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Innovation in Global Value Chains

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Innovation in Global Value Chains^{*}

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ABSTRACT

Developing countries are faced with significant challenges related to building and deepening their innovation capabilities. In this chapter, we focus on innovation in global value chains and on the role that such chains play in building and deepening capability. We also focus on the trajectories along which firms, once inserted into global value chains and located in developing countries, acquire or lose innovation capability. To do so, we bring together the global value chains and innovation systems approaches. Our key arguments are that global value chains interact with innovation systems in multiple ways and that these interactions have important implications for the speed, depth, and overall quality of capability building in developing-country firms. We outline five innovation capability trajectories and show how capability building at the firm level interrelates with the various ways in which global value chains and innovation systems co-evolve.

Keywords: global value chains, innovation systems, technological capabilities, innovation policy, coevolution.

JEL: F23, D23, L22, L25, O10, O32, O38.

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1. Introduction

Innovation is a prerequisite for sustainable economic growth and development. Global interconnectedness is progressing rapidly in developing countries, especially through global value chains (GVCs). However, it is still an open question whether and under what circumstances GVCs create new opportunities for building learning and innovation capabilities and whether and under what circumstances it becomes a hindrance for doing so.

In this chapter, we look at the processes by which firms in developing countries seek to develop their innovation capabilities. As such, we discuss innovation in GVCs by examining the effects that value chains and governance patterns have on local firms' processes for building innovation capabilities. We suggest that, to foster understanding of the possible trajectories of learning and innovation in developing countries, combining the GVC and innovation system (IS) approaches can help. These approaches are relational in nature and complement each other by drawing attention to diverse actors' linkages and interactions. However, these approaches do not provide much understanding of dynamics. To fill this gap, we introduce the notion of the co-evolution of GVCs and IS and outline a framework for investigating the interaction between the two. This fosters an understanding of the trajectories that learning and innovation can take in developing countries.

We focus on firms that have inserted themselves into GVCs as suppliers of commodities, products, and services. We intentionally exclude the analysis the innovative efforts of some firms in a handful of emerging countries, which are able to acquire lead firm status and to create and govern their own value chains. Similarly, we pay only subsidiary attention to the innovation strategies of multinational corporations and of chain leaders in advanced economies.

The chapter is organised as follows. We start by providing (in Section 2) a brief introduction to the notion of innovation in the context of developing countries and by describing what can be learnt from evolutionary economics in this respect. We then discuss (in Section 3) how the concepts of innovation and upgrading differ and how GVCs can crucially influence innovation in developing countries. A proper understanding of these issues requires attentiveness to the embeddedness of firms in IS at different levels of maturity. Therefore, we proceed by bringing together the GVC and IS approaches (in Section 4). We also present a conceptual framework for investigating how GVCs and IS jointly contribute to innovation in developing countries. We outline five illustrative trajectories, ranging from scenarios in which there is an improvement in local innovation capabilities with potentially positive effects on overall competitiveness, to scenarios in which there is little progress or even a decline) in innovation capacity. We conclude the chapter (in Section 5) with considerations for public policy and directions for future research.

2. Innovation and Development

Innovation is a widely used but variably defined concept. Therefore, clarifications are helpful to define this chapter's focus and scope, especially for readers who are not familiar with innovation studies or with the emerging field of innovation and development.

To begin, *innovation* is not the same as *invention*. The latter involves a new idea— often, in a commercial setting, in the form of an idea for a new product or process, along with its specification and demonstration. Innovation is the process of putting such an idea into practice. This can include elements of creative imagination, but the majority of innovation effort is related to the organisation of implementation. Furthermore, innovation is not only a discrete event; it is also a continuous process. What is often thought of as an innovation (e.g., a new product or business model) is typically the result of a long process involving many individual innovations. Thus, we define *innovation capabilities* broadly as ‘the capabilities needed to imagine, develop and implement innovations in the goods and services an economy produces and in how it produces them’ (Bell, 2009, p. 12). In this chapter, we regard firms, and the firm-level processes of acquiring or improving innovation capabilities, as our primary unit of analysis.

In recent years, researchers have paid increasing attention to innovation in the developing world and the relatively new phenomenon of innovation policy implementation in developing countries. The literature on innovation and development, which dates back to 1980s, draws on evolutionary economics for research on technological change in the developing world (Amsden, 1992; Dahlman, Ross-Larson, & Westphal, 1987; Enos, 1991; Fransman & King, 1984; Kim, 1997; Lall, 1987; Pack & Westphal, 1986; Pietrobelli, 1998). In the remainder of this section, we briefly present what this body of literature reveals regarding the nature of innovation in the developing world.

The key point of departure for this research involves a break from the sharp distinction (often used in conventional economics) between innovation and diffusion. For a long time, scholars conceived of innovation as essentially a breakthrough in established practices, production processes, or products (inventions); such a change would only occur in the North, spurred by innovative entrepreneurs in advanced countries. Knowledge and technology would only reach developing countries (the South) through a process of *technology transfer* (Stewart, 1977). This transfer would still require some adaptation (though technical assistance would often help with this) and would often conflict with the notion of appropriate technology, but it would mainly imply that developing countries’ firms have passive relationships to technology.

However, during the 1980s and 1990s, the increased attention on the accelerated development in East Asia led to substantial field- and firm-level evidence, which in turn opened up a new conceptualisation of how innovation and technology work in developing countries. This research reveals that firms in developing countries produce a lot of innovation and this is essential to explaining productivity growth and industrial dynamics. Technological change can no longer be conceived of as a process by which technology is transferred to passive firms in developing countries. This not only misrepresents reality (given that sustained innovation is observed in the developing world) but also, if strictly followed, implies the existence of serious risks related to failure in technological adoption, absorption, or mastery, with subsequent delays and gaps in efficiency.

This ‘discovery’ of the remarkable innovation processes that are taking place in developing countries was influenced (and mutually reinforced by) the development of evolutionary economics as a conceptual framework that can aptly incorporate many of the dimensions that are relevant in developing countries (Dosi, Freeman, & Nelson, 1990; Nelson & Winter,

1977). Some of the typical innovation features in developing countries are briefly discussed in the rest of this section.

Firstly, when observing innovation in developing countries, researchers need to pay attention to innovative activities that do not occur at the technological frontier but rather imply adoption and adaptation of technology, the acquisition of a mastery over it, and the many marginal and incremental innovations that are new and change, in fundamental ways, the production process in developing countries' firms.

Secondly, there is a considerable tacit element in what is required to operate technology, and 'a firm will not be able to know with certainty all the things it can do, and certainly will not be able to articulate explicitly how it does what it does' (Nelson, 1987, p. 84). Technology is not simply a set of blueprints that, if followed exactly, always produce the same outcome. This implies that each firm must exert considerable absorptive effort to learn the tacit elements of technology and thus gain adequate mastery.

Thirdly, in developing countries, technological change often is not exogenous but is instead complementary to production activities, resulting in minor innovations such as substituting specific inputs and accommodating various market demands (Katz, 1984). Innovation also plays a central role in traditional manufacturing, which is a typical area of specialisation in developing countries, as well as in natural resources, where it can complement static resource endowments by providing the scientific knowledge and technological capabilities that are needed to exploit new, dynamic comparative advantages (Marín, Navas-Alemán, & Perez, 2015).

Fourthly, technological change is the result of a firm's purposeful, well-directed efforts to create and strengthen its technological capabilities (Bell, 1984; Lall, 1992). The capacity to generate technological dynamism is the result of investments in technological capability (by firms and by public and private institutions) rather than those investments focused on increasing production capacity (Bell & Pavitt, 1993).¹

Fifthly, this dynamic technological effort implies a learning process that is qualitatively different from the traditional process of *learning by doing*, since it involves an active attitude to learning (Lall, 1987). In all instances, learning is highly specialised; it requires specific pre-existing capabilities (learning capabilities) and is costly (Stiglitz, 1987).

Sixthly, in all countries (but especially developing ones), technological development requires suitable social organisation of the production and labour processes. The institutions that are capable of assembling individuals' knowledge and specialised skills to achieve a common purpose are crucial components in the exploitation of innovation and technology in economic development (Enos, 1991).

In summary, researchers have contended that the innovation perspective is highly relevant in developing countries, but they have also made the simple but fundamental point that the formation of innovation capabilities requires both strategic intent and the willingness to make

¹ Researchers have proposed many categorisations of technological capabilities, and these categorisations have influenced the thinking of many governments and international organisations (Cirera & Maloney, 2017; Staritz & Whitfield, 2018; UNCTAD, 2007; UNIDO, 2002).

necessary investments (Bell & Albu, 1999; Figueiredo, 2003). There has been little direct discussion about how GVCs influence learning and innovation in latecomer firms.² Our immediate task in this chapter is to explain the processes and channels by which GVCs promote (or hinder) the building of learning and innovation capability in developing countries' supply bases.

The main point coming out of this literature is that firms inserted in GVCs must act to capture new opportunities, as this is not an automatic process. There is a danger of viewing insertion into a GVC as a *benign escalator* for upgrading in supplier firms (Humphrey & Schmitz, 2002, p. 1020). The key task is to reveal some of the main sources and mechanisms that are involved when suppliers climb the *demanding stairway*. A key tenet of this chapter is that the innovation lens is useful in this respect. Upgrading and innovation are clearly related, but they also have important differences, which is the focus of the next section.

3. Upgrading and Innovation in GVCs

The concept of upgrading originated in international trade theory, where researchers used it to indicate when firms, regions, and countries within GVCs had improved, such as by moving from relatively low-value to relatively high-value activities (Gereffi, 1999). Ponte and Ewert (2009, p. 1637) proposed a broader view of upgrading as 'any trajectory or strategy that is likely to yield a positive impact on developing country firms', thus clarifying that moving up the value chain is only one possible trajectory. Moreover, Ponte and Ewert underlined that processes and product upgrading does not necessarily coincide with process and product innovation; for example, an upgrade can consist of matching the standards set by international buyers, satisfying strict logistic conditions and lead times or providing a larger portfolio of products (see also Gereffi, 2018). Along the same lines, Ponte and Ewert stressed that exploiting economies of scale (simply by increasing the size of orders) can lead to a more profitable operation and therefore for upgrading within a value chain.

From these examples of how upgrading can manifest in GVCs, it should be clear that there is no overlap between upgrading and innovation; they are distinct concepts that originated in different analytical contexts. In the GVC literature, researchers have often treated innovation and upgrading as interchangeable concepts (see, for instance, Taglioni & Winkler, 2016) but have rarely directly investigated innovation, as De Marchi, Giuliani, and Rabellotti (2018) clearly pointed out. Due to the GVC concepts' origin in the fields of international economics and development studies, researchers on this topic have focused on upgrading rather than on innovation. In turn, they have often related upgrading to the various governance patterns (e.g., market, modular, and relational, as proposed by Gereffi, Humphrey, & Sturgeon, (2005) and investigating the role that leading companies play in value chains by fostering (or hindering) knowledge transfers, mutual learning, suppliers' innovation, and so on (see for instance Cirera & Maloney, 2017; Farole & Winkler, 2014). Moreover, an excessive focus on lead-firms, rather than on developing country suppliers, leads to a poor conceptualisation of learning processes in developing countries. Researchers have often overlooked the

² On the contrary, prominent researchers have assumed that the main influence is in the opposite direction. This assumption suggests that the buildup of competences is an independent process that allows latecomer firms to form various linkages with buyers or parent firms, including innovation-centred linkages (Ariffin, 2006). We draw on this notion in Section 4.1.

heterogeneity in how firms, clusters, and regions learn and innovate through their involvement in GVCs (Morrison, Pietrobelli, & Rabellotti, 2008).

Three important issues exist with regard to knowledge and technology access via GVCs. Firstly, access to GVCs is unequal across countries and regions, with some parts of the world acting as GVC hubs and other parts not enjoying easy access to those international linkages (Chaminade & Plechero, 2015; World Bank, 2017). Secondly, despite the opportunities generated by global value chains, the precise nature of GVC inter-firm relationships remains rather controversial, and the impact on learning for developing country firms integrated into GVCs can be very significant. Pietrobelli and Rabellotti (2011) showed that governance patterns have heterogeneous impacts on learning mechanisms in value chains; in modular chains, learning can be the result of a pressure to match international standards, and value-chain leaders can facilitate learning through direct involvement if the suppliers' competence is low and if the risk of non-compliance is high. Learning can also be mutual, based on intense face-to-face interactions between the actors in the value chain, provided that they have complementary competencies. Thirdly, local suppliers differ in their capacity to absorb, master, and adapt the knowledge and capabilities that leading firms can transfer to them. Local suppliers also differ in their openness to complementary sources of knowledge from outside the GVC – including that from international trade, foreign direct investment, human-capital mobility, and international research collaboration – as well as in level of maturity of the local ISs in which they are embedded.

As De Marchi et al. (2018) suggested, capability building is interactive and requires deliberate efforts from a wide range of actors, many of which are not directly included in the relevant value chains. When successful local firms innovate, they do so because they also invest considerable effort in building their internal capabilities. A review of the empirical literature on innovation in GVCs shows that, in many cases, suppliers in developing countries, even when they participate in one or more GVCs, do not use those GVCs as privileged sources of knowledge and technologies; these suppliers thus undertake very little innovation. In many cases, learning and innovation are more effective when GVC-related knowledge is used to complement other forms of local knowledge, such as collaborative learning and interactions with non-GVC actors (e.g., other local firms that are not embedded in GVCs, universities, and business associations) within clusters and ISs. The local embeddedness of developing-country firms in ISs is therefore critical to the innovation process and to those firms' international competitiveness.

4. GVCs and ISs

Developing-country firms' participation in GVCs is contingent on local institutional, social, and economic dynamics: 'the local institutional framework identifies how local, national and international conditions and policies shape a country's participation in each stage of the value chain' (Gereffi & Fernandez-Stark, 2016, p. 16). Traditionally, in GVC analyses, researchers have focused on how institutions can influence insertion into and upgrading in GVCs, including industrial and labour policies, vocational training to supply qualified workers, and financial systems. Given the increasing recognition of the importance of investigating how innovation takes place in GVCs, scholars have also begun to pay more attention to ISs, which can be defined as 'the set of institutions whose interactions determine the innovative performance of national firms' (Nelson, 1993). For our aims, the IS approach is especially

useful, as it includes all market and non-market networks that foster the creation, transfer, adoption, adaptation, and diffusion of knowledge through personal, collective, and organisational learning processes (Lundvall, Joseph, Chaminade, & Vang, 2009; Nelson, 1993).

On the whole, the experiences of countries such as South Korea and China show that the formation of strong ISs is crucial to overcoming capability failures and thus moving away from an export specialisation based on static comparative advantage and towards sustained knowledge-based competitiveness (Fu, 2015; Lee, 2013). In this respect, value chains' role in the building of learning and innovation capability is very important; however, with some notable exceptions (Altenburg, Schmitz, & Stamm, 2008; Lema, Rabellotti, & Gehl Sampath, 2018; Pietrobelli & Rabellotti, 2011), this role remains under-explored in the innovation literature.

4.1. Co-evolution of GVC and IS

In this section, we combine the GVC and IS perspectives with the aim of exploring possible learning and innovation trajectories for firms in developing countries. The key point is that the GVC and IS approaches complement each other in the investigation of the relationships among the global and domestic actors that impact the innovation process. However, neither framework is sufficient to provide a full understanding of the underlying dynamics of innovation and learning. Considering the relationships of local firms within ISs and GVCs, there are two main types of overall flows:

- *Forward-feeding flows* (the light- and dark-grey arrows in Figure 1) are mechanisms through which ISs and GVCs contribute to the process of accumulating and shaping firm-level capabilities (learning).
- *Feedback flows* (the black arrows in Figure 1) are mechanisms through which innovative firms, via their evolving capabilities, influence local IS characteristics and value-chain governance.

We elaborate upon these connections below. However, it is first necessary to provide a caveat. Although a conceptual framework is useful for highlighting and sharpening observations of certain variables and relationships, it inevitably causes others move out of focus. Thus, in this study, we focused on local firms as mediators in the bidirectional relationships between chains and systems.³ However, changes in value chains and systems can also occur via direct interactions between them (i.e., ones that firms do not mediate). For example, such changes can take place during a negotiation regarding how value chains' leading firms will enter a country, provided that those firms are asked to contribute to the IS in the form of infrastructure and/or training centres.⁴ In other cases, leading firms lobby local

³ This relationship is akin to the theory of structuration, in which actors and structures shape each other's behaviour simultaneously (Giddens, 1983). However, the idea of co-evolution highlights the ways in which actors (local firms) are key mediators in an interactive relationship between two types of structures (ISs and GVCs).

⁴ Historically, multinational corporations in Singapore have been subject to such demands (Carney, 2014)

governments for preferential terms of entry, which can limit skill formation and the demand for local involvement. Thus, multinational firms often insert themselves into local systems and thus shape institutional frameworks and industry dynamics – an indication of a direct link between GVCs and ISs. Although we acknowledge both direct and indirect links, this section’s focus is on the effects that such interactions have on the capabilities of firms in developing countries.

Figure 1, based on Lema et al. (2018), offers a schematic picture of the following interactions:

(1) GVCs and local firms:

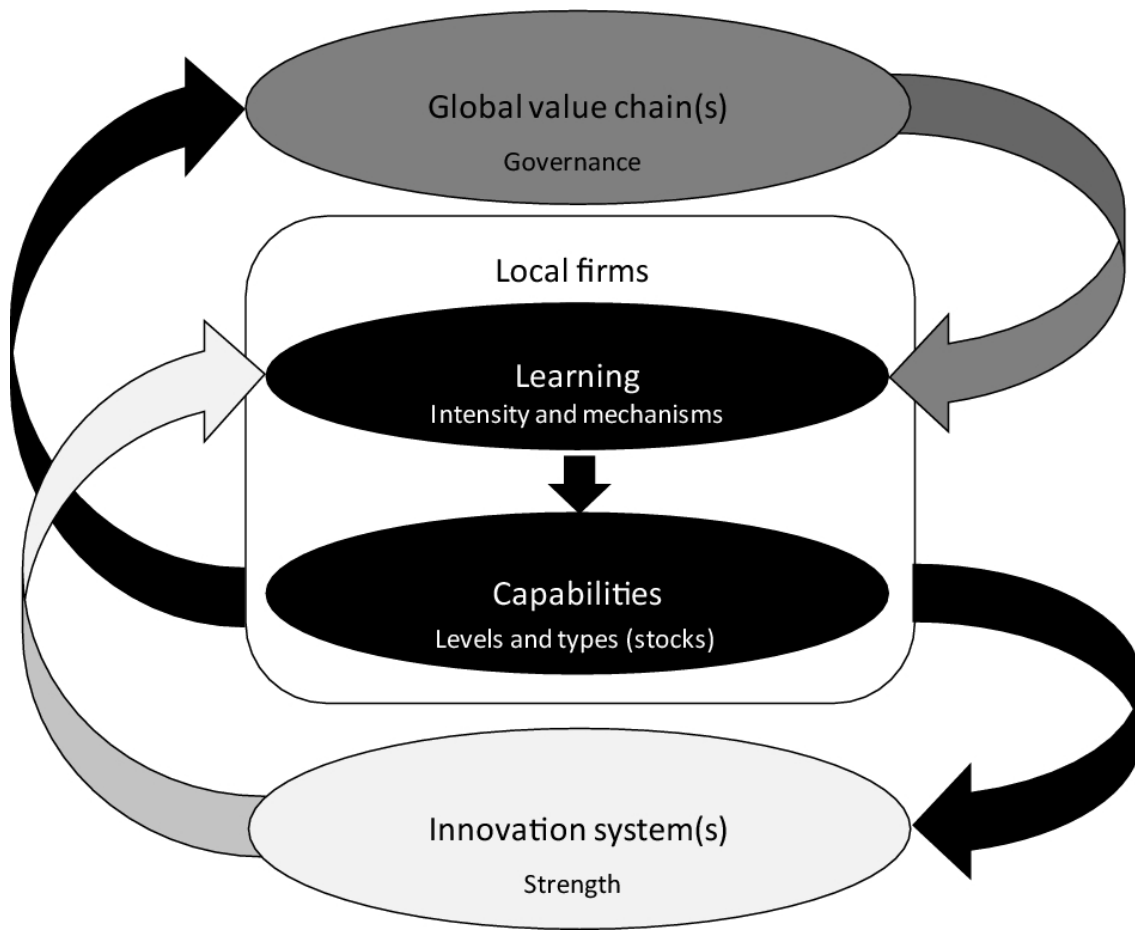
- The dark grey arrow in the top right indicates that learning takes place thanks to access to knowledge about global product requirements; technologies, know-how, licenses, and other means; organisational models; and direct support from the GVC’s leading companies, with the precise proportions depending on the dominant governance patterns (Pietrobelli & Rabellotti, 2011).
- The black arrow in the top left indicates that local firms’ existing capabilities influence where and how they can engage in various types of GVC governance, including the leading firms’ sourcing strategies (Gereffi et al., 2005).

(2) ISs and local firms:

- The light grey arrow in the bottom left indicates that learning occurs thanks to access to specialised skills, capital, extension services (e.g., metrology), standard certifications, incubation services, financial resources, and local research inputs. This learning is mainly based on adaptations of existing knowledge and is subject to the strength of the IS.
- The black arrow in the bottom right indicates that the demand for knowledge and resources in the education and science system, as well as for specific services (as offered by quality and standards agencies, business associations, or technology centres) can vary depending on the local firm. In addition, spillovers can also occur in the form of demonstration effects or labour rotation.

In addition, the co-evolutionary effects on firms’ capabilities depend on an assortment of other factors. At the broadest level, these include history, geography, and social context. At a more concrete level, they include the key characteristics of the country’s socio-economic development, its overall governance capacity, its macroeconomic context, its trade-policy framework, its main market segments. They also include the existence and development of other external channels (e.g., foreign direct investment, human capital mobility, and direct exports), the predominant sectors’ technological characteristics and knowledge bases, and the local firms’ characteristics (e.g., size, openness, presence of knowledge gatekeepers, and level of formality).

Figure 1: The co-evolution of GVC and IS with regard to firms' innovation capabilities



Source: Lema et al. (2018)

4.2. Examples of innovation trajectories

There is no automaticity in the interactions between GVCs and ISs or in their effects on firms (presented in Figure 1). On the contrary, these effects do not always arise and can be severely constrained. As such, the purpose of Figure 1 is not to show how co-evolution ‘works’ but rather to act as a conceptual building block for discussing how co-evolution can unfold in a large array of context-specific trajectories regarding firms’ innovation capabilities. In this sense, trajectories are possible routes along which firms can achieve innovation capability under the actions of the co-evolution of GVC and IS.

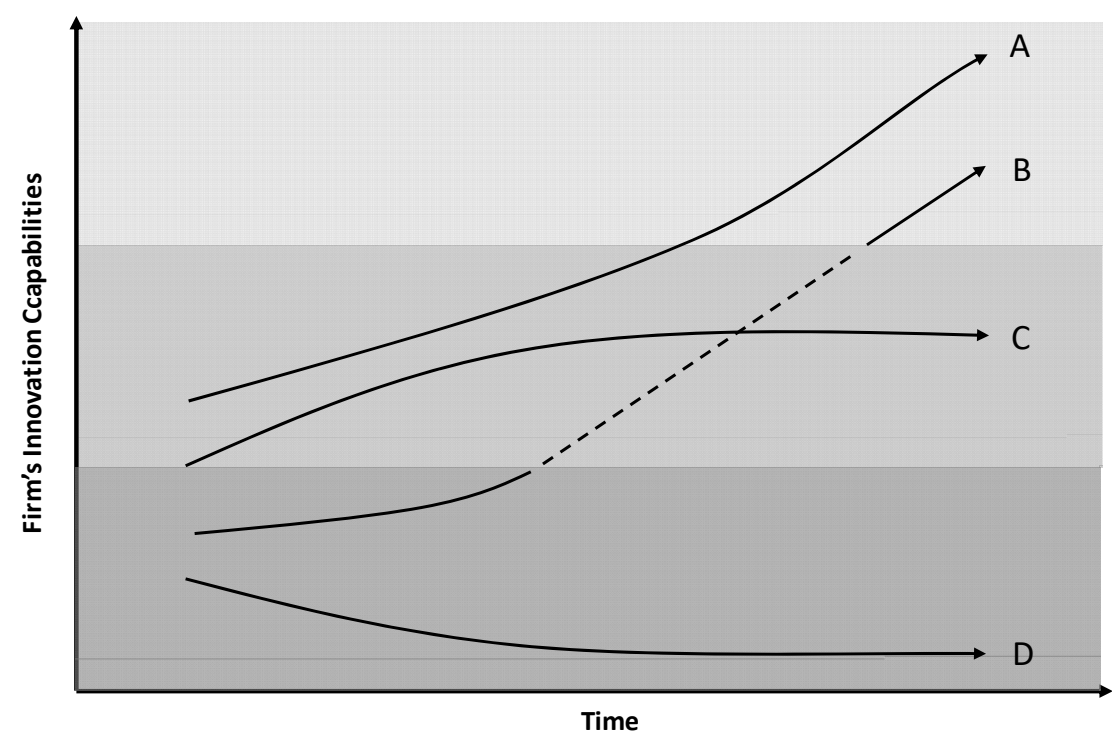
Figure 2 presents (in a two-dimensional space) some possible trajectories for the changes in a firm's innovation capability.⁵ Analytically, it is helpful to think of such trajectories as

⁵ Researchers have extensively discussed the process by which firms form and deepen their innovation capabilities in developing countries (see Section 2). Researchers have tended to focus on the accumulation of innovation capabilities. However, erosion can also occur when capabilities becomes obsolete or when they develop too slowly in relation to the evolution of demand preferences and technological trajectories (Kaplinsky, 2000).

involving various inflection points or shifts that indicate changes in the intensity or quality of learning and innovation dynamics. The table has graded fields along the vertical axis, representing the levels or depths of innovation capability, ranging from basic to advanced (Bell, 2006; Figueiredo, 2003). As such, capability levels can vary over time in trajectories, and sequences and speed can differ markedly at the country and sector levels. The variation across experiences is remarkable, and the empirical cases that have been documented in the existing literature (see below) show manifold possible trajectories: Some indicating improvement in local firms' innovation capabilities, and others indicating a lack of progress or even a loss of previous capabilities.

Table 1 presents five illustrative trajectories, showing that the co-evolution of GVC and IS can influence firms' innovation capabilities in various ways (in terms of the direction, speed, and depth of capability development). The trajectories are *gradually increasing* (A); *leap-wise increasing* (B); *stagnating* (C), and *declining* (D). Table 1 summarises some of these trajectories' key aspects, noting their key characteristics regarding IS and the value chain, as well as how their co-evolution influences the trajectories by which firms develop innovation capabilities. (The latter effect is illustrated in the graphs in the last column of Table 1, based on Figure 2.)

Figure 2: Trajectories of firms' innovation capabilities



A gradually increasing trajectory results from complementarity and a positive interaction between GVCs and ISs; this trajectory occurs when the local IS has a prerequisite strength (e.g., because of previous innovation policies at the country or local level) and when the value-chain characteristics allow for knowledge flow and interactive learning. Researchers have offered a number of examples of such trajectories, particularly in large, middle-income

countries with relatively high governance capacity. Focusing on China and India, Altenburg et al. (2008) showed how ISs, together with knowledge acquired within GVCs, contributed to the attainment of innovation capability in diverse industries such as electronics, automobiles, and space. Another example is the salmon industry in Chile, where involvement in the GVC created a demand for technicians with knowledge in biochemistry and related fields, such as engineering; this demand was successfully addressed via the strengthening of the local IS (Hosono et al. 2016). Humphrey et al. (2018) also shed light on some of the factors that can support the emergence of a gradually increasing trajectory, revealing how the rapidity and complexity of technological change – due to either the technological characteristics of some sectors (a push factor) or the nature of demand (a pull factor) – creates opportunities for more intense interactions between ISs and GVCs. By analysing the drivers of product differentiation and innovation in very different sectors in China (mobile phones and electric two-wheelers), Humphrey et al. noted that changing customer demands created pressure to improve products' functionality and quality in the Chinese market; however, in both sectors, public policy supported the development of capabilities. The electric two-wheeler sector expanded rapidly due to governmental restrictions on gasoline-based motorcycles. Thus, although the technological change was relatively slow, the domestic policy helped Chinese firms to secure greater shares of an expanding market by investing in greater R&D capabilities and simultaneously benefiting from extensive support from the national IS. In the mobile-phone sector, technological change was rapid and disruptive, but firms similarly benefited from public policies that supported capability development.

The leap-wise increasing trajectory can unfold in two ways (trajectories B1 and B2). In the former (B1 in Table 1), there is a relatively well-developed IS, but the GVCs are characterised by limited learning opportunities, as in the cases of Korean and Brazilian firms. Lee et al. (2018) suggested an *in-out-in* trajectory characterised by (a) initial participation in the GVCs, which is necessary to acquire foreign knowledge and production skills (in the value chain); (b) separation and independence from existing foreign-dominated GVCs, which is required for functional upgrading in the mid-level phases (out of the value chain); and (c) reintegration into the global chain of latecomer firms and economies after establishing local value chains (in the value chain again, but this time led by a local firm). According to Lee et al., new technologies – particularly *short-cycle* technologies, which have relatively little reliance on existing knowledge stocks – offer better opportunities for latecomer countries to achieve world-class competence.

The software industry in Bangalore, India, presents another type (B2) of leap-wise trajectory in which a value chain's learning opportunities are strong but the IS initially is fragmented and disconnected from the local enterprises. At first, this city's software industry developed almost exclusively within GVCs. Capability development was constrained for many years, and *body shopping* (the software equivalent to outsourced low-cost manufacturing services) was the key business activity. This characteristics of this industry's trajectory were very similar to those of a stagnant or aborted trajectory (e.g., limited learning in key business tasks and an IS unable to support firms in overcoming learning constraints). Over time, however, key firms were able to move on to more demanding tasks – first, efficiency-improving services and then innovation-improving services – on the basis of the learning-by-doing method (i.e., by doing business with buyers) and through firms' investments in capability. Although Bangalore was originally the centre of the Indian science system, it had no IS

beyond n arms-length and one-way flow of engineers from universities to the enterprise sector. Over time, feedback mechanisms helped in the formation of the industry's IS by developing and connecting support organisations; thus, institutions and enterprises began to connect more closely to local market users. As with the in-out-in trajectory, the key feature here is a strong but time-bound bias towards one source of learning – in this case, learning within GVCs (Chaminade & Vang, 2008; Lema, 2015; Lema, Quadros, & Schmitz, 2015). Gereffi (1999), in the seminal study of the apparel commodity chain in Asia, similarly suggested that the mechanisms allowing for organisational learning and advancement (from assembly to OEM) were mainly internal to the chain. The micro-level foundations involved both backward (sourcing) and forward (marketing) linkages, and the macro-level foundations were seemingly limited to an efficient production system that lacked a strong sectoral IS. Only when organisational learning allowed for OBM production could firms connect more closely to local markets and develop more profound horizontal linkages.

A stagnating trajectory (C) can occur if an IS becomes relatively weak and fragmented or if the value chains do not provide access to critical knowledge, resources, and pressure for learning – perhaps because they only subcontract as part of the low-value-added, unskilled production phases. As a result, in this case, local firms fail to increase their innovation capacities. Their learning rates are slow, and their knowledge is not transmitted to (and does not spill over from) GVC enterprises to the wider IS due to the latter's limited local absorptive capacity. There is ample evidence about trajectories in which involvement in GVCs fails to generate improved local innovation capabilities. For example, Ponte et al. (2014) investigated the aquaculture chains in four Asian countries and found that, in contrast to producers in China, Vietnam, and Thailand (where functional upgrading had occurred) producers in Bangladesh lacked sufficient quality and capacity with respect to the domestic regulatory framework and public-sector support; thus, upgrading attempts in Bangladesh were unsuccessful. Due to government subsidies for processing plants in the shrimp and prawn value chains, firms had little incentive to invest, as Bangladeshi plants were able to operate at lower efficiencies than those in competing locations. Moreover, the GVCs provided inadequate knowledge and resources for meeting international food-safety standards through the implementation of quality controls, partly because the traceability norms were not enforced. This combination of local weaknesses and low GVC involvement clearly impacted the local industry's inability to improve.

Finally, a *declining trajectory* (D) can occur if the IS becomes too weak to sustain previously attained competitiveness in GVCs when changes in GVCs and global demand arise. This is the case for the Thai cassava industry that Kaplinsky, Terheggen, and Tijaja (2011) examined; the shift in this industry from the EU market to the GVC (with a focus on the Chinese market) caused a change in product form (from pellets to chips). This transition led to a reduction in processing; chip production is labour-intensive and has very low added value, but pellet production adds value through grounding, stemming, and moulding the chips into pellets. Kaplinsky et al. also described a similar case in which the Gabon timber industry also sought entry into the international market (particularly China), shifting from exporting processed logs to the EU (which has strict environmental standards) to the shipping of unprocessed logs (with a focus on quantity rather than quality), including some compelling evidence of illegal exports. These examples show how local production and an IS are not always able to prevent footloose sectors from relocating or responding to external

competitive threats that arise due to the entry of competitors into the world market. Initial success is not inevitably followed by more success, and GVCs can squeeze out local businesses, which lose some of their technological capacities as a result.

Future research need to determine which of these trajectories is more common, to identify their main determinants, and to describe other possible methods for increasing innovation capability. Trajectories A, B1, and B2 are difficult to achieve and perhaps difficult to replicate outside of emerging countries. Trajectories C and D may be more common in developing countries, particularly in the low and lower-middle income ranges.

Furthermore, as mentioned above, the proposed trajectories are merely illustrative devices, and they should be treated with caution – particularly with reference to the issue of linearity. Specific co-evolutionary trajectories can vary substantially, as they depend on many factors that directly feed into this process at the country, local, and firm levels, in addition to other global determinants (e.g., market trends and technology evolution).⁶

More empirical research and policy elaboration is needed in this area, including focuses on context specificity and on feedback loops between GVCs and ISs. Researchers should document and provide robust evidence regarding the large array of possible trajectories, depending upon the roles that the various (global, country-level, local, and firm-level) factors play in this process.

5. Conclusions and Policy Implications

In this chapter, we have argued that value chains interact with ISs in multiple ways and that such interactions have remarkable implications for the speed and depth of innovation-capability accumulation. We have also set out the specific mechanisms that local firms in developing countries utilise with respect to the development of their innovation capabilities, and we have explained how the co-evolution of IS and GVC governance influences this process.

The trajectories of innovation-capability development can take multiple forms. We have illustrated five possible trajectories, each exemplified by concrete historical experiences, in which the co-evolution of ISs and GVCs resulted in diverse effects on local firms' innovation capabilities. These illustrative trajectories are not linear, nor are they the only possible ones. Rather, they rather represent instructive examples for developing the theory.

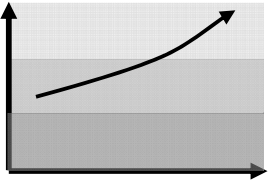
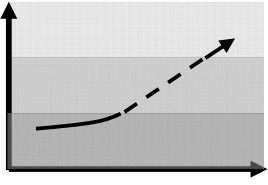
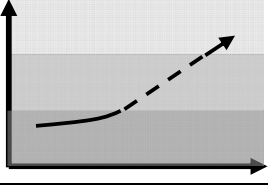
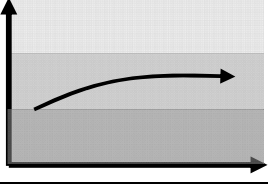
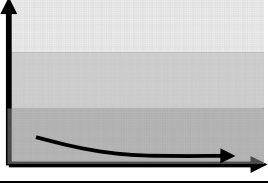
The challenges of future research include gathering new empirical micro-level evidence to enrich the list of trajectories and advance the process of theory building regarding the co-evolution of ISs and GVCs, as well as their influences on innovation capabilities. This micro-level evidence should be collected to explain the firm-level processes of learning and innovation, as well as how the context is likely to affect the firms. In particular, it is crucial to study if and how GVCs change when local innovation capabilities evolve, as well as how ISs develop when firms become involved in GVCs. We expect the evidence to differ by sector and based on the local context.

⁶ Trajectories can also vary in intensity or speed. Capturing intensity requires careful attention to and specification of the timescales of observed trajectories (i.e., how long they take). This also requires longitudinal research, as the observation of trajectories can be distorted if a time-bound lens is used (Bell, 2006).

In terms of policy implications, it is clear that policies that are meant to attract GVCs (e.g., integrate firms into a value chain) are very different from policies that are meant to capture possible but uncertain gains from GVC integration (Pietrobelli & Staritz, 2018). The former set of policies may be needed when countries do not easily attract the interest of GVC leaders due to new-entry disadvantages, incomplete or asymmetric information regarding potential suppliers' capacity and the business context, or a lack of specific inputs and factors. This kind of policy pertains more to new ways of attracting foreign direct investment and new trade policies. However, the latter are more related to the programmes that are aimed at strengthening and deepening the IS by building the firm-level innovation capabilities that are necessary for capturing gains. In this respect, it is important to emphasise that learning gains (in terms of innovation capability and innovation policy) can play a role. For example, a GVC-oriented policy of this nature could include innovation policies (e.g., matching-grant programmes) to support firms' innovation or collaborative innovation involving firms and universities, in a coherent way that is based on the characteristics and requirements of the GVCs that are present in the country (as well as those of the GVCS that could be entering it). Other examples of such policies include targeted training programmes (to create the skills local firms need for their integration into and upgrading within GVCs), methods of attracting foreign investors to fill gaps in specific parts of the value chain (Blyde, Pietrobelli, & Volpe, 2014), and organisational investments to provide technology services in the areas of standards, metrology, testing, and certification. This is still a largely uncharted and expanding field, and further, focused research and analyses are necessary.

The framework in this chapter is intended to stimulate a debate regarding how policy should be structured to combine GVCs and ISs so as to promote innovation capabilities and economic development. In addition to the need to move away from policies that automatically assume that GVC involvement has a positive effect, there is an urgency to proactively utilise GVCs and ISs as complementary instruments for promoting sustainable economic development.

Table 1: Illustrative trajectories of innovation capabilities

	Trajectory	Firms' capabilities	ISs	GVCs	GVC-IS co-evolution
Gradually increasing trajectory (A) <i>Chile: salmon</i> <i>China and India: electronics, cars, space technologies</i> <i>China: mobile phones and electric two-wheelers</i>		Firms' capabilities gradually and cumulatively strengthen.	IS strengthens sufficiently due to GVC involvement.	Value chains play a learning-intensive role.	GVC and IS exhibit complementarity and positive interactions.
Leap-wise increasing trajectory (B1) <i>Brazil: footwear</i> <i>India: pharmaceuticals</i> <i>Korea: toys, musical instruments, and helmets</i>		Firms' capabilities strengthen in successive jumps; firms oscillate between GVC and IS as alternate sources of knowledge and capability building.	Initially weak IS eventually develops to support value-chain development.	GVCs provide initial learning opportunities; local firms exit the chain; and the value chains move from local to global.	IS and GVC have sequential one-way relationships (each playing the stronger role in turn).
(B2) <i>India: software</i> <i>East Asia: apparel</i>		Firms' capabilities increase but are biased towards export-demand preferences until IS grows.	Absent or weak IS fails to support enterprise capabilities.	GVCs provide sustained learning opportunities that eventually feed back into IS development.	A one-way relationship is followed by a two-way interaction.
Stagnating trajectory (C) <i>Bangladesh: aquaculture</i> <i>Kenya, Lesotho and Swaziland: textiles</i>		Firms' capabilities remain unchanged (stagnant) or develop only marginally.	IS becomes fragmented and thus cannot support value-chain development, leading to limited absorptive capacity.	Value-chain participation remains stagnant, leading to limited learning in key tasks.	Initial efforts at mutual support are followed by disjunction or ineffective interaction.
Declining trajectory (D) <i>Gabon: timber</i> <i>Thailand: cassava</i>		Firms shift to lower-value-added stages or exit from the value chain.	Absent or very weak IS fails to support value-chain development.	Lead firms with strong bargaining power play a negative role.	GVC and IS have disjointed and/or negative interactions.

Source: Adapted from Lema et al. (2018)

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