Global Value Chains and Innovation Systems

Rasmus Lema
Aalborg University
lema@business.aau.dk

Carlo Pietrobelli
Università Roma Tre e UNU-MERIT
carlo.pietrobelli@uniroma3.it

Roberta Rabellotti
Università di Pavia e Aalborg University
roberta.rabellotti@gmail.com

PRELIMINARY DRAFT

Per la 59° Riunione Scientifica Annuale della Società Italiana degli Economisti – SIE - Bologna 25-27 Ottobre, 2018

Abstract

In this paper we study the relationship between innovation, upgrading and Global Value Chains (GVCs). We first introduce what is meant by innovation in developing countries in an evolutionary economics perspective. Then we discuss why an innovation perspective is important for the discussion of upgrading in GVCs, and how GVCs may crucially influence (foster or hinder) innovation in developing countries. To this aim, a proper understanding of the concept of innovation systems in a development context is essential, and this is presented in the third section, in which we also discuss a conceptual framework to investigate how GVCs and innovation systems jointly contribute to innovation in developing countries. We conclude the paper by summarizing our argument and drawing some essential considerations for public policies.

JEL Codes: O14, O32, O43

Keywords: Global Value Chains; Innovation and learning; Governance; Innovation systems

1. Innovation and Development

In this chapter we study the relationship between innovation, upgrading and Global Value Chains (GVCs). We first introduce what is meant by innovation in developing countries in an evolutionary economics perspective. Then we discuss why an innovation perspective is important for the discussion of upgrading in GVCs, and how GVCs may crucially influence (foster or hinder) innovation in developing countries. To this aim, a proper understanding of the concept of innovation systems in a development context is essential, and this is presented in the third section, in which we also discuss a conceptual framework to investigate how GVCs and innovation systems jointly contribute to innovation in developing countries. We conclude the chapter by summarizing our argument and drawing some essential considerations for public policies.

For a long time, a traditional view prevailed in the analysis of innovation and development. Innovation was conceived essentially as a (Schumpeterian) breakthrough in established practices, production processes and products, that 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). Such transfer would still require some process of adaptation, often helped by technical assistance, and could often conflict with the notion of "appropriate" technology but would mainly imply a passive attitude in developing countries' firms.

However, during the eighties and the nineties, sometimes due to the new attention to the experiences of accelerated development in East Asia, substantial field and firm-level evidence opened the way to a new conceptualization of innovation and technology in developing countries. This research revealed how a lot of innovation would be occurring in firms in developing countries, often of a different nature, but still essential to explain productivity growth and industrial dynamics (Amsden, 1989, Dalhman et al., 1987, Enos, 1991, Fransman and King, 1984, Kim, 1997, Lall, 1987, Pack and Westphal, 1984, Pietrobelli, 1998). Technological change could not be conceived anymore as a process of technology being transferred to passive firms in developing countries. This attitude would not only misrepresent reality, given the sustained innovation then observed in the developing world, but if strictly followed, it would also imply serious risks of failure in the adoption, absorption, mastery of the technology, with subsequent delays and gaps in efficiency.

This "discovery" of the remarkable innovation processes taking place in developing countries was influenced by, and mutually reinforced the ideas being shaped and disseminated in those years with the publication of the Oslo Manual (OECD 1996), and the development of the evolutionary economics as a conceptual framework better apt to incorporate many dimensions that are relevant in

developing countries (Dosi et al., 1988, Nelson and Winter, 1982). Some of the features of innovation that are typical for developing countries are briefly discussed in the rest of this section.

First of all, innovation in developing countries needs to include all the innovative activities that do not occur at the technology frontier, but rather imply adoption and adaptation of technology, the acquisition of a mastery over it, the many marginal and incremental innovations that are new and change in fundamental ways the production process in developing countries' firms. From the point of view of the individual firm, the distinction between movements of the production function or movements along the production function, or even within the production function, is not a relevant one (Katz, 1984).

Secondly, firms in developing countries do not simply select the preferred option from the "freely available international technology shelf". There is a considerable tacit element in what is required to operate many technologies, 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 1987:84). Technology is not simply a set of blueprints, or of instructions, that if followed exactly will always produce the same outcome. This implies that each firm must exert considerable absorptive efforts to learn the tacit elements of technology and gain adequate mastery.

Thirdly, technological change in developing countries is often not exogenous but complementary to production activities: "*...a good part of technological change activities carried out in semi-industrialized countries should be conceptualised as a necessary answer to the presence of constraints and bottlenecks that must be by-passed or removed to accomplish production. These constraints generally operate by generating demand … for technological change efforts resulting in minor innovations to substitute specific inputs and to accommodate different scale and other market demands. The adaptation type of technological change then becomes a necessary step to accomplish production*" (Katz, 1984). Related to the last remark, innovation plays a central role also in traditional manufacturing sectors, a typical area of specialization for many developing countries, and also in natural resources, where they may complement (static) resource endowments with the scientific knowledge and technological capabilities to exploit new areas of dynamic comparative advantages (Marin et al., 2015).

Fourthly, technological change is the result of purposeful, well-directed efforts conducted inside the firm to create and strengthen "technological capabilities" (Bell, 1984, Lall, 1992, Enos, 1991). The

capacity to generate technological dynamism is not the result of investments to increase production capacity, but of investments in technological capability (Bell and Pavitt, 1993).[1]

Fifthly, this dynamic technological effort implies a process of learning that is qualitatively different from the traditional "learning by doing", as it involves an active attitude. In simple industries, this passive learning may be sufficient to acquire all the skills that are needed for efficient production (e.g. processed food or garments for the domestic markets). However, with more complex technologies and tighter demand requirements, learning requires an active attitude even to reach "best practice" efficiency and can occur in a variety of ways (Lall, 1987). In all instances, learning is a highly specialised process, which involves the organisation of the accumulation of technical knowledge. It has to be learnt (Stiglitz, 1987, Stiglitz and Greenwald, 2014), requires specific capabilities and is costly.

Sixthly, everywhere but notably in developing countries, technological development requires a suitable social organisation of the production and labour processes. The institutions capable of assembling individuals' knowledge and specialised skills for a common purpose are crucial components of the ability to exploit what innovation and technology can contribute to economic development (Enos, 1991).

2. Upgrading and Innovation in GVCs

The concept of upgrading has its origin in international trade theory where it is used to indicate the improvement of firms, regions and countries within global production networks, moving from low value to relatively high value activities (Gereffi, 1999). Ponte and Ewert (2009) propose a broader concept of upgrading as "*any trajectory or strategy that is likely to yield a positive impact on developing country firms*" (1637), clarifying that moving up the value chain is only one of the possible trajectories of upgrading. Moreover, they underline that in global value chains process and product upgrading do not necessarily coincide with process and product innovation because for example, it may also consist in matching standards set by international buyers, satisfying strict logistic conditions and lead times or providing a larger portfolio of products. Along the same lines, they stress that exploiting economies of scale, simply by increasing the size of orders, can be another way for a profitable operation and therefore for upgrading within value chains.

From these examples about how upgrading could manifest in global value chains, it should be clear that there is not an overlapping between upgrading and innovation; they are two distinct concepts,

[1] Many different categorizations of Technological Capabilities have been proposed in the literature and have influenced thinking in many governments as well as international organizations (UNIDO, 2002, UNCTAD, 2007, Cirera and Maloney, 2017).

originated in different analytical contexts. In the GVC literature, although they are often used as if they were interchangeable (see for instance Taglioni and Winkler, 2016), innovation is rarely directly investigated as clearly pointed out by De Marchi, Giuliani, and Rabellotti (2018). Due to its origin in the field of international economics and development studies, the GVC literature focuses more on upgrading rather than on innovation, relating it to the different governance patterns (i.e. market, modular, relational, captive and hierarchical as proposed by Gereffi, Humphrey and Sturgeon, 2005), investigating the role played by the leading companies in the chains fostering (hindering) knowledge transfers, mutual learning, suppliers' innovation, etc. (see for instance Farole and Winkler, 2014 and Cirera and Maloney, 2017).

Nevertheless, according to Morrison, Pietrobelli and Rabellotti (2008) and Nadvi (2011), given its main focus on the lead companies, the GVC literature provides a poor conceptualization of technological capabilities accumulation and learning processes at the level of GVC suppliers, often overlooking the heterogeneity at the local level about how firms, clusters and regions learn and innovate through their involvement in global value chains.

Considering knowledge and technology access via GVC, three important issues arise First, access to global value chains is uneven across countries and regions, and while some parts of the world are considerable GVC hubs, several other countries do not enjoy easy access to such international linkages (Plechero and Chaminade 2016).

Second, despite the opportunities generated by global value chains, the precise nature of GVC inter-firm relationships remains rather controversial, and their impact on the learning for developing country firms integrated into global value chains can be very diverse, because local firms have to satisfy product quality, delivery time, process efficiency, environmental, labor and social standards required by the leading companies. Pietrobelli and Rabellotti (2011) have shown that different governance patterns have a heterogeneous impact on the learning mechanisms in the chains: in modular chains learning can be the result of pressure to match international standards, while it may be facilitated by direct involvement of the value chain leaders if the competence of suppliers is low and the risk of non-compliance is high or rather it can be mutual and based on intense face-to-face interactions when the actors in the value chain have complementary competences.

Third, local suppliers differ in their capacity to absorb, master and adapt knowledge and capabilities that lead firms potentially can transfer to them. They also differ in their openness to other sources of knowledge outside the GVC such as international trade, foreign direct investments, human capital mobility and international research collaborations, as well as in their embeddedness in more or less advanced and mature local innovations systems.

As suggested by De Marchi, Giuliani, and Rabellotti (2018), capability-building is interactive and requires deliberate effort from a large range of actors, many of which are not directly included in (global) value chains. The more successful local firms that innovate, do so because they invest considerable efforts to build internal capabilities. Based on a review of the empirical literature on innovation in global value chains, they find that in many cases suppliers located in developing countries, despite participation in one or more global value chains, do not use the GVC as a privileged source of knowledge and technologies and undertake very little innovation. In most of the cases considered, learning and innovation are more effective when GVC-related knowledge is used as a complement to other forms of local knowledge channels, such as collaborative learning and interations with non GVC actors like other local firms. universities or business associations within clusters and innovation systems. The local embeddedness of developing country firms in innovation systems is therefore critical to the innovation process and their international competitiveness.

3. GVCs and Innovation Systems

It is widely accepted that '*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 2016:16, see also Gereffi 1995). With its origin in the tradition of economic sociology and the notion of 'embeddedness' in the local context, the GVC framework is often adopted for analyses which include attention to the interface between global value chains and local 'coordinated markets' which are shaped by social and institutional conditions. Participation in global value chains is highly contingent on such local institutional, social and economic dynamics: '*Because global value chains touch down in many different parts of the world, the use of this framework allows one to carry out more systematic comparative (cross-national and cross-regional) analysis to identify the impact of different features of the institutional context'* (Gereffi and Fernandez-Stark 2016:16).

However, despite this widespread attention given to the institutional frameworks, there is still no uniform or agreed way to conceptualise this institutional framework in GVC analyses, with most studies adopting an 'ad hoc' approach by paying attention to those institutions which seems important in a given context, including industrial and labour policies, vocational training institutions for supplying qualified workers, financial systems etc. that may influence insertion into and upgrading GVCs.

With the increasing recognition of the importance to investigate how innovation takes place in global value chains mentioned above, scholars have also begun to pay more attention to the institutional frameworks governing knowledge-flows and learning activities, including innovation policy,

university-industry linkages, research institutes etc. In particular, researchers have begun to combine GVC and innovation system analysis (Lema, Rabellotti, and Gehl Sampath 2018; Pietrobelli and Rabellotti 2011).

An innovation system can be defined as '*the set of institutions whose interactions determine the innovative performance of national firms*' (Nelson, 1993). It is the combination of all market and non-market networks that foster the creation, transfer, adoption, adaptation and diffusion of knowledge through learning processes that are personal, collective and organizational (Archibugi and Lundvall 2002; Gu and Lundvall 2006; Oyeyinka and Gehl Sampath 2007). As opposed to a narrower interpretation of innovation as the outcome of science-based research and development, innovation system studies sees innovation as a wider economic, social and cultural process (Lundvall 1992).

Over time, a wealth of studies about innovation systems has emerged in different regions of the world; while many of them have a national focus (Chen 2007), others study regional and sectoral innovation system (Chaminade and Plechero 2015; Malerba and Nelson 2011). The broader definition of innovation within the innovation system approach makes the concept particularly useful to study innovation from a developmental perspective (Lundvall et al 2009; Metcalfe and Ramlogan, 2008, Lall and Pietrobelli, 2005).

On the whole, experiences of countries show that the formation of strong innovation systems is crucial to overcome capability failures and move from simply a trade-based specialisation of exports to sustained knowledge-based competitiveness (Lee, 2013). In this respect, the role of value chains in building innovation capacity is highly important, but relatively underexplored in the innovation literature until now.

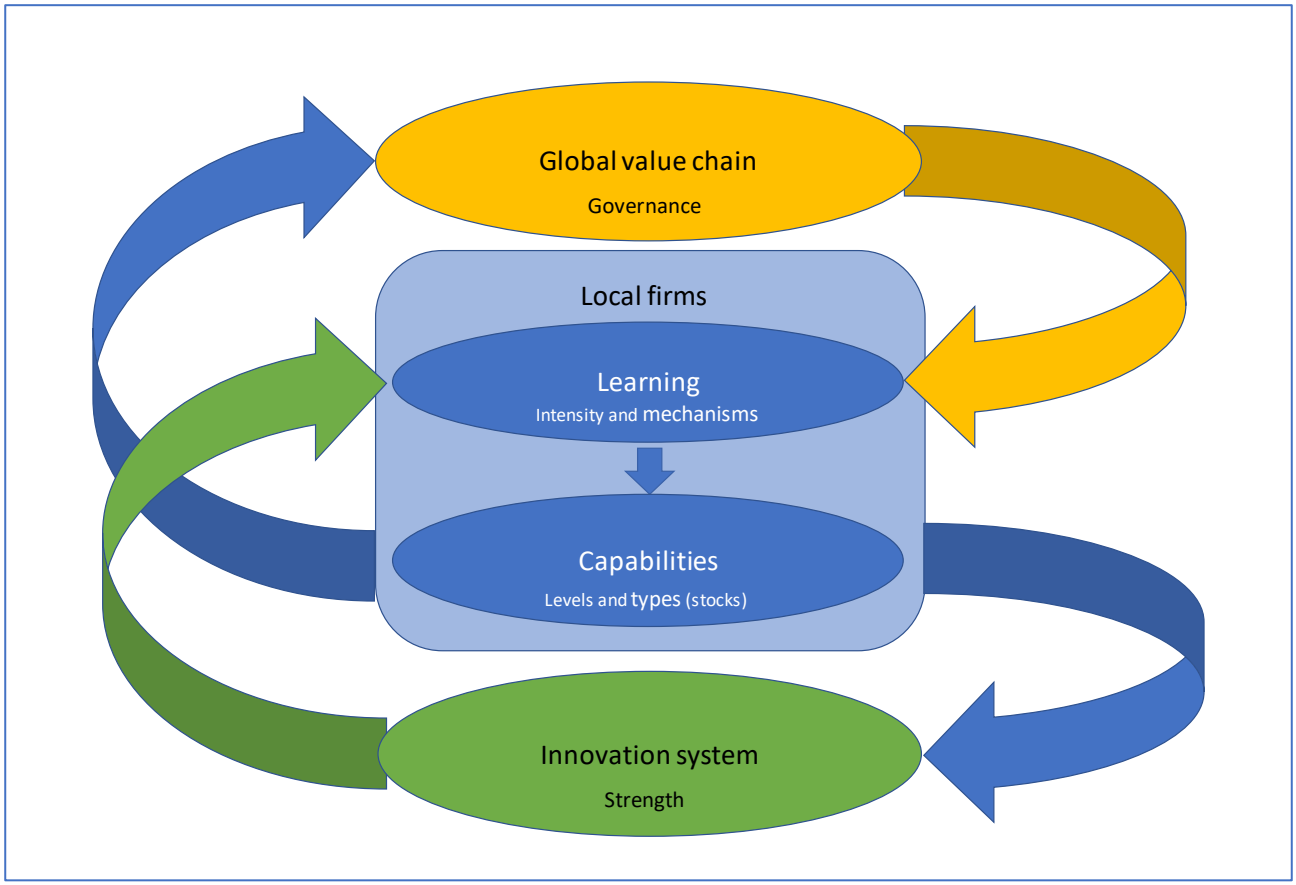
Figure 1 lays out the co-evolutionary relationships in which local firms are involved with innovation systems and global value chains. There are flows (yellow and green arrows) indicating how innovation systems and global value chains contribute to the accumulation of firms' capabilities and learning processes, as well as feedbacks (blue arrows) identifying how they co-evolve thanks to their interactions with local innovative firms and their evolving capabilities.

The interactions between global value chains and local firms (yellow arrows) can involve knowledge about product requirements in the global markets, technologies (know-how, licenses or other means) and organizational models as well as direct support from the GVC leading companies, depending on the dominant governance patterns. Subject to the strength of the system, the flows between the innovation systems and the local firms (green arrows) could provide specialized skills, capital, extension services such as metrology, standard certifications, incubation services, financial resources, and local research inputs mainly based on adaptations of existing knowledge.

The blue arrow (left side) indicates that changing local firm capabilities influence where and how they can engage in different types of global value chains, e.g. with different markets and competitive dynamics. Changes in local firm capabilities, arising from local and global learning processes, may change the governance structures of global value chains (Gereffi, Humphrey and Sturgeon, 2005), including the sourcing strategies of the lead firms (Lema, 2012). On the right side, the blue arrow points to the relative stock of capabilities in local firms inserted in global value chains influencing the evolution of the innovation system. This may happen because of the demand of different types of knowledge and resources in the education and science system or of specific services offered by quality and standard agencies, business associations etc. Besides, there may also be spillovers in the form of demonstration effects, labour rotation as well as various kinds of forward and backward linkages within the innovation system.

As evident in Figure 1, at the centre stage there are local firms, which are the main actors of the innovation process based on internal knowledge and capabilities as well as on external knowledge acquired via interactions with many other stakeholders, among which here we focus on those within innovation systems and global value chains. Of course, there may also be other forms of interactions between chains and systems that are not captured in Figure 1. For example, there are sometimes more direct links between global value chains and innovation systems, when multinational firms insert themselves into local systems and shape industry dynamics. While acknowledging such direct links, the focus in this section is on the co-evolution of system/chain relationships involving local firms.

Figure 1: GVC and IS co-evolutionary role in firms' innovative process



Source: Lema. Rabellotti and Sampath 2018

Furthermore, there is no automaticity in these interactions and their effects. They may not arise at all or may be severely constrained. The specific nature of co-evolution of IS and GVC will vary greatly depending on an assortment of external factors. These include the level of development and governance capacity of the country, the macroeconomic context, the trade policy framework, the main market segments, the existence and development of other external channels (e.g. FDI, human capital mobility, direct exports), the technological characteristics and knowledge bases of the predominant sectors, the characteristics of local firms (e.g. size, openness, presence of knowledge gatekeepers, level of formality). Also depending on such factors, co-evolution between GVC and IS will unfold in a large array of context specific trajectories.

Lema. Rabellotti and Sampath (2018) propose three possible stages of the co-evolutionary process, suggesting four illustrative trajectories, which are possible combinations involving all or some of these stages.

Depending on the dominant governance patterns in the GVC and the strength of the innovation system the stylized stages are the following. The *preliminary development stage* is characterized by a not yet fully formed innovation system, with only pockets of efficiency enabling basic capabilities, required

as an entry ticket to get initially involved in global value chains. This stage sees the initial insertion into global value chains, typically exploiting low costs of production factors, namely labour or the availability of natural resources. Local suppliers are low skilled, and the most diffused patterns of governance are captive or hierarchical ones. Lead firms intervene actively in the learning process of their local suppliers or subsidiaries that often lack competences and through their supervision they may strengthen local production and organisational capabilities, increasing productivity and the capacity to cope with the international market. However, their support is usually confined to a narrow range of tasks – for example simple assembly (as in the case of the shoe industry in the Sinos Valley in Brazil described in Navas-Alemán, 2011).

The *expansion and strengthening stage* endowed by denser and more coherent innovation systems, required in order to supply more complex and knowledge intensive support services and functioning vocational training institutes, key to assist the strengthening of capability in firms involved in global value chains. In this case the range of governance modes in use may expand to include modular or relational types. In modular chains, suppliers learn how to produce components and parts to fully specified technical standards. Lead firms impose pressure on their suppliers to keep abreast of technological advancements, but do not become directly involved in the learning process. In addition, positive knowledge externalities may result for the rest of the economy. Quite differently in relational value chains, transactions are complex and not easily codified and firms have highly complementary competences. Therefore, local learning is the result of very tight, face-to-face interactions. Beyond firms directly involved in GVC, there are commonly technology spillover, increased demand for skilled labour and for locally produced inputs (Amendolagine et al, 2017).

In the *maturity stage*, the demand for knowledge-creation is increasing as world-class capabilities need nurturing and support. The deepening innovation system becomes stronger and more dynamic. The flow of information, knowledge and technology among individuals, enterprises and institutions become denser and more varied. Governments design and implement tailored innovation policies and invest in R&D institutions and tertiary education to create a world-class workforce, while also globalising the innovation system through international innovation networks (see Fu and Gong, 2011 for the case of China). This is a long-time horizon stage for firms and countries able to connect directly to lead-markets and anticipate future customer needs, including end-user needs. Firms in developing countries may also take on coordination tasks – thereby significantly shaping cross-border value chains. Local firms are in direct relationship or might even become leading companies in global value chains. This may happen more easily in short cycle technologies because barriers are lower, given that they require competence and knowledge rapidly changing in which incumbents have lower technological advantages (Lee, Szapiro and Mao, 2018). Intensive two-way knowledge flows

underlie value chain relationships as firms expand from problem-solving to problem-framing, sometimes based on research and development capabilities.

Based on some of the potential combinations of the above three stages and informed by the extant literature, Lema. Rabellotti and Sampath (2018) depict four illustrative trajectories of GVC-IS co-evolution, summarised in Table 1. The *gradual trajectory* results from a positive co-evolution between global value chains and innovation systems when the local firms move on from the *Preliminary Development* stage to the *Expansion and Strengthening* phase, eventually reaching the *Maturity* stage. This path occurs when the local innovation system has the prerequisite strength and the value chain characteristics allow for knowledge-flows and interactive learning. The literature offers a number of examples in which such pathways are found, not least in large middle-income countries with relatively high governance capacity. Altenburg, Schmitz, and Stamm (2008) show how innovation systems together with knowledge acquired within global value chains have contributed to the attainment of innovation capability in China and India in diverse industries such as electronics, automobiles and the space industry. Another example is the salmon industry in Chile, where the involvement in the GVC has created a demand for knowledge in biochemistry and related science fields as well as for engineering educated technicians which has been successfully addressed by the strengthening of the local innovation system (Hosono, Iizuka, & Katz, 2016). Also Humphrey, Ding, Fujita and Hioki (2018) shed light on some of the factors that can support the emergence of a *gradual trajectory*. They show how the rapidity and complexity of technological change – either due to the technology characteristics of some sectors (technology push factor) or to the nature of demand (demand pull factor) – create opportunities for more intense interactions between innovation systems and global value chains. They analyse the drivers of product differentiation and innovation in two very different sectors in China (the mobile phone and electric two-wheeler). The authors note that although changing customer demand created the pressure to improve functionality and quality of products in the Chinese market, in both sectors, public policy supported the development of capabilities. The electric two-wheeler sector expanded rapidly due to governmental restrictions on gasoline-led motorcyles. So although the technological change was much slower, the domestic policy helped Chinese firms to secure greater shares of an expanding market by investing greater R&D capabilities while at the same time, benefiting from extensive support form the national innovation system. In the mobile phone sector where technological change was rapid, and of a disruptive nature, firms similarly benefited from public policies that supported capabilities development.

The *in-out-in Trajectory* may unfold if the innovation system is relatively well developed, but global value chains are characterised by limited learning opportunities. Lee, Szapiro, and Mao (2018) present evidence supporting the *in-out-in* trajectory, using cases of Korean and Brazilian firms. They

suggest that (a) participation in the global value chains is necessary to acquire foreign knowledge and production skills in the *Preliminary Development* stage (b) separation and independence from existing foreign-dominated GVCs is required for functional upgrading at mid-level stages and that (c) latecomer firms and economies need to reintegrate back into the global chain after establishing their own local value chains, ultimately reaching the *Maturity* stage. According to them, new technologies, and more precisely *short cycle* technologies which rely less on existing knowledge stocks, offer better opportunities for latecomer countries to achieve world-class competence.

An *aborted trajectory* may occur if the innovation system is relatively weak and fragmented and the value chains do no not provide access to critical knowledge, resources and pressure for learning. In this case, after the *Preliminary Development* stage the local firms remain stacked somewhere in between this stage and the following one, thereby failing to reach the *Maturity* stage. Learning rates are slow and knowledge does not transmit or spill over from GVC enterprises to the wider innovation system due to limited local absorptive capacity. There is ample evidence about such aborted trajectories in which the involvement in global value chains fails to generate improved local innovation capabilities. For example, Ponte et al. (2014) investigate the aquaculture chains in four Asian countries finding that in contrast to producers in China, Vietnam and Thailand where functional upgrading has occurred, Bangladesh lacked sufficient quality and capacity with respect to the domestic regulatory framework and public sector support, which meant that upgrading attempts were unsuccessful. Due to government subsidies for processing plants in the shrimp and prawn chains, there was little incentive to invest as plants were able to operate at lower efficiency levels than in competing locations. Moreover, global value chains themselves provided inadequate knowledge and resources for meeting international food safety standards through implementation of quality controls, partly because traceability norms were not enforced. This combination of local weaknesses with little GVC involvement clearly impacted on the inability of the local industry to improve.

Finally, a *retrograding trajectory* may occur if the innovation system is too weak to sustain competitiveness in global value chains and changes in the GVCs and in global demand occur. This is the case of the cassava industry analysed by Kaplinsky, Terheggen and Tijaja (2011) in Thailand, where the shift from the EU market to the GVC targeting the Chinese market has caused a change in product forms from pellets to chips. This transition has led to a reduction in the degree of processing, given that chip production is a labour-intensive operation with very low added value while pellet production builds on chip production, adding value by grounding, stemming and moulding chips into pellets. A similar case is described by the same authors in the Gabon timber industry, again due to the entry into the international market of China and the shift from exporting processed logs to the EU, under strict environmental standards, to unprocessed logs, with a focus on quantity rather than quality

and even some compelling evidence of illegal exports. These examples show how the local production and innovation system may be unable to prevent footloose sectors from relocating or to respond to external competitive threats arising from the entry of competitors into the world market. In such cases, the local businesses may be squeezed out from global value chains and lose some of their capacities, moving down the technological chain.

Table 1: Illustrative trajectories of GVC-IS co-evolution

Trajectories	**Firm capabilities**	**Innovation system(s)**	**Value Chain(s)**
Gradual (All stages from *Preliminary Development* to *Expansion and strengthening* to *Maturity*)	Firm capabilities gradually and cumulatively strengthened	Innovation system sufficiently strong and strengthened by GVC involvement	Value chains strengthened with more rewarding and learning-intensive roles
In-out-in (From *Preliminary Development* to *Maturity*, skipping *Expansion and strengthening*)	Firm capabilities strengthened in successive jumps; firms oscillate between GVC and IS as alternate sources of knowledge and capabilities building	Innovation system sufficiently strong to support value chain development	GVC fail to provide learning opportunities; interrupted value chain development; sequencing of local and global value chains
Aborted (Stuck in between *Preliminary Development* and *Expansion and strengthening)*	Firm capabilities unchanged or developed marginally	Innovation system fragmented and unable to support value chain development; limited absorptive capacity	Value chain participation stagnant; limited learning in key tasks
Retrograding (Going backward from *Preliminary Development* to reduced innovation capacity)	Firm capabilities weakened	Very weak innovation system unable to support value chain development; negatively affected by lead firms with strong bargaining power	Change of value change or exit from value chain

Source: Lema. Rabellotti and Sampath 2018

The stages and trajectories proposed are merely illustrative devises and they should be treated with caution, particularly with reference to the issue of linearity along given pathways. Specific co-evolutionary pathways may vary substantially, depending on many factors that directly feed into this process at country, local and firm level as well as other global determinants (such as market trends and technology evolution). This is an area where more empirical research and policy elaboration is strongly needed, with a focus on context specificity and on feedback loops between global value chains and innovation systems in order to document and provide robust evidence on a large array of

possible trajectories, depending upon the role that the various factors (at global, country, local and firms level) might play in this process.

4. Conclusions and Policy Implications

To be completed

References

Amsden A.H, 1989, *Asia's Next Giant. South Korea and Late Industrialization*, Oxford: Oxford University Press.

Bell M.R., 1984, "'Learning' and the Accumulation of Industrial Technological Capacity in Developing Countries", in Fransman and King, pp.187-209.

Altenburg, T., Schmitz, H., & Stamm, A. (2008). Breakthrough? China's and India's Transition from Production to Innovation. *World Development*, *36*(2), 325–344. http://doi.org/10.1016/j.worlddev.2007.06.011

Amendolagine, V., Rabellotti, R., Sanfilippo, M., & Seric, A. (2017). *FDI, Global Value Chains, and Local Sourcing in Developing Countries* (Working Paper No. WP/17/284). Washington.

Archibugi, Daniele and Bengt-Åke Lundvall. 2002. *The Globalizing Learning Economy*. edited by D. Archibugi and B.-Å. Lundvall. Oxford University Press.

Bell M.R. and Pavitt K., 1993, 'Technological Accumulation and Industrial Growth : Contrasts between Developed and Developing Countries', *Industrial and Corporate Change*, Vol.2 No.2.

Chaminade, C., & Plechero, M. (2015). Do Regions Make a Difference? Regional Innovation Systems and Global Innovation Networks in the ICT Industry. *European Planning Studies*, *23*(2), 215–237. http://doi.org/10.1080/09654313.2013.861806

Chen, S. H. (2007). The national innovation system and foreign R&D: The case of Taiwan. *R and D Management*, *37*(5), 441–453. http://doi.org/10.1111/j.1467-9310.2007.00485.x

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

Dahlman C., Ross-Larson B., Westphal L.E., 1987, "Managing Technological Development: Lessons from Newly Industrializing Countries", *World Development*, 15(6), pp.759-75.

De Marchi, V. Giuliani E. and Rabellotti, R. (2018) Do Global Value Chains Offer Developing Countries Learning and Innovation Opportunities? *The European Journal of Development Research*, pp.1-19.

Dosi G., Freeman C., Nelson R.R., Silverberg G., Soete L., (eds.) (1988) *Technical Change and Economic Theory*, Pinter Publisher, London.

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

Farole, T. and Winkler, D. eds., 2014. *Making foreign direct investment work for Sub-Saharan Africa: local spillovers and competitiveness in global value chains*. World Bank Publications.

Fransman M. and King K. (eds.), 1984, *Technological Capability in the Third World*, London: Macmillan.

Fu, X., & Gong, Y. (2011). Indigenous and Foreign Innovation Efforts and Drivers of Technological Upgrading: Evidence from China. *World Development*, *39*(7), 1213–1225. http://doi.org/10.1016/j.worlddev.2010.05.010

Gereffi, Gary and Karina Fernandez-Stark. 2016. "GLOBAL VALUE CHAIN ANALYSIS: Global Value Chain Analysis: A Primer."

Gereffi, G. (1995). Global Production Systems and Third World Development. In B. Stallings (Ed.), *Global Change, Regional Response: The New International Context of Development* (pp. 100-142). Cambridge; New York and Melbourne: Cambridge University Press.

Gereffi, G., 1999. International trade and industrial upgrading in the apparel commodity chain. *Journal of international economics*, *48*(1), pp.37-70.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy*, *12*(1), 78–104. http://doi.org/10.1080/09692290500049805

Gu, Shulin and Bengt-Åke Lundvall. 2006. "Introduction." *Innovation* 8(1–2):1–26.

Hosono, A., Iizuka, M., & Katz, J. (Eds.). (2016). *Chile's Salmon Industry*. Tokyo: Springer Japan. http://doi.org/10.1007/978-4-431-55766-1

Humphrey, Ding, Fujita, & Hioki. (2018). Platforms, innovation and capability development in the Chinese domestic market. *European Journal of Development Research*, *30*(3).

Kaplinsky, R., Terheggen, A., & Tijaja, J. (2011). China as a Final Market: The Gabon Timber and Thai Cassava Value Chains. *World Development*, *39*(7), 1177–1190. http://doi.org/10.1016/j.worlddev.2010.12.007

Katz J. (ed.), 1987, *Technology Generation in Latin American Manufacturing Industry*, London Macmillan.

Katz J., 1984, "Domestic Technological Innovations and Dynamic Comparative Advantage", *Journal of Development Economics*, vol.16.

Kim L., 1997, *Imitation to Innovation. The Dynamics of Korea's Technological Learning*. Boston: Harvard Business School Press.

Lall S. and Pietrobelli C., 2005, "National Technology Systems in Sub-Saharan Africa", *International Journal of Technology and Globalization*, Vol.1 No.3-4.

Lall S., 1987, *Learning to Industrialize: The Acquisition of Technological Capability by India*, Macmillan, London.

Lall S., 1992, "Technological Capabilities and Industrialization", *World Development*, 20:2.

Lee, K. (2013b). *Schumpeterian Analysis of Economic Catch-up*. *Schumpeterian analysis of economic catch-up: Knowledge, path-creation, and the middle-income trap*. Cambridge: Cambridge University Press. http://doi.org/10.1017/CBO9781107337244

Lee, K., Szapiro, M., & Mao, Z. (2018). From Global Value Chains to Innovation Systems for Local Value Chains and Knowledge Creation. *The European Journal of Development Research*, *30*(3). http://doi.org/10.1057/s41287-017-0111-6

Lema, R. (2012). Outsourcing and supplier learning: insights from the Indian software industry. *International Journal of Technology and Globalisation*, *6*(4), 285. http://doi.org/10.1504/IJTG.2012.050961

Lema, Rasmus, Roberta Rabellotti, and Padmashree Gehl Sampath. 2018. "Innovation in Developing Countries: Co-Evolution of Global Value Chains and Innovation Systems." *European Journal of Development Research* In press.

Lundvall, B.-Å. (1992). *National systems of innovation: towards a theory of innovation and interactive learning*. London: Pinter.

Lundvall, B.-Å., Joseph, K. J. J., Chaminade, C., & Vang, J. (2009). *Handbook of innovation systems and developing countries: building domestic capabilities in a global setting*. *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*. Cheltenham: Edward Elgar.

Malerba, F., & Nelson, R. (2011). Learning and catching up in different sectoral systems: Evidence from six industries. *Industrial and Corporate Change*, *20*(6), 1645–1675.

http://doi.org/10.1093/icc/dtr062

Marin, A., Navas-Aleman, L. y Perez, C. (2015). Natural Resource Industries as a Platform for the Development of Knowledge Intensive Industries. *Tijdschrift Voor Economische en Sociale Geografie*. Vol 106, Issue 2.

Metcalfe, S., & Ramlogan, R. (2008). Innovation systems and the competitive process in developing economies. *The Quarterly Review of Economics and Finance*, *48*(2), 433–446. http://doi.org/10.1016/J.QREF.2006.12.021

Morrison, A., Pietrobelli, C., and Rabellotti, R. (2008) Global value chains and technological capabilities: A framework to study industrial innovation in developing countries. Oxford Development Studies 36(1): 39–58.

Nadvi, K. (2011) Labour standards and technological upgrading: Competitive challenges in the global football industry. International Journal of Technological Learning, Innovation and Development 4(1/2/3): 235–257.

Navas-Alemán, L., 2011. The impact of operating in multiple value chains for upgrading: the case of the Brazilian furniture and footwear industries. *World development*, *39*(8), pp.1386-1397.

Nelson R.R. and Winter S.J., 1982, *An Evolutionary Theory of Economic Change*, Cambridge, Ma.: Harvard University Press.

Nelson R.R., 2008, "Economic Development from the Perspective of Evolutionary Theory", *Oxford Development Studies* Vo.36 No.1 March, pp.9-22

Nelson R.R., 1991, "Why do firms differ, and how does it matter?", *Strategic Management Journal*, Vol. 12: S2, pp.61-74. https://doi.org/10.1002.smj.4250121006

Nelson, Richard R. 1987. "Innovation and Economic Development Theoretical Reprospect and Prospect." Pp. 78–93 in *Technology Generation in Latin American Manufacturing Industries*. London: Palgrave Macmillan UK.

OECD, 1996, *Oslo Manual* 2nd edition, Paris: OECD.

Oyeyinka, B., & Gehl Sampath, P. (2007). *Latecomer Development*,. UK: Routledge Publishing.

Pack H., and Westphal L.E., 1986, "Industrial Strategy and Technological Change", *Journal of Development Economics*.

Pietrobelli C., 1997, 'On the Theory of Technological Capabilities and Developing Countries' Dynamic Comparative Advantage in Manufactures', *Rivista Internazionale di Scienze Economiche e Commerciali*, Vol.XLIV, No. 2, June.

Pietrobelli C., 1998, *Industry, Competitiveness and Technological Capabilities in Chile. A New Tiger from Latin America?*, London and New York: Macmillan and St.Martin's.

Pietrobelli, C., & Rabellotti, R. (2011). Global Value Chains Meet Innovation Systems: Are There Learning Opportunities for Developing Countries? *World Development*, *39*(7), 1261–1269. http://doi.org/10.1016/j.worlddev.2010.05.013

Plechero, M., & Chaminade, C. (2016). The role of regional sectoral specialisation on the geography of innovation networks: a comparison between firms located in regions in developed and emerging economies. *International Journal of Technological Learning, Innovation and Development*, *8*(2), 148. http://doi.org/10.1504/IJTLID.2016.077106

Ponte, S. and Ewert, J., 2009. Which way is "up" in upgrading? Trajectories of change in the value chain for South African wine. *World Development*, *37*(10), pp.1637-1650.

Ponte, S., Kelling, I., Jespersen, K. S., & Kruijssen, F. (2014). The Blue Revolution in Asia: Upgrading and Governance in Aquaculture Value Chains. *World Development*, *64*, 52–64. http://doi.org/10.1016/J.WORLDDEV.2014.05.022

Stewart F., 1977, *Technology and Underdevelopment*, Macmillan, London.

Stiglitz J.E., 1987, "Learning to Learn, Localized Learning and Technical Progress", in Dasgupta P. and Stoneman P., (eds.) *Economic Policy and Technological Development*, Cambridge University Press, Cambridge.

Stiglitz J.E., Greenwald B.C., 2014, *Creating a Learning Society. A New Approach to Growth, Development, and Social Progress*. New York: Columbia University Press.

Taglioni, D. and Winkler, D., 2016. *Making global value chains work for development*. World Bank Publications.

UNCTAD, 2007, *The Least Developed Countries Report: Knowledge, technological learning and innovation for development*, Geneva: United Nations

UNIDO, 2002, *World Industrial Development Report 2001 – 2002*, Vienna: United Nations.