# Innovation in Global Value Chains

Lema, Rasmus; Pietrobelli, Carlo ; Rabellotti, Roberta

*Published in:*
Handbook on Global Value Chains

*DOI (link to publication from Publisher):*
10.4337/9781788113779.00032

*Publication date:*
2019

*Document Version*
Version created as part of publication process; publisher's layout; not normally made publicly available

# 23. Innovation in global value chains

*Rasmus Lema, Carlo Pietrobelli and Roberta Rabellotti*

## 23.1 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 and deepening innovation capabilities and whether and under what circumstances they become a hindrance for doing so.

In this chapter, we look at the processes by which firms in developing countries seek to build 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 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. We introduce the notion of the co-evolution of GVCs and ISs and outline a framework for investigating the interaction between the two. This fosters a better understanding of the trajectories that 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 from the analysis the innovative efforts of some firms in a handful of emerging countries, which can acquire lead firm status and create and govern their own value chains (see Raj-Reichert, Chapter 22 this volume). Similarly, we pay only subsidiary attention to the innovation strategies of multinational corporations and of chain leaders in advanced economies.

The chapter is organized as follows. We start by providing (in Section 23.2) 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 23.3) 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 ISs at different levels of maturity. Therefore, we proceed by bringing together the GVC and IS approaches (in Section 23.4). We also present a conceptual framework for investigating how GVCs and ISs jointly contribute to innovation in developing countries. We outline five illustrative trajectories (see Figure 23.2 below), 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 23.5) with considerations for public policy and directions for future research.

## 23.2 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, 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 most innovation effort is related to implementation. Furthermore, innovation is not a discrete event; it is 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 the 1980s, draws on evolutionary economics and research on technological change in the developing world (Amsden, 1992; Dahlman, Ross-Larson and Westphal, 1987; Enos, 1991; Fransman and King, 1984; Kim, 1997; Lall, 1987; Pack and 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 Global North, spurred by innovative entrepreneurs in advanced countries. Knowledge and technology would only reach developing countries (the Global South) through a process of technology transfer (Stewart, 1977). This transfer would still require some adaptation, supported by technical assistance, and 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, increased attention to the accelerated development of countries in East Asia opened new conceptualizations of how innovation and technology work in developing countries. Research revealed that firms in developing countries indeed produce much 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. The realization that remarkable innovation processes are indeed taking place in developing countries was influenced (and mutually reinforced by) the development of evolutionary economics as a conceptual framework aptly incorporating many of the dimensions that are relevant in developing countries (Dosi, Freeman and Nelson, 1988; Nelson and Winter, 1977). Some of the typical innovation features in developing countries are briefly discussed in the rest of this section.

First, 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 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.

Second, there is a considerable tacit element in what is required to operate a new technology, as '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.

Third, 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 specialization 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 (Marin, Navas-Alemán and Perez, 2015).

Fourth, technological change is the result of a firm's purposeful, well-directed efforts to create and strengthen its 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 investments focused on increasing production capacity (Bell and Pavitt, 1993).[1]

Fifth, 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 specialized – it requires specific pre-existing capabilities (learning capabilities) and is costly (Stiglitz, 1987).

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

In sum, researchers have contended that the innovation perspective is highly relevant in developing countries, and that the formation of innovation capabilities requires both strategic intent and the willingness to make necessary investments (Bell and Albu, 1999; Figueiredo, 2003). Yet, there has been little direct discussion of 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 supply bases in developing countries. The main point arising from this literature is that firms inserted into 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 and Schmitz, 2002, p. 1020), while often suppliers climb a 'demanding stairway'.

## 23.3 UPGRADING AND INNOVATION IN GLOBAL VALUE CHAINS

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, Chapter 14 this volume). Along the same lines, Ponte and Ewert stressed that exploiting economies of scale (simply by increasing the size of orders) can lead to more profitable operations and therefore to upgrading within a value chain (Gibbon and Ponte, 2005).

In the GVC literature, researchers have often treated innovation and upgrading as interchangeable concepts (see, for instance, Taglioni and Winkler, 2016) but have rarely directly investigated innovation (De Marchi, Giuliani and Rabellotti, 2018). In turn, they have often related upgrading to various types of governance (as in Gereffi, Humphrey and Sturgeon 2005) and investigated the role that lead firms play in value chains by fostering (or hindering) knowledge transfer, mutual learning and suppliers' innovation (see, for instance, Cirera and Maloney, 2017; Farole and Winkler, 2014). Moreover, an excessive focus on lead firms, rather than on developing country suppliers, leads to a poor conceptualization of learning processes in developing countries (for an exception, see Raj-Reichert, Chapter 22 this volume). Researchers have often overlooked the heterogeneity in how firms, clusters and regions learn and innovate through their involvement in GVCs (Morrison, Pietrobelli and Rabellotti, 2008).

Three important issues arise in relation to knowledge and technology access via GVCs. First, 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 these international linkages (Chaminade and Plechero, 2015; World Bank, 2017). Second, despite the opportunities generated by GVCs, the precise nature of interfirm relationships remains rather controversial, and the impact on learning for developing country firms integrated into GVCs can vary significantly. Pietrobelli and Rabellotti (2011) show 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 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 actors in the value chain, if they have complementary competencies. Third, local suppliers differ in their capacity to absorb, master and adapt 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 – for example, that from international trade, foreign direct investment, human-capital mobility, and international research collaboration – as well as in the level of maturity of the local ISs in which they are embedded.

As De Marchi et al. (2018) suggest, 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 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 these 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.

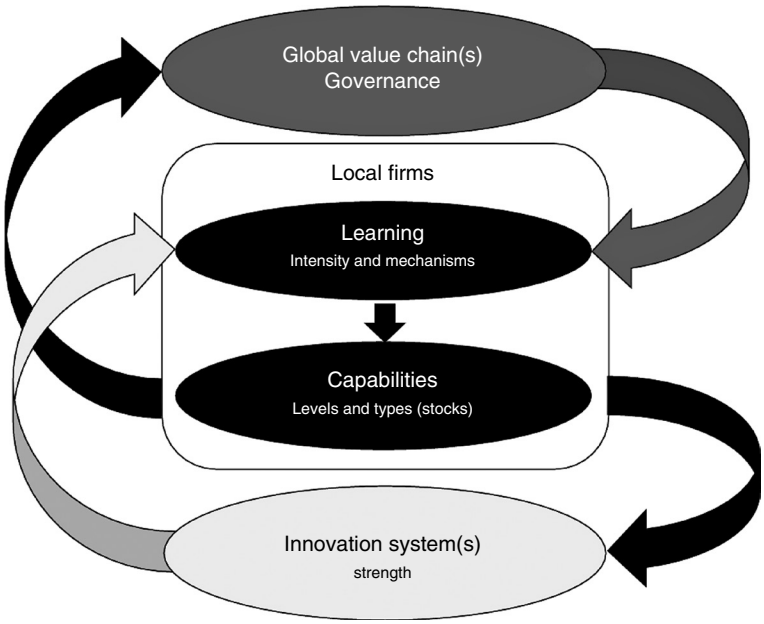
## 23.4 GLOBAL VALUE CHAINS AND INNOVATION SYSTEMS

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 and Fernandez-Stark, 2016, p. 16). Traditionally, in GVC analyses, researchers have focused on how institutions can influence insertion and upgrading in GVCs, including industrial and labour policies, vocational training to supply qualified workers, and financial systems. An innovation system can be defined as 'the set of institutions whose interactions determine the innovative performance of national firms' (Nelson, 1993). For our aim, 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 organizational learning processes (Lundvall et al., 2009; Nelson, 1993).

The experience of countries such as South Korea and China shows that the formation of strong ISs is crucial to overcoming capability failures and thus moving away from an export specialization based on static comparative advantage and towards sustained knowledge-based competitiveness (Fu, 2015; Lee, 2013). In this respect, the role of GVCs in the building of learning and innovation capability is very important. However, with some notable exceptions (Altenburg, Schmitz and Stamm, 2008; Lema, Rabellotti and Gehl Sampath, 2018; Pietrobelli and Rabellotti, 2011), this role remains underexplored in the innovation literature.

### 23.4.1 Co-evolution of Global Value Chains and Innovation Systems

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 between 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.




*Source:* Lema et al. (2018).

*Figure 23.1 The co-evolution of GVC and IS with regard to firms' innovation capabilities*

We propose two main types of flows that take place within ISs and GVCs: forward-feeding flows (the light- and dark-grey arrows in Figure 23.1), the mechanisms through which ISs and GVCs contribute to the process of accumulating and shaping firm-level capabilities (learning); and feedback flows (the black arrows in Figure 23.1), the mechanisms through which innovative firms, via their evolving capabilities, influence local IS characteristics and GVC governance. In Figure 23.1, based on Lema et al. (2018), we offer a schematic picture of various possible interactions:

- *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 and licences, organizational models and direct support lead firms – with the relative importance of these factors depending on the dominant governance patterns (Pietrobelli and Rabellotti, 2011).
  - he black arrow in the top left indicates that local firms' existing capabilities influence where and how they can engage in various types of GVCs, including the leading firms' sourcing strategies (Gereffi et al., 2005).
- *ISs and local firms:*
  - The light grey arrow in the bottom left indicates that learning occurs thanks to access to specialized skills, capital, extension services (e.g., metrology), standard

certifications, incubation services, financial resources and local research inputs. 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 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 specific level, they include the key characteristics of the country's socioeconomic development, its overall governance capacity, its macroeconomic context, its trade policy framework, and 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 technological characteristics and knowledge bases in a sector, and the local firms' characteristics (e.g., size, openness, presence of knowledge gatekeepers, and level of formality).

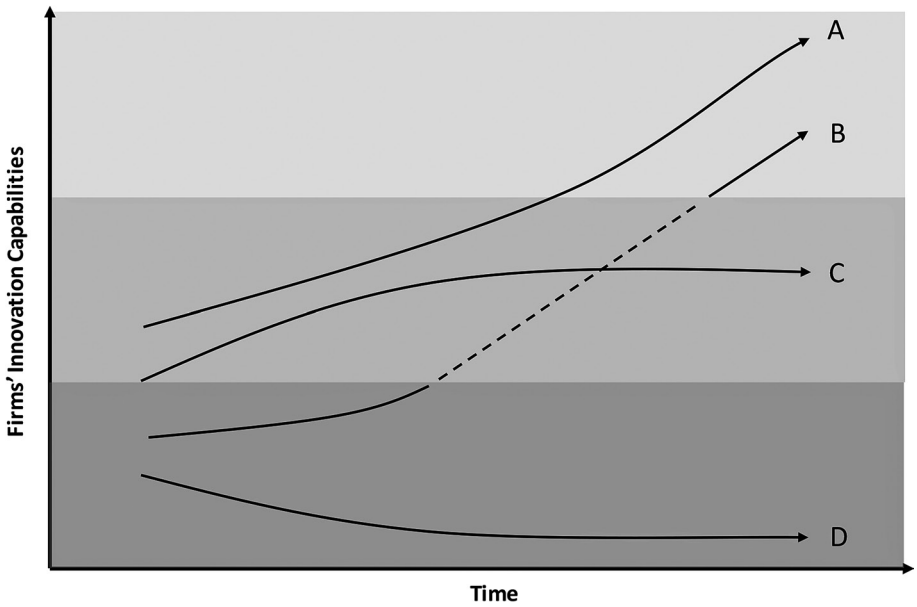
### 23.4.2 Examples of Innovation Trajectories

There are no automatic interactions between GVCs and ISs presented in Figure 23.1. Specific effects do not always arise from the same combinations and can be severely constrained. As such, Figure 23.1 does not show how co-evolution 'works'; it is a conceptual and heuristic building block for discussing how co-evolution can unfold in a large array of context-specific trajectories. In this sense, trajectories are possible routes along which firms can achieve innovation capability under the co-evolution of GVC and IS.

Figure 23.2 presents (in a two-dimensional space) some possible trajectories in a firm's innovation capability.[3] Analytically, it is helpful to think of such trajectories as involving various inflection points or shifts that indicate changes in the intensity or quality of learning and innovation dynamics. The figure 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 indicate improvement in local firms' innovation capabilities, while others indicate a lack of progress or even a loss of previous capabilities.

In Figure 23.2, we illustrate some 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: (A) gradually increasing; (B) leap-wise increasing; (C) stagnating; and (D) declining. Figure 23.3 summarizes the main characteristics of these trajectories in relation to GVCs and ISs, as well as how their co-evolution influences the trajectories by which firms develop innovation capabilities (see the graphs in the second column of Figure 23.3).

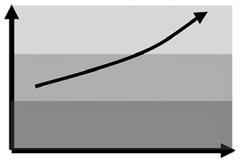
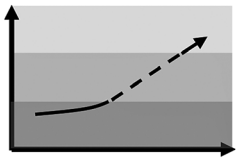
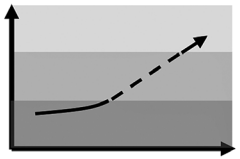
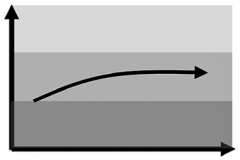
A gradually increasing trajectory results from complementarity and positive interactions




*Source:* Authors' own.

*Figure 23.2 Trajectories of firms' innovation capabilities*

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 several examples of such trajectories, particularly in large, middle-income countries with relatively high governance capacity. Focusing on China and India, Altenburg et al. (2008), for example, shows how ISs, together with knowledge acquired within GVCs, contributed to the attainment of innovation capability in diverse industries such as electronics, automobiles and aerospace. 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, Iizuka and Katz, 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. note 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

| | Trajectory | Firms' capabilities | ISs | GVCs | GVC–IS co-evolution |
|---|---|---|---|---|---|
| ***Gradually increasing trajectory (A)***<br>*Chile*: salmon<br>*China and India*: electronics, cars, space technologies<br>*China*: mobile phones and electric two-wheelers |  | 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)***<br>*Brazil*: footwear<br>*India*: pharmaceuticals<br>*Korea*: toys, musical instruments, and helmets |  | 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)***<br>*India*: software<br>*East Asia*: apparel |  | 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)***<br>*Bangladesh*: aquaculture<br>*Kenya, Lesotho and Swaziland*: textiles |  | 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)***<br>*Gabon*: timber<br>*Thailand*: cassava |  | 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).

*Figure 23.3 Illustrative trajectories of innovation capabilities*

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 B1, there is a relatively well-developed IS, but the GVC is characterized by limited learning opportunities, as in the case of Korean and Brazilian firms. Lee, Szapiro and Mao (2018) suggest an in-out-in trajectory characterized by: (1) initial participation in the GVCs, which is necessary to acquire foreign knowledge and production skills (within the value chain); (2) separation and independence from existing foreign-dominated GVCs, which is required for functional upgrading in the mid-level phases (outside the value chain); and (3) reintegration into the global chain of latecomer firms and economies after establishing local value chains (within 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 an example of a leap-wise trajectory (B2) in which the GVC learning opportunities are strong but the IS initially is fragmented and disconnected from 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. These 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 – based on 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 innovation systems beyond arm's-length relationships and only a one-way flow of engineers from universities to the enterprise sector. Over time, though, feedback mechanisms helped in the formation of the industry's IS by developing and connecting support organizations; 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 a GVC (Chaminade and Vang, 2008; Lema, 2015; Lema, Quadros and Schmitz, 2015). Gereffi (1999), in relation to the apparel commodity chain in Asia, similarly suggested that the mechanisms allowing for organizational 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 organizational learning allowed for original brand manufacturing (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 GVC does not provide access to critical knowledge, resources and pressure for learning – perhaps because lead firms only subcontract low-value-added, unskilled

production functions. 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) investigate aquaculture value 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 an appropriate domestic regulatory framework and public-sector support; thus, upgrading attempts in Bangladesh were unsuccessful. Moreover, the GVC 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 shaped 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. This is the case for the Thai cassava industry (Kaplinsky, Terheggen and Tijaja 2011), where the shift in end markets from the EU to China 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 describe 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 that it is not always possible to prevent footloose sectors from relocating or to respond to external competitive threats that arise from the entry of competitors into the world market. Initial success is not inevitably followed by further success, as GVCs can squeeze out local businesses, which can lose some of their technological capacities as a result.

Future research needs 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 low- and lower-middle-income countries. Furthermore, the proposed trajectories are merely illustrative devices, and they should be treated with caution – in particular, they should not be perceived as linear. 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).[4] More empirical research and policy elaboration is needed in this area, including efforts to understand context specificity and the feedback loops between GVCs and ISs.

## 23.5 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 utilize with respect to the development of their innovation capabilities and 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 represent instructive examples for further conceptual work.

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. 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.

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 and 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 to new ways of attracting foreign direct investment and new trade policies. However, the latter set of policies, those aimed at capturing gains, 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 such capturing gains. In this respect, it is important to emphasize that learning gains (in terms of innovation capability and innovation policy) can play a role. For example, a GVC-oriented policy focused on learning 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 and Volpe, 2014), and organizational 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 further debate regarding how policy should be structured to combine GVCs and ISs 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 utilize GVCs and ISs as complementary instruments for promoting sustainable economic development.

## NOTES

1. Researchers have proposed many categorizations of technological capabilities, and these categorizations have influenced the thinking of many governments and international organizations (Cirera and Maloney, 2017; UNCTAD, 2007; UNIDO, 2002; see also Staritz and Whitfield, Chapter 24 this volume).
2. On the contrary, prominent researchers have assumed that the main influence is in the opposite direction. This assumption suggests that the build-up 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 23.4.1.
3. Researchers have extensively discussed the process by which firms form and deepen their innovation capabilities in developing countries (see Section 23.2). Researchers have tended to focus on the accumulation of innovation capabilities. However, erosion can also occur when capabilities become obsolete or when they develop too slowly in relation to the evolution of demand preferences and technological trajectories (Kaplinsky, 2000).
4. 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).

## REFERENCES


Altenburg, T., H. Schmitz and A. Stamm (2008), 'Breakthrough? China's and India's transition from production to innovation', *World Development*, **36** (2), 325–44.

Amsden, A.H. (1992), *Asia's Next Giant*, Oxford: Oxford University Press.

Ariffin, N. (2006), 'Globalisation of innovative capabilities: evidence from local and foreign firms in the electronics industry in Malaysia and Brazil', *Science Technology and Society*, **11** (1), 191–227.

Bell, M. (1984), '"Learning" and the accumulation of industrial technological capacity in developing countries', in M. Fransman and K. King (eds), *Technological Capability in the Third World*, London: Palgrave Macmillan, pp. 187–209.

Bell, M. (2006), 'Time and technological learning in industrialising countries: how long does it take? How fast is it moving (if at all)?', *International Journal of Technology Management*, **36** (1/2/3), 25–39.

Bell, M. (2009), 'Innovation capabilities and directions of development', *STEPS Working Papers, Vol. 33*, Brighton, UK: STEPS Centre.

Bell, M. and M. Albu (1999), 'Knowledge systems and technological dynamism in industrial clusters in developing countries', *World Development*, **27** (9), 1715–34.

Bell, M. and K. Pavitt (1993), 'Accumulating technological capability in developing countries', *Proceedings of the World Bank Annual Conference on Development Economics, 1992*.

Blyde, J.S., C. Pietrobelli and M. Volpe (2014), 'A world of possibilities: internationalization for productive development', in G. Crespi, E. Fernández-Arias and E. Stein (eds), *Rethinking Productive Development: Sound Policies and Institutions for Economic Transformation*, New York: Palgrave Macmillan for Inter-American Development Bank, pp. 233–78.

Chaminade, C. and M. Plechero (2015), 'Do regions make a difference? Regional innovation systems and global innovation networks in the ICT Industry', *European Planning Studies*, **23** (2), 215–37.

Chaminade, C. and J. Vang (2008), 'Upgrading in Asian clusters: rethinking the importance of interactive learning', *Science Technology and Society*, **13** (6), 61–94.

Cirera, X. and W.F. Maloney (2017), *The Innovation Paradox: Developing-Country Capabilities and the Unrealized Promise of Technological Catch-Up*, Washington, DC: World Bank.

Dahlman, C.J., B. Ross-Larson and L.E. Westphal (1987), 'Managing technological development: lessons from the newly industrializing countries', *World Development*, **15** (6), 759–75.

De Marchi, V., E. Giuliani and R. Rabellotti (2018), 'Do global value chains offer developing countries learning and innovation opportunities?', *The European Journal of Development Research*, **30** (3), 389–407.

Dosi, G., C. Freeman and G. Nelson et al. (1988), *Technical Change and Economic Theory*, London: Pinter.

Enos, J.L. (1991), *The Creation of Technological Capability in Developing Countries*, London: Pinter.

Farole, T. and D. Winkler (2014), *Making Foreign Direct Investment Work for Sub-Saharan Africa: Local Spillovers and Competitiveness in Global Value Chains*, Washington, DC: World Bank.

Figueiredo, P.N. (2003), 'Learning, capability accumulation and firms' differences: evidence from latecomer steel', *Industrial and Corporate Change*, **12** (3), 607–43.

Fransman, M. and K. King (eds) (1984), *Technological Capability in the Third World*, London: Palgrave Macmillan.
Fu, X. (2015), *China's Path to Innovation*, Cambridge, UK: Cambridge University Press.
Gereffi, G. (1999), 'International trade and industrial upgrading in the apparel commodity chain', *Journal of International Economics*, **48** (1), 37–70.
Gereffi, G. and K. Fernandez-Stark (2016), *Global Value Chain Analysis: A Primer*, 2nd edition, Durham, NC: Duke University, Global Value Chains (GVC) Center.
Gereffi, G., J. Humphrey and T. Sturgeon (2005), 'The governance of global value chains', *Review of International Political Economy*, **12** (1), 78–104.
Gibbon, P. and S. Ponte (2005), *Trading Down: Africa, Value Chains, and the Global Economy*, Philadelphia, PA: Temple University Press.
Hosono, A., M. Iizuka and J. Katz (2016), *Chile's Salmon Industry: Policy Challenges in Managing Public Goods*, Tokyo: Springer Japan.
Humphrey, J. and H. Schmitz (2002), 'How does insertion in global value chains affect upgrading in industrial clusters?', *Regional Studies*, **36** (9), 1017–27.
Humphrey, J., K. Ding and M. Fujita et al. (2018), 'Platforms, innovation and capability development in the Chinese domestic market', *European Journal of Development Research*, **30** (3), 408–23.
Kaplinsky, R. (2000), 'Globalisation and unequalisation: what can be learned from value chain analysis?', *Journal of Development Studies*, **37** (2), 117–46.
Kaplinsky, R., A. Terheggen and J. Tijaja (2011), 'China as a final market: the Gabon timber and Thai cassava value chains', *World Development*, **39** (7), 1177–90.
Katz, J.M. (1984), 'Domestic technological innovations and dynamic comparative advantage: further reflections on a comparative case-study program', *Journal of Development Economics*, **16** (1–2), 13–37.
Kim, L. (1997), *Imitation to Innovation: The Dynamics of Korea's Technological Learning (Management of Innovation and Change)*, Boston, MA: Harvard Business School Press.
Lall, S. (1987), *Learning to Industrialize*, London: Palgrave Macmillan.
Lall, S. (1992), 'Technological capabilities and industrialization', *World Development*, **20** (2), 165–86.
Lee, K. (2013), *Schumpeterian Analysis of Economic Catch-up: Knowledge, Path-creation, and the Middle-income Trap*, Cambridge, UK: Cambridge University Press.
Lee, K., M. Szapiro and Z. Mao (2018), 'From global value chains (GVC) to innovation systems for local value chains and knowledge creation', *The European Journal of Development Research*, **30** (3), 424–41.
Lema, R. (2015), 'Problem-framing in new innovation spaces: insights from software outsourcing', in M. McKelvey and S. Bagchi-Sen (eds), *Innovation Spaces in Asia*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar Publishing, pp. 279–300.
Lema, R., R. Quadros and H. Schmitz (2015), 'Reorganising global value chains and building innovation capabilities in Brazil and India', *Research Policy*, **44** (7), 1376–86.
Lema, R., R. Rabellotti and P. Gehl Sampath (2018), 'Innovation trajectories in developing countries: co-evolution of global value chains and innovation systems', *The European Journal of Development Research*, **30** (3), 345–63.
Lundvall, B.-Å., K.J.J. Joseph, C. Chaminade and J. Vang (2009), *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar Publishing.
Marin, A., L. Navas-Alemán and C. Perez (2015), 'Natural resource industries as a platform for the development of knowledge intensive industries', *Tijdschrift Voor Economische en Sociale Geografie*, **106** (2), 154–68.
Morrison, A., C. Pietrobelli and R. Rabellotti (2008), 'Global value chains and technological capabilities: a framework to study learning and innovation in developing countries', *Oxford Development Studies*, **36** (1), 39–58.
Nelson, R.R. (1987), 'Innovation and economic development: theoretical retrospect and prospect', in J.M. Katz (ed.), *Technology Generation in Latin American Manufacturing Industries*, London: Palgrave Macmillan, pp. 78–93.
Nelson, R.R. (1993), *National Innovation Systems: A Comparative Analysis*, Oxford: Oxford University Press.
Nelson, R.R. and S.G. Winter (1977), 'In search of useful theory of innovation', *Research Policy*, **6** (1), 36–76.
Pack, H. and L.E. Westphal (1986), 'Industrial strategy and technological change', *Journal of Development Economics*, **22** (1), 87–128.
Pietrobelli, C. (1998), *Industry, Competitiveness and Technological Capabilities in Chile*, London: Palgrave Macmillan.
Pietrobelli, C. and R. Rabellotti (2011), 'Global value chains meet innovation systems: are there learning opportunities for developing countries?', *World Development*, **39** (7), 1261–9.
Pietrobelli, C. and C. Staritz (2018), 'Upgrading, interactive learning, and innovation systems in value chain interventions', *The European Journal of Development Research*, **30** (3), 557–74.
Ponte, S. and J. Ewert (2009), 'Which way is "up" in upgrading? Trajectories of change in the value chain for South African Wine', *World Development*, **37** (10), 1637–50.

Ponte, S., I. Kelling, K.S. Jespersen and F. Kruijssen (2014), 'The blue revolution in Asia: upgrading and governance in aquaculture value chains', *World Development*, **64**, 52–64.
Stewart, F. (1977), 'Technology and underdevelopment', *Development Policy Review*, **A10** (1), 92–105.
Stiglitz, J.E. (1987), 'Learning to learn, localized learning and technological progress', in P. Dasgupta and P. Stoneman (eds), *Economic Policy and Technological Performance*, Cambridge, UK: Cambridge University Press, pp. 125–53.
Taglioni, D. and D. Winkler (2016), *Making Global Value Chains Work for Development*, Washington, DC: World Bank.
UNCTAD (2007), *The Least Developed Countries Report: Knowledge, Technological Learning and Innovation for Development*, Geneva: United Nations Conference on Trade and Development.
UNIDO (2002), *Industrial Development Report: Competing Through Innovation and Learning*, Vienna: United Nations Industrial Development Organization.
World Bank (2017), *Measuring and Analyzing the Impact of GVCs on Economic Development: Global Value Chain Development Report*, Washington, DC: World Bank.