GVC can take on different forms, such as producing more sophisticated products, improving efficiency and effectiveness, capturing higher value-adding functions, and getting into new value chains specializing in higher value-added activities (Humphrey and Schmitz 2002). The literature seems to have reached consensus on the crucial role that knowledge, technology, and advanced skills play in the upgrading process (Taglioni and Winkler 2016, UNESCAP 2015). Kaplinsky (2015), however, emphasized that the ability to upgrade will necessarily vary depending on domestic capabilities and the size of an economy and its resource endowments, among other factors.

Establishing an enabling innovation ecosystem clearly merits policy attention, especially for emerging economies trying to capture the better deals that participating in a GVC can offer. To do this, it is essential to identify the elements of an innovation ecosystem and how they interact with varying degrees of participation along the value chain. Here, the coevolution of GVCs and innovation ecosystem is seen as invaluable, particularly when this seeks to foster a synchronized system of innovation-building activities in which participating in a value chain results in the acquisition of knowledge and skills, and advanced technologies and processes.

Several empirical studies provide evidence that a strong innovation ecosystem improves GVC participation in developing economies. Sampath and Vallejo (2018) found that the ability of emerging economies to technologically diversify across export categories—and hence to be able to participate in GVCs—is linked to a higher-level innovation ecosystem in the form of public R&D investments, scientific publications, intellectual property payments, and registered patents by residents. The study posited that such a system forces firms in emerging economies to leverage knowledge flows within and outside GVCs, and to build export capacity and diversify horizontally into new GVCs. In a similar vein, Guan (2018) documented how innovation through investment in R&D helped a chemical company in Singapore to offer new and improved products amid stiff competition. The PRC’s rise in the global photovoltaic industry is largely due to how public research institutions caught up with industry leaders in critical technological areas (de la Tour, Glachant, and Ménière 2011).

Many developing Asian economies have made strides in improving their innovation performance, as shown by their ranking on the Global Innovation Index (Figure 1). The PRC experienced the largest increase in the index between 2008 and 2018, allowing it to nearly match the index values of the region’s innovation powerhouses, especially the Republic of Korea and Singapore. Also performing well on the index during the review period are India, Indonesia, Malaysia, the Philippines, and Thailand. Among economies with lower levels of innovation on the index are
Bangladesh and the Kyrgyz Republic. Economies in this group tend to have weak human capital development and R&D. Per data from the United Nations Educational, Scientific and Cultural Organization, Central Asian economies generally spend less than 0.2% of gross domestic product (GDP) on R&D and have fewer than 1,000 R&D personnel per 1 million people. In comparison, the PRC’s R&D expenditure is 2.2% of GDP, and it has 3,000 R&D personnel per 1 million people.

III. Enabling Factors for Developing Asia to Capture More of the Global Value Chain

Strengthening the participation of economies in GVCs by upgrading to higher value-added activities is essential for maximizing the positive spillovers from value chains—and as noted earlier, this can be achieved in different ways.
This paper discusses GVC upgrading broadly, based on a multiregional input–output framework that identifies which industries produce more goods (and more intermediate goods) for other economies, including those exported to third economies for final goods production. ADB documents, quantifies, and characterizes GVCs in its Multiregional Input–Output (ADB MRIO) tables. This initiative builds on the latest World Input–Output Database, following Timmer et al. (2015), to update coverage by adding 19 ADB member economies. The ADB MRIO tables show from which economy each industry sources inputs from around the world and to whom each industry’s output is sold at home and abroad, whether as inputs to downstream industries or to final end users. Other inter-economy input–output databases include the Eora Multiregional Input–Output database, the OECD’s Inter-Country Input–Output Tables, and the IDE-JETRO Asian Input–Output Tables.

Applying the GVC index system by Wang, Wei, and Zhu (2018) to the ADB MRIO tables, ADB has built a panel dataset decomposing gross exports into several value-added terms at the bilateral-sector level. The value-added structure of export transactions, each with a distinct economic interpretation, is illustrated in Figure 2. The first four parts are the domestic value added embodied in an exporter economy’s gross exports (final or intermediates) to a foreign economy. The first three components are directly and indirectly absorbed by the importer economy, while the fourth component returns to the exporter economy through its imports and is consumed at home.

The paper focuses on components 5–8 in Figure 2, which gives the decomposition of the vertical specialization in trade and provides summary statistics of international production sharing that are widely used in the GVC literature (e.g., Hummels, Ishii, and Yi 2001; Amador and Cabral 2009). The four elements forming the vertical specialization is an extension of the VS1 measure proposed by Hummels, Ishii, and Yi (2001). The decomposition by Wang, Wei, and Zhu (2018) enables examining the components within vertical specialization that represent different types of GVC participation. The term foreign value added in final exports (FVA_FIN) reflects participation at the lower end of value chains because it involves largely final-assembly activities. By contrast, the foreign value added in intermediate exports

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5The accounting methodology in Wang, Wei, and Zhu (2018) improved the gross exports decomposition framework in Koopman, Wang, and Wei (2014) by identifying the different types of cross-country production sharing arrangements at much greater disaggregated levels at either the sector, bilateral, or bilateral-sector level. The distinction made between backward and forward industrial linkages, which is also used in Borin and Mancini (2017), enables tracing the structure of international production sharing at a disaggregated level. The online appendixes in Wang, Wei, and Zhu (2018) detail the decomposition methodology in an input–output framework. The ADB panel dataset covers 63 economies (including the rest of the world) with 35 sectors for the years 2000 and from 2007 to 2018.
signals upgrading, which we use to examine the efforts of economies to get a bigger share of the higher end of the value chain. The growing share of this suggests that GVC transactions involve more intermediate inputs needed by other economies’ production. The double-counted terms (PDC) in the vertical specialization quantify the back-and-forth trade of intermediates, which serves as the measure of the depth of participation. The vertical specialization structure of Taipei, China exemplifies this trend as it occupies several different positions in the global production chain, particularly in electronics by producing both memory chips and components that embed the chips.

A. Deepening Cross-Economy Production Sharing in Developing Asia

Developing Asia’s comparative advantage in factor inputs, such as labor and natural resources, initially propelled the region’s crucial role in GVCs, with the PRC becoming the “factory of the world.” Many countries in Southeast Asia have also embraced cross-border production-sharing arrangements, largely at the lower end of GVCs.

Figure 2. Decomposition of Gross Exports

Source: Wang, Zhi, Shang-Jin Wei, and Kunfu Zhu. (2013), 2018. “Quantifying International Production Sharing at the Bilateral and Sector Levels.” NBER Working Paper Series No. 19677.
the value chain, such as assembly. Figure 3 shows the share of vertical specialization to gross exports—the VS ratio. Pacific comprises only Fiji, and Central Asia comprises only Kazakhstan and the Kyrgyz Republic, reflecting limitations on economy coverage in the Asian Development Bank’s Multiregional Input–Output tables.

Source: Authors’ calculation using global value chain statistics from ADB’s Key Indicators Database. https://kidb.adb.org/themes/global-value-chains (accessed March 15, 2020).
Regional integration lowers trade-related costs. The closer distance between economies within developing Asia reduces transaction costs from transporting goods and delivering services. This is notwithstanding sharing similarities in other aspects, such as culture, language, and practices, as well as infrastructure connectivity, movement of people and capital, and institutional integration. All these features make cross-border production and trading more efficient. It seems the benefits of more comprehensive regional integration come from the ability of these relationships to deepen the involvement of economies in regional value chains, thereby expanding their role in cross-border production sharing.

Figure 3 shows the striking variations in the extent of participation in cross-border production sharing across regions in developing Asia. The more mature GVC players in East Asia and Southeast Asia have shown a stable expansion in GVC activities over time. This pattern highlights the role of knowledge spillovers and technology diffusion from investments from multinational firms. Stronger economic ties among member states of the Association of Southeast Asian Nations could have also played a role. By comparison, South Asia is less integrated; this is partly because of high intraregional trade costs (Johns and McLinden 2016) and the vertical specialization content of exports in the Pacific and Central Asia remaining limited. Central Asia’s GVC participation could be enhanced by strengthening the Central Asia Regional Economic Cooperation Program and similar initiatives.

These observations coincide with the general pattern evidenced in the extent of regional integration across different subregions in Figure 4. Southeast Asian and East Asian economies are highly integrated, while Central Asian economies have a lower level of integration. Integration among the member states of the Association of Southeast Asian Nations is particularly strong in trade and investment, and the movement of people. Institutional and social integration, alongside infrastructure and connectivity cooperation, are boosting integration within East Asia. Regional integration in Central Asia is being held back by weak integration in finance, trade and investment, and the movement of people. Greater economic integration brings substantial benefits through efficiency gains, increases in market size, and cost-sharing in regional production and cross-border infrastructure (ADB 2019).

B. Upgrading Concentrated in a Few Mature Global Value Chain Players in Developing Asia

To determine whether GVC participation in developing Asia is at the lower or higher end of value chains, we examine the pattern of the FVA_INT as a component of
vertical specialization. A growing share of this component suggests that industries are shifting more toward producing products required in other economies’ final production or exports. In this complex type of GVC, defined as those involving value added crossing borders more than once, it can be assumed that industries are able to capture more value by offering more sophisticated products or services.

Table 1’s all sectors column shows the level of value chain upgrading of developing Asian economies classified by the share of foreign value added in intermediate exports to vertical specialization, or FVA_INT share. From the information at the bilateral economy-sector level, we calculated the average FVA_INT share by economy and year (weighted by the size of the bilateral economy-sector VS ratio). The levels of upgrading are then derived by classifying average FVA_INT share in the first and second quintile as “low,” the third and fourth quintile as “medium,” and the fifth quintile as “high.” We find that many economies in developing Asia have a low level of GVC upgrading, including Bangladesh, Cambodia, and Nepal. Indonesia, India, and Viet Nam have a medium level of upgrading. East Asia—particularly the PRC; the Republic of Korea; and Taipei,China—shows higher levels of upgrading, with the PRC moving from medium in 2000 to high in 2007.

Figure 4.  Asia-Pacific Regional Cooperation and Integration Index, 2007–2017

Notes: In this figure, Southeast Asia comprises Cambodia, Indonesia, the Lao People’s Democratic Republic, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam. Central Asia comprises Georgia, Kazakhstan, and the Kyrgyz Republic. East Asia comprises the People’s Republic of China; Hong Kong, China; Japan; the Republic of Korea; and Mongolia. South Asia comprises Bangladesh, India, Nepal, Pakistan, and Sri Lanka. Asia and the Pacific also includes Australia and New Zealand. The values refer to the index in 2017. Sources: Asian Development Bank, Asia Regional Integration Center. Asia-Pacific Regional Cooperation and Integration Index Database. https://aric.adb.org/database/arci (accessed July 15, 2020).
In East Asia, the Republic of Korea and Taipei, China have long been key players in exports of sophisticated parts and components to international production chains. The PRC is building its innovation capacity and — already at a high level of upgrading — is steadily moving further up the GVC. Taglioni and Winkler (2016) observe that Southeast Asia is increasingly becoming a hub for knowledge-intensive goods and services. Interestingly, when looking only at upgrading in Table 1’s innovative sectors column, the Philippines can be classified at the medium level of upgrading, a result of its gradual shift toward advanced manufacturing and services from limited manufacturing (World Bank 2020). Belderbos et al. (2016) documented the growing

| Economy                  | All Sectors | Innovative Sectors |
|--------------------------|-------------|--------------------|
|                          | 2000  | 2007  | 2018  | 2000  | 2007  | 2018  |
| Bangladesh               | Low   | Low   | Low   | Low   | Low   | Low   |
| Brunei Darussalam        | Low   | Low   | Low   | Low   | Low   | Low   |
| Bhutan                   | Low   | Low   | Low   | Low   | Low   | Low   |
| Fiji                     | Low   | Low   | Low   | Low   | Low   | Low   |
| Hong Kong, China         | Medium| Low   | Low   | Medium| Low   | Low   |
| Kazakhstan               | Low   | Low   | Low   | Low   | Low   | Low   |
| Kyrgyz Republic          | Low   | Low   | Low   | Low   | Low   | Low   |
| Cambodia                 | Low   | Low   | Low   | Low   | Low   | Low   |
| Lao PDR                  | Low   | Low   | Low   | Low   | Low   | Low   |
| Sri Lanka                | Low   | Low   | Low   | Low   | Low   | Low   |
| Maldives                 | Low   | Low   | Low   | Low   | Low   | Low   |
| Mongolia                 | Low   | Low   | Low   | Low   | Low   | Low   |
| Nepal                    | Low   | Low   | Low   | Low   | Low   | Low   |
| Pakistan                 | Low   | Low   | Low   | Low   | Low   | Low   |
| Philippines              | Low   | Medium| Low   | Medium| Medium| Medium|
| Indonesia                | Medium| Medium| Medium| Medium| Medium| Medium|
| India                    | Medium| Medium| Medium| Medium| Medium| Medium|
| Malaysia                 | High  | Medium| Medium| High  | Medium| Medium|
| Singapore                | High  | Medium| Medium| High  | Medium| Medium|
| Thailand                 | Medium| Medium| Medium| Medium| Medium| Medium|
| Viet Nam                 | Low   | Low   | Medium| Low   | Low   | Medium|
| PRC                      | Medium| High  | High  | Medium| High  | High  |
| Republic of Korea        | High  | High  | High  | High  | High  | High  |
| Taipei, China            | High  | High  | High  | High  | High  | High  |

Lao PDR = Lao People’s Democratic Republic, PRC = People’s Republic of China.
Source: Authors’ calculation using global value chain statistics from the Asian Development Bank’s Key Indicators Database. https://kidb.adb.org/themes/global-value-chains (accessed March 15, 2020).

6For the definition of innovative sectors, see Figure 6.
number of firms deciding to offshore R&D and innovative activities. Among the cities in Asia benefiting from this trend are Bangalore (now Bengaluru), Beijing, Shanghai, and Singapore. But many economies in the region, particularly low-income ones, either have limited participation in GVCs or are at the low end of the value chain, specializing in tasks that rely more on unskilled labor. If this persists, these economies will have fewer opportunities to acquire the technological know-how and skills needed to move up the GVC.

Later in the empirical section, the paper assesses how value chain upgrading also varies depending on how economies are positioned in their production networks. Using the ADB MRIO tables and following the production activity decomposition framework in Wang et al. (2017), ADB has built a panel dataset of two GVC participation indices in both simple and complex value chains, with the latter involving factor content crossing a border at least twice.7 The first index relates to the domestic value added generated from an economy-sector pair’s GVC activities through downstream firms (backward-linkage participation index). The second index refers to the value added that is involved in GVC activities through the upstream firms (forward-linkage participation index). Intuitively, one can identify whether participation in production networks involves more upstream or downstream activities.

Figure 5 shows the level of backward and forward GVC participation in developing Asia. A higher degree of forward participation relative to backward participation implies active involvement in upstream production activities in production networks. GVC transactions in developing Asia are primarily in downstream activities, particularly those involved in complex GVCs. In 2017, only a third of economy-sector pairs had higher forward participation relative to backward participation, largely from GVC activities from Malaysia, the PRC, the Republic of Korea, and Thailand, and mainly from service sectors relating to finance, professional activities, and trade.

Although the calculated ratio of forward to backward participation is relatively lower in Hong Kong, China; Singapore; Taipei, China; and Vietnam; their individual forward and backward participation indices are above the median indices in the region. This means that these economies have higher value-added content in global production networks. Relatedly, there are many manufacturing activities that have a low ratio of forward to backward participation, but still have above-median indices of both forward and backward participation. This is particularly the case for R&D intensive manufacturing activities, such as basic metals, chemicals, electrical equipment, and

7Detailed mathematical derivations are in the appendix of Wang et al. (2017).
machinery. It is also observed in transport services since these are critical for a well-functioning, cross-economy production chain.

IV. Empirical Analysis

This section details the empirical exercises to identify the essential factors that influence how economies capture activities that create more value from GVCs. To enable economies to deepen their participation at the higher end of GVCs, trade and investment policies should foster openness and be complemented by policies promoting well-functioning markets, such as fair competition (OECD 2007).

Van der Marel (2015) examines three major factors that affect the position of economies in a GVC. The first is the importance of structural forces, such as domestic market and economic size, and factor endowments. These include human, physical, information, and communication-technology-related capital; knowledge capital; internet penetration; and the rule of law. The second factor is the trade and regulatory regimes that are vital for an economy’s participation in a GVC and, ultimately, its capabilities to move up the chain. The third is the ease of conducting business transactions and the extent to which regulatory barriers to trade-related services affect the decisions of multinational companies on where to locate their innovation and production facilities. Policies related to foreign direct investment, labor market regulation, availability of credit, and competition also play important roles.

It is well-established in the GVC literature that moving up the value chain requires a high level of sophistication, and technological and innovation capacity. The
level of knowledge and technology in an economy’s production and exports are determining factors for its position in a GVC (Taglioni and Winkler 2016). The capacity to innovate will create opportunities to derive more value from production. It is noteworthy that the PRC’s R&D is already higher than that of many advanced economies and is on its way to surpassing R&D spending in the United States. To sustain a culture of innovation and creativity, economies should equip their workers with skills that can handle higher value-added activities. To stimulate innovation, economies need to protect intellectual property rights and complement this with practices, tools, and networks that increase access to knowledge. It requires a great deal of innovation to be able to participate in a GVC focused on innovative activities (World Bank 2020).

A. Data and Estimating Equation

Using the calculated levels of upgrading based on the ratio of FVA_INT to vertical specialization—low, medium, and high—we examine the various factors that could help economies move toward a higher value-adding share of GVCs and, in doing so, leverage these networks to advance economic development. The data are from the ADB panel dataset on GVC-related statistics based on ADB MRIO tables discussed in previous sections.

Given the three possible outcomes (low, medium, high) of upgrading, we use a multinomial logit model to estimate the log-odds, \( \log \frac{\pi_{ij}}{\pi_{iJ}} \), of economy \( i \) to move upward (medium and high) relative to being in the lower end of the value chain, while considering various factors, most importantly variations in several dimensions of innovation. Assuming that the log-odds of each outcome follow a linear model, we estimate the following:

\[
\eta_{ij} = \log \frac{\pi_{ij}}{\pi_{iJ}} = \alpha_j + \mathbf{x}'_{it} \beta_j + \epsilon_{ijt},
\]

where \( \alpha_j \) is a constant and \( \beta_j \) is a vector of coefficients for \( j = \text{low}, \text{medium}, \text{or high} \), with low or medium as the base category over the upgrading outcomes to consider both leveling up from low to medium and from medium to high. The error term, \( \epsilon_{ijt} \), is assumed independent and identically distributed across all outcomes \( j \).

The vector of independent variables, \( \mathbf{x}'_{it} \), based on the literature cited, are essential factors for economies moving higher up the value chain that need to be controlled to draw unbiased estimates on the influence of innovation variables. The log of real GDP per capita tries to purge the effect of varying domestic market size and
purchasing power. The variable also attempts to isolate expectations that higher-income economies tend to be at the higher end of value chains. The other indicator is domestic market size index from the World Economic Forum’s *Global Competitiveness Report*.8

Several infrastructure variables with their corresponding quality also form part of the equation; this is because good logistics and soft infrastructure facilitate the efficient movement of goods and delivery of services. For trade logistics infrastructure, we use the World Bank’s Logistics Performance Index.9 This examines the efficiency of customs and border management clearance; the quality of trade and transport infrastructure; the ease of arranging competitively priced shipments; the competence and quality of logistics services (truckling, forwarding, and customs brokerage); the ability to track and trace consignments; and the timeliness of shipments. The soft infrastructure variable, which includes the intensive use of information and communication technology, is captured in the innovation indicators discussed in the rest of this section.

Selected policy-related variables also form part of the specification to investigate how structural forces influence the participation of economies at the higher end of GVCs. These include policies to promote openness to trade and investment, institutional quality, and innovation. The ease of trading and investing overseas are obviously critical elements for GVCs. We use information on the prevalence of trade barriers from the *Global Competitiveness Report* and foreign direct investment (net inflows, percentage of GDP) from the World Bank’s World Development Indicators database.10 An equally important element for GVCs is the quality of domestic public sector institutions. Businesses participating in GVCs tend to deal with quite a few government procedures for trading and other activities. Here, governments should ensure these transactions can be carried out smoothly to avoid backlogs. For this aspect, we use the intellectual property protection and strength of investor protection indicators in the *Global Competitiveness Report* alongside the number of procedures involved in registering property from the World Bank’s Doing Business project.11

8 The size of the domestic market is calculated as the natural log of the sum of the GDP valued at purchasing power parity (PPP) plus the total value (PPP estimates) of imports of goods and services, minus the total value (PPP estimates) of exports of goods and services. Data are then normalized on a 1–7 scale.
9 World Bank. Logistics Performance Index. https://lpi.worldbank.org/ (accessed March 15, 2020).
10 World Bank. World Development Indicators. https://databank.worldbank.org/source/world-development-indicators (accessed March 15, 2020).
11 World Bank. Doing Business. https://www.doingbusiness.org/en/doingbusiness (accessed March 15, 2020).
To achieve the ultimate objective of this paper—characterizing the nexus of an enabling innovation ecosystem and participation at the higher end of GVCs—several dimensions forming part of the innovation ecosystem are added. The econometric specification uses the Global Innovation Index. In separate exercises, we distinguish the effect between innovation input (i.e., institutions, human capital and research, infrastructure, market sophistication, and business sophistication) and innovation output, which refers to the ability to produce knowledge, technology, and creative outputs.

To provide more insights, several elements of innovation capacity from the *Global Competitiveness Report* are also used, categorized here as national and firm level. National innovation capacity includes the availability of scientists and engineers, university–industry collaboration in R&D, the quality of scientific research institutions, and the availability of latest technologies. Firm-level innovation capacity includes the extent of marketing, company spending on R&D, the sophistication of production processes, the quantity and quality of local suppliers, and the absorption of technology by companies.

The baseline equation (1) is estimated using pooled multinomial logistic regression with robust standard errors to account for possible correlation across years. Fixed effects panel estimation is not carried out due to limited variation in the outcome variable across the observations. The baseline cross-economy panel data have an unbalanced structure because of the availability of information. The analysis covers 55 economies—18 from developing Asia—over the period 2009–2018.

**B. Summary Statistics**

Table 2 summarizes the stylized facts of the varying characteristics of economies at different levels of upgrading. It is clear from the table how upgrading in a GVC differs with the level of development. Real GDP per capita is highest among economies at the higher end of the value chain. It is therefore essential to include real GDP per capita as one of the controlling factors. Economies with a better performance in trade logistics—that is, those that can efficiently move goods and deliver services—are classified under the economies with a high level of upgrading. This is particularly true in all dimensions of logistics performance. Better telecommunication infrastructure, especially fixed broadband, is apparent, on average, among economies with a high level of upgrading. Trade barriers and the enforcement of investor protection also vary with the level of GVC upgrading.
Table 2. **Summary Statistics of Explanatory Variables**

| Variable | No. of Observations | Mean | Std Dev | Minimum | Maximum |
|----------|---------------------|------|---------|---------|---------|
| (a) Economies with a low level of GVC upgrading | | | | | |
| Real GDP per capita (log) | 181 | 8.7 | 1.3 | 6.3 | 10.6 |
| Domestic market size index | 181 | 3.4 | 0.8 | 1.9 | 5.0 |
| Logistics Performance Index, overall | 181 | 2.8 | 0.5 | 0.0 | 3.9 |
| Customs | 181 | 2.6 | 0.5 | 0.0 | 3.8 |
| Infrastructure | 181 | 2.6 | 0.5 | 0.0 | 4.0 |
| Ease of arranging shipments | 181 | 2.8 | 0.5 | 0.0 | 3.8 |
| Quality of logistics services | 181 | 2.7 | 0.5 | 0.0 | 3.9 |
| Tracking and tracing | 181 | 2.8 | 0.5 | 0.0 | 3.9 |
| Timeliness | 181 | 3.2 | 0.6 | 0.0 | 4.1 |
| Fixed-broadband subscriptions | 181 | 15.0 | 12.6 | 0.1 | 43.7 |
| Mobile-cellular telephone subscriptions | 181 | 115.6 | 30.0 | 20.8 | 270.0 |
| Number of procedures to register property | 181 | 6.1 | 2.5 | 1.0 | 11.0 |
| Strength of investor protection, 0–10 (best) | 181 | 5.8 | 1.0 | 3.0 | 8.0 |
| FDI, net inflows (% of GDP) | 181 | 10.3 | 32.3 | −37.2 | 280.1 |
| Intellectual property protection, 1–7 (best) | 181 | 3.6 | 0.8 | 2.0 | 5.9 |
| Prevalence of trade barriers, 1–7 (best) | 181 | 4.5 | 0.5 | 3.6 | 5.8 |
| (b) Economies with a medium level of GVC upgrading | | | | | |
| Real GDP per capita (log) | 250 | 9.9 | 1.2 | 7.1 | 11.6 |
| Domestic market size index | 250 | 4.6 | 0.8 | 2.5 | 6.4 |
| Logistics Performance Index, overall | 250 | 3.5 | 0.4 | 2.5 | 4.2 |
| Customs | 250 | 3.3 | 0.5 | 2.0 | 4.2 |
| Infrastructure | 250 | 3.5 | 0.5 | 2.3 | 4.3 |
| Ease of arranging shipments | 250 | 3.4 | 0.3 | 2.5 | 4.2 |
| Quality of logistics services | 250 | 3.5 | 0.4 | 2.5 | 4.3 |
| Tracking and tracing | 250 | 3.6 | 0.4 | 2.5 | 4.4 |
| Timeliness | 250 | 3.9 | 0.3 | 3.0 | 4.8 |
| Fixed-broadband subscriptions | 250 | 22.7 | 12.2 | 0.6 | 46.4 |
| Mobile-cellular telephone subscriptions | 250 | 126.6 | 29.5 | 43.1 | 251.8 |
| Number of procedures to register property | 250 | 5.2 | 2.6 | 1.0 | 14.0 |
| Strength of investor protection, 0–10 (best) | 250 | 6.0 | 1.5 | 2.7 | 9.3 |
| FDI, net inflows (% of GDP) | 250 | 6.3 | 12.9 | −41.5 | 80.8 |

*Continued.*
Table 3 gives the summary statistics of the several elements of an innovation ecosystem. Like the other explanatory variables, economies at different levels of upgrading also vary in several dimensions of innovation, with those at the higher end of value chains showing advances in many areas of the innovation ecosystem. The Global Innovation Index, for example, is higher among economies classified as having a high level of GVC upgrading. This observation holds for different innovation input and output pillars. It also holds for innovative capacity, both at the national and firm level.
Table 3. Summary Statistics of Innovation Ecosystem Indicators

| Variable                                      | No. of Observations | Mean | Std Dev | Minimum | Maximum |
|-----------------------------------------------|---------------------|------|---------|---------|---------|
| **(a) Economies with a low level of GVC upgrading** |                     |      |         |         |         |
| Global Innovation Index                       | 181                 | 36.2 | 8.7     | 21.1    | 55.5    |
| Innovation input                              | 181                 | 42.8 | 9.2     | 23.7    | 66.7    |
| Innovation output                             | 181                 | 29.7 | 9.4     | 12.1    | 53.3    |
| Capacity for innovation, 1–7 (best)           | 181                 | 3.5  | 0.7     | 2.0     | 5.0     |
| National innovation capacity                   |                     |      |         |         |         |
| Availability of scientists and engineers       | 181                 | 4.0  | 0.5     | 2.8     | 5.4     |
| University–industry collaboration in R&D       | 181                 | 3.4  | 0.6     | 2.0     | 4.9     |
| Quality of scientific research institutions   | 181                 | 3.7  | 0.8     | 2.0     | 5.4     |
| Availability of latest technologies           | 181                 | 4.8  | 0.7     | 3.3     | 6.3     |
| Firm-level innovation capacity                 |                     |      |         |         |         |
| Extent of marketing                            | 181                 | 4.1  | 0.5     | 2.6     | 5.3     |
| Production process                             | 181                 | 3.6  | 0.6     | 2.3     | 5.4     |
| Local supplier quantity                        | 181                 | 4.5  | 0.4     | 3.5     | 5.5     |
| Local supplier quality                         | 181                 | 4.4  | 0.5     | 3.3     | 5.4     |
| Company spending on R&D                        | 181                 | 3.1  | 0.5     | 1.8     | 4.4     |
| Firm-level technology                          | 181                 | 4.6  | 0.5     | 3.4     | 5.6     |
| **(b) Economies with a medium level of GVC upgrading** |                     |      |         |         |         |
| Global Innovation Index                       | 250                 | 47.6 | 10.4    | 27.5    | 68.4    |
| Innovation input                              | 250                 | 54.5 | 11.5    | 30.6    | 74.9    |
| Innovation output                             | 250                 | 40.7 | 10.4    | 18.5    | 68.6    |
| Capacity for innovation, 1–7 (best)           | 250                 | 4.3  | 0.9     | 2.7     | 6.2     |
| National innovation capacity                   |                     |      |         |         |         |
| Availability of scientists and engineers       | 250                 | 4.6  | 0.6     | 3.3     | 6.3     |
| University–industry collaboration in R&D       | 250                 | 4.4  | 0.8     | 2.9     | 6.0     |
| Quality of scientific research institutions   | 250                 | 4.8  | 0.8     | 3.2     | 6.6     |
| Availability of latest technologies           | 250                 | 5.6  | 0.8     | 3.6     | 6.9     |
| Firm-level innovation capacity                 |                     |      |         |         |         |
| Extent of marketing                            | 250                 | 4.9  | 0.6     | 3.2     | 6.2     |
| Production process                             | 250                 | 4.9  | 0.9     | 3.0     | 6.5     |
| Local supplier quantity                        | 250                 | 5.0  | 0.5     | 3.4     | 5.9     |
| Local supplier quality                         | 250                 | 5.1  | 0.6     | 3.6     | 6.4     |
| Company spending on R&D                        | 250                 | 4.1  | 0.9     | 2.7     | 6.1     |

Continued.
V. Empirical Findings

Table 4 reports the coefficient estimates of the baseline multinomial logistic regression given in equation (1). The estimates generally support the stylized facts in earlier discussions. Column 1 shows how the factors of domestic market size, trade logistics infrastructure, and regulatory quality influence the transition of economies from the lower level of upgrading to the medium level. This is done by estimating the baseline equation with the low level of upgrading as the reference category. The roles of market size, quality of trade logistics, and a favorable environment for foreign investment and property registration for moving up a GVC are apparent. It is interesting to note that the strength of investor protection in an economy has a negative coefficient, which poses a counterintuitive interpretation. This could partly be explained by the fact that foreign investors do not have homogeneous motives when

| Variable                                      | No. of Observations | Mean | Std Dev | Minimum | Maximum |
|-----------------------------------------------|---------------------|------|---------|---------|---------|
| Firm-level technology absorption              | 250                 | 5.3  | 0.6     | 3.4     | 6.5     |

(c) Economies with a high level of GVC upgrading

| Variable                                      | No. of Observations | Mean | Std Dev | Minimum | Maximum |
|-----------------------------------------------|---------------------|------|---------|---------|---------|
| Global Innovation Index                       | 113                 | 53.1 | 6.4     | 34.6    | 63.4    |
| Innovation input                              | 113                 | 59.8 | 6.9     | 42.2    | 70.8    |
| Innovation output                             | 113                 | 46.4 | 7.3     | 26.4    | 60.9    |
| Capacity for innovation, 1–7 (best)           | 113                 | 4.9  | 0.6     | 3.1     | 6.0     |
| National innovation capacity                  |                     |      |         |         |         |
| Availability of scientists and engineers       | 113                 | 4.9  | 0.5     | 4.0     | 5.9     |
| University–industry collaboration in R&D       | 113                 | 4.9  | 0.7     | 3.1     | 5.9     |
| Quality of scientific research institutions   | 113                 | 5.4  | 0.7     | 3.4     | 6.4     |
| Availability of latest technologies           | 113                 | 5.9  | 0.7     | 4.2     | 6.6     |
| Firm-level innovation capacity                |                     |      |         |         |         |
| Extent of marketing                           | 113                 | 5.3  | 0.6     | 4.3     | 6.5     |
| Production process                            | 113                 | 5.5  | 0.7     | 3.7     | 6.6     |
| Firm-level technology absorption              | 113                 | 5.5  | 0.5     | 4.2     | 6.4     |

GVC = global value chain, R&D = research and development.
Source: Authors’ calculation.

Table 3. Continued.
investing (e.g., priority may be given to other essential elements such as market access). Similarities can be found in examining only economies in developing Asia, with the exception of a significant positive influence for strengthening investor protection (column 2). In both samples, economies at a low level of upgrading need to improve their innovation ecosystems so they can move into the medium level.

Columns 3 and 4 are the empirical results of an exercise showing how economies in the medium level of upgrading can potentially transition to a high

Table 4. **Factors Influencing the Transition to a Higher Level of the Value Chain**

| Variable                                              | Low to Medium Level of Upgrading | Medium to High Level of Upgrading |
|-------------------------------------------------------|---------------------------------|----------------------------------|
|                                                       | All Economies (1) | Developing Asia (2) | All Economies (3) | Developing Asia (4) |
| Real GDP per capita (log)                             | 0.066              | −4.463**              | 1.153***          | 14.002***          |
|                                                       | (0.259)            | (2.068)               | (0.318)           | (0.841)            |
| Domestic market size index                            | 4.178***           | 11.077***             | 3.013***          | 19.380***          |
|                                                       | (0.634)            | (3.516)               | (0.360)           | (0.732)            |
| Logistics Performance Index                           | 4.881***           | 7.174***              | 4.824***          | −25.309***         |
|                                                       | (1.232)            | (2.403)               | (1.828)           | (5.835)            |
| Number of procedures in property registration         | −0.325**           | −1.912**              | 0.282***          | −1.708***          |
|                                                       | (0.145)            | (0.754)               | (0.085)           | (0.537)            |
| Strength of investor protection                       | −0.563***          | 1.003**               | −0.068            | −6.724***          |
|                                                       | (0.119)            | (0.400)               | (0.116)           | (0.637)            |
| FDI, net inflows (% of GDP)                           | 0.008*             | −0.219***             | 0.012             | −0.953***          |
|                                                       | (0.005)            | (0.074)               | (0.015)           | (0.062)            |
| Intellectual property protection                      | −0.246             | −1.250                | −0.326            | −6.650***          |
|                                                       | (0.382)            | (0.802)               | (0.314)           | (0.972)            |
| Prevalence of trade barriers                          | −0.305             | −2.176***             | −0.076            | 5.730***           |
|                                                       | (0.568)            | (0.743)               | (0.331)           | (1.167)            |
| Global Innovation Index                               | 0.223***           | 0.797***              | −0.002            | 2.097***           |
|                                                       | (0.055)            | (0.289)               | (0.038)           | (0.165)            |
| Constant                                              | −34.556***         | −41.268***            | −44.971***        | −184.175***        |
|                                                       | (6.334)            | (12.545)              | (5.852)           | (14.876)           |
| Observations                                          | 544                | 181                   | 544               | 181                |
| Pseudo $R^2$                                          | 0.705              | 0.951                 | 0.705             | 0.951              |
| Log likelihood                                        | −168.3             | −8.506                | −168.3            | −8.506             |

FDI = foreign direct investment, GDP = gross domestic product.

Notes: Robust standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.
Source: Authors’ calculation.
This exercise necessitates using medium upgrading as the reference category in estimating equation (1). The positive influence of market access and the quality of logistics infrastructure is clear. But economies in developing Asia at the medium level of upgrading seem to have reached gradual improvement in trade logistics, causing a negative coefficient on the Logistics Performance Index in column 4. In contrast to the transition from low to medium, the coefficient of property registration becomes positive, while strength in investor protection is ambiguous. This can also be explained by the differing motives of investors. Based on the results, market-seeking seems at play in GVC upgrading, which puts a priority on the size and purchasing power of the domestic market and efficiency-seeking motives. In developing Asia, the transition to a high level of upgrading from a medium one requires the elimination of non-tariff barriers that limit the entry of imported intermediates. And, particularly in developing Asia, enhancing innovation performance earns more weight in the transition from a medium to high level of upgrading. Although, it should be noted that the innovation ecosystem shows an ambiguous result in the global sample. As the results in Tables 5–8 show, this is because of the differing needs or focus of each upgrading in terms of innovation. To avoid potential collinearity resulting in biased estimates, note that each coefficient from Tables 5–8 is derived by estimating equation (1) with all the baseline control variables in separate regressions for each innovation variable, except for innovation input and output, which are jointly added.

Table 5 shows that the ability of economies to produce knowledge and technology, and creative outputs and content, is essential for capturing the higher end of a value chain. From a policy perspective, while it is important to increase the scale of investments in innovation inputs, policy makers should be aware of the need to produce knowledge and creative outputs. It is the case, however, that the transition from a low to medium level of upgrading requires a sizable effort to improve innovation inputs. To move to the higher end of a value chain, especially for firms at the medium level, innovation efficiency, as Table 5 shows, should be the focus.

Table 5 also shows the significant heterogeneity in the mix of innovation components that could potentially facilitate a transition to higher levels of GVC upgrading. It is also apparent that upgrading can be different in the developing Asian context, with other areas of innovation capacity influencing upgrading in stark contrast with the global sample. In general, as observed in the global and developing Asian samples, GVC upgrading requires strengthening the role of local suppliers, particularly for quality. A gradual shift to sophisticated production processes and increased R&D spending are viable ways for economies to boost their GVC upgrading efforts.
It is interesting to note that a huge catch-up is expected by economies in developing Asia at the low level of GVC upgrading to the medium level. This view is supported by estimates that an improved performance in innovation input has more weight relative to innovation output. Making progress on all components of capacity
to innovate is essential to make the transition from the low to the medium level of upgrading. Capturing better deals in GVCs requires firm-level knowledge and technology absorption largely from the use of the latest technologies, learning from various sources such as university–industry collaboration and public research institutions, and by developing human resources.
### Table 7. Innovation Ecosystem and Upgrading at Different Global Value Chain Levels

| Variable                                      | Low to Medium Level of Upgrading | Medium to High Level of Upgrading |
|-----------------------------------------------|----------------------------------|----------------------------------|
|                                               | Interaction with Complex GVC Participation | Interaction with Complex GVC Participation |
|                                               | Baseline (1)                     | Baseline (3)                     |
| Global Innovation Index, overall              | 0.224** (0.094)                  | -0.067 (0.045)                  |
| Innovation efficiency                         | 9.379*** (3.496)                | 2.406 (2.188)                   |
| Areas of innovation capacity                  |                                  |                                  |
| Availability of scientists and engineers      | -0.998 (0.954)                  | 0.528 (0.678)                   |
| University–Industry collaboration in R&D     | 1.039 (0.707)                   | 0.634 (0.542)                   |
| Quality of scientific research institutions  | 0.007 (0.482)                   | 0.606 (0.524)                   |
| Availability of latest technologies          | 0.168 (0.746)                   | -0.900 (0.845)                  |
| Extent of marketing                           | 1.259 (1.067)                   | -1.572** (0.797)                |
| Production process sophistication             | 3.019*** (0.794)                | 2.137*** (0.799)                |
| Local supplier quantity                       | 0.229 (1.435)                   | -0.186 (0.664)                  |
| Local supplier quality                        | 3.672** (1.821)                 | 1.268 (0.821)                   |
| Firm-level technology absorption              | 2.000*** (0.734)                | -1.217 (0.855)                  |
| Company spending on R&D                       | 2.401*** (0.926)                | 0.279 (0.506)                   |

GVC = global value chain, R&D = research and development.
Notes: The innovation efficiency ratio substitutes joint addition of innovation input and output in equation (1) to overcome convergence issue. Robust standard errors in parentheses. ***(p < 0.01), **(p < 0.05), and *(p < 0.1.

Source: Authors’ calculation.

A. Global Value Chain Upgrading in Research and Development Intensive Industries

The results discussed in the previous section offer insights that relate to all sectors. In this section, we examine only the GVC participation of innovative
sectors—that is, those identified as having above-average R&D intensity. It can be assumed that the capacity of these sectors to undertake knowledge and market-knowledge activities, and the ability to be a critical source of sophisticated intermediates, are higher than for other sectors. We use sector-level R&D intensity information from the OECD’s Science, Technology and Industry Scoreboard 2017 for

| Variable                                      | Low to Medium Level of Upgrading | Medium to High Level of Upgrading |
|-----------------------------------------------|----------------------------------|----------------------------------|
|                                               | All Economies (1)               | Developing Asia (2)             |
| Global Innovation Index                       | 0.009 (0.027)                   | 0.044 (0.048)                   |
| Innovation efficiency                         | 2.581** (1.151)                 | 2.475 (1.947)                   |
| Areas of innovation capacity                  |                                 |                                  |
| Availability of scientists and engineers      | 1.685*** (0.359)                | 0.038 (0.523)                   |
| University–Industry collaboration in R&D      | 1.311*** (0.272)                | −1.243** (0.485)                |
| Quality of scientific research institutions   | 0.656** (0.270)                 | −1.182** (0.515)                |
| Availability of latest technologies           | 1.468*** (0.344)                | −0.295 (0.988)                  |
| Extent of marketing                           | 2.894*** (0.457)                | 1.657** (0.799)                 |
| Production process sophistication             | 4.121*** (0.518)                | 3.236*** (0.627)                |
| Local supplier quantity                       | 2.752*** (0.380)                | 2.362*** 570.817***            |
| Local supplier quality                        | 2.674*** (0.509)                | 2.335*** 17.426                |
| Firm-level technology absorption              | 1.628*** (0.326)                | 0.153 14.369**                 |
| Company spending on R&D                       | 2.466*** (0.382)                | 1.635*** −0.112                |

R&D = research and development.
Notes: The innovation efficiency ratio substitutes joint addition of innovation input and output in equation (1) to overcome convergence issue. Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, and *p < 0.1.
Source: Authors’ calculation.
30 advanced economies and 35 sectors, which we map to the ADB MRIO sectors. Using the median R&D intensity of advanced economies in 2015, we classify sectors in different levels: low, medium, medium high, and high. Less R&D-intensive sectors are those with an R&D intensity below the median. Those with above-median R&D intensity are classified as medium to high. With these distinctions, we recalibrate the economy-specific GVC upgrading level covering only the nine sectors classified as medium to high R&D intensive, as shown in Figure 6.

Table 6 tabulates the coefficient estimates in equation (1) with the upgrading level derived from the information on R&D-intensive industries. In the global sample, efforts to improve the efficiency of innovation policies are driving GVC upgrading from the low to the medium level. This transition could be further facilitated by making broad-based advances in many areas related to innovation capacity—for example, the use of the latest technologies in production processes, increased R&D, and collaboration with knowledge bodies. The transition from a medium to high level of GVC upgrading requires making further progress in both areas.

For developing Asia, a gradual improvement in innovation performance is needed to facilitate a shift toward the higher level of GVC upgrading. Our exercise returned rather ambiguous results for the transition from the low to the medium level of upgrading in examining the areas of innovation capacity. A transition to the high level of upgrading requires considerable improvements in turning innovation investments into relevant innovation outputs. Efforts to boost the capability of local suppliers in value chains and intensify their technological absorption are needed. This should be regarded as an issue of high importance.

B. Concentration Effects in Upstream and Downstream Activities

Another potential source of the heterogeneity of the results is the position in a global production network. Economies with higher forward than backward participation is an indication of active engagement in the upstream production activities of GVCs. These economies can be considered closer to the production sources, while economies with dominant downstream activities are much closer to the market. The difference can reflect varying innovation capability needs.

Table 7 summarizes the results of equation (1) adjusted to include the interaction term with innovation indicators and a dummy variable classifying an economy on whether it is largely upstream (value equals 1) or downstream (value equals 0). Using

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12R&D intensity is defined as the percentage of spending on R&D in a sector’s gross value added.
Figure 6. **Research and Development Intensity by Industry**

| Sectors with Medium to High R&D Intensity |
|------------------------------------------|
| Electrical and optical equipment         |
| Transport equipment                      |
| Machinery, nec                           |
| Post and telecommunications              |
| Textiles and textile products            |
| Chemicals and chemical products          |
| Rubber and plastics                      |
| Basic metals and fabricated metal        |
| Renting of machinery and equipment, and other business activities |

| Sectors with Low R&D Intensity |
|-------------------------------|
| Agriculture, hunting, forestry, and fishing |
| Mining and quarrying          |
| Food, beverages, and tobacco   |
| Leather, leather products, and footwear |
| Wood and products of wood and cork |
| Pulp, paper, paper products, printing, and publishing |
| Coke, refined petroleum, and nuclear fuel |
| Other nonmetallic minerals     |
| Manufacturing, nec; recycling  |
| Electricity, gas, and water supply |
| Construction                  |
| Sale, maintenance, and repair of motor vehicles and motorcycles; retail sale of fuel |
| Wholesale trade and commission trade, except of motor vehicles and motorcycles |
| Retail trade, except of motor vehicles and motorcycles; repair of household goods |
| Hotels and restaurants         |
| Inland transport               |
| Water transport                |
| Air transport                  |
| Other supporting and auxiliary transport activities; activities of travel agencies |
| Financial intermediation       |
| Real estate activities         |
| Public administration and defense; compulsory social security |
| Education                      |
| Health and social work         |
| Other community, social, and personal services |
| Private households with employed persons |

nec = not elsewhere classified, R&D = research and development.

Source: Authors’ calculation using data from Organisation for Economic Co-operation and Development. 2017. *Science, Technology and Industry Scoreboard 2017: The Digital Transformation*. Paris: OECD Publishing.
the forward-linkage and backward-linkage complex GVC participation indices dataset, following Wang et al. (2017), an economy is classified as largely upstream if its forward-linkage complex GVC participation index is larger than its backward-linkage complex GVC participation index; otherwise, the economy is largely downstream. Columns 2 and 4 are the coefficients of the interaction term, which indicate whether the baseline coefficients (columns 1 and 3) are statistically different depending on the position to the global production network. For the transition from a low to a medium level of upgrading, improved innovation is proved essential in both the extent of participation and the efficiency of innovation investments, but the latter seems more evident in economies with largely downstream activities. Intuitively, upgrading in more upstream economies relies more on the quantity of local suppliers and, interestingly, conducting more R&D.

The transition from a medium to a high level of upgrading largely occurred in upstream activities, and this was achieved by further improvements in the

![Figure 7. Value Chain Breadth Scores, 2008 and 2018](image)

PRC = People’s Republic of China.

Note: The dashed line refers to the median value chain breadth scores in the two periods.

Source: Authors’ calculation using data from World Economic Forum, *Global Competitiveness Report*. https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018 (accessed March 15, 2020).
sophistication of production processes, as well as the presence of numerous local suppliers.

C. Robustness: Alternative Measure of Upgrading

Input–output-based measures of the degree and position of an economy’s participation in global production networks have been well developed and widely used, but analyses that could be drawn from this information have some limitations. Considering that the main players in GVCs are multinational companies, a more granular approach at the firm level remains indispensable in this type of research in lieu of sector- or industry-based analysis. However, as compiling input–output tables is becoming routine for many international organizations, and the data quality has been improving, we can expect our theory being better tested in some years. Further, due to data limitations, careful interpretation of the empirical results is needed. The analysis covers a limited 10-year time frame observing little variation in the dependent variable. Under the current empirical setup, the estimates might potentially be biased downward given that a decade might be too short for innovation policies and efforts to take full effect toward value chain upgrading.

For robustness purposes, we examine the survey-based measure of the economy-specific index of value chain breadth reported in the World Economic Forum’s Global Competitiveness Report. This gives some micro perspectives on how economies participate in value chains. The value chain breadth scores are derived by asking survey respondents how broad their presence in the value chain is. Scores range from 1 (narrow or primarily involved in individual steps of the value chain, for example, resource extraction or production) to 7 (broad or present across the entire value chain, for example, production, marketing, distribution, and design). Figure 7 plots the economy-level scores in 2008 and 2018 for developing Asian economies and the rest of the world.

We generate a categorical variable that considers the value chain breadth index of economies. Three levels of value chain breadth are derived by classifying the economies with the index in the first and second quintile as “low,” the third and fourth quintile as “medium,” and the fifth quintile as “high.” This variable replaces the level of upgrading based on the FVA_INT share from ADB MRIO’s GVC statistics.

13Since 2000, only a few Asian economies have transitioned to participate in the higher end of GVC activities, while most economies at the high end of GVCs upgraded long before the study period. It would be interesting to empirically test if the specific historical factors that contributed to their success are statistically significant.
Table 8 summarizes the coefficients after estimating the adjusted baseline multinomial logistic regression in equation (1). Intuitively, the results support the baseline evidence. Broad participation in GVCs, including in the more sophisticated functions of production and design, is made possible by the ability to improve the efficiency of innovation policies and investments, which is observed in both the global and developing Asian samples.

Similar to the baseline results, much of the catch-up should be undertaken early in the transition process and moving higher up GVCs requires more focused innovation policy agendas. A higher level of upgrading and participation in GVCs requires improving the quality and sophistication of production processes, as well as continuous learning from value chains (i.e., by strengthening technology absorption).

VI. Conclusions and Policy Implications

Developing Asia could be getting a lot more out of participating in GVCs if economies take steps to move into a higher level of upgrading, both individually and as part of deepening regional cooperation. Over the years, participation in GVCs by many economies in the region, particularly the PRC and some Southeast Asian economies, became instrumental for fast-tracking their growth processes. The comparative advantage of these economies, particularly in labor inputs, made them desirable destinations for foreign investment by multinational companies. But their participation is still predominantly at the lower end of the value chain, characterized by activities involving assembly and production of less sophisticated inputs. The Philippines, for example, is a globally recognized offshoring center, but its offshoring services are largely for low value-added functions, such as call centers. India, on the other hand, has been successful in high value-added business process outsourcing.

Capturing the higher end of the value chain will remain a big challenge for many economies in developing Asia, even as this paper reveals significant improvements in some developing Asian economies. The PRC is moving up the value chain by gradually undertaking high-tech manufacturing, although its share of low-tech manufacturing remains high in comparison with other economies at its income level and with advanced economies. Much of this shift toward higher value-added activities can be attributed to the PRC’s strides in technology and innovation. The country’s development plans have a strong focus on upgrading technological and innovation capacity. It also spends more on R&D than advanced economies. This is creating opportunities for other economies in the region, especially those with relatively low
labor costs, such as Bangladesh and Central Asian countries, to integrate into regional value chains and move up those chains.

The empirical results suggest that moving up a GVC heavily depends on economy-specific endowments that can be strengthened by supportive policies in infrastructure, institutions, and innovation. Governments should facilitate an enabling innovation ecosystem by implementing effective innovation policies. The transition from a low level of upgrading to a medium one necessitates an increase in the scale of investments in innovation inputs as well as allowing firms to improve their innovative capacity. But to get the biggest benefits from being in a GVC and move into the higher end of the chain, the focus should be on innovation efficiency. The design of innovation policies should focus more on how to produce technology, knowledge, and creative outputs relative to actual investments in innovation inputs, such as institutional quality, human capital, and infrastructure.

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