A theory of capabilities for productive transformation: Learning to catch up

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4.1 Introduction

Patterns and processes of productive transformation have varied greatly across countries. Some countries have shown high performance, sustaining rapid growth over long periods. These high-performing countries have managed to achieve a pattern of growth and structural transformation that has led to fast and sustained technological change and productivity growth, the generation of more and better jobs, more sophisticated occupational structures, and employment patterns that result in rising incomes and in poverty reduction. In short, they achieved high-performing catching-up growth and economic development. Others have gone through a more fitful and uneven transformation process with growth spurts followed by slowdowns. Yet others have failed to trigger much in the way of transformation, continuing to rely heavily on traditional activities in the rural economy and informal activities in the urban economy.

This differentiated performance among countries and regions in their patterns and processes of catching up raises significant policy issues and challenges. One of them is the role of capabilities in productive transformation. Economists take different perspectives on how capabilities enable and shape productive transformation. One strand of the literature, the structural change perspective, argues that capabilities determine the products and technologies that firms and economies can easily develop (Hausmann et al., 2011; Richardson, 1972). A second strand, the process perspective, discusses capabilities as the determinant of the behaviour of firms and economies and their competences to perform such tasks as coordinating, investing, innovating, identifying and solving problems, and learning

(Chang, 2010; Dosi, Winter and Nelson, 2000; Lall, 1992 and 2000; Nelson, 2008; Nelson and Winter, 1982; Sutton, 2012; Teece, Pisano and Shuen, 1997). Thus, these two separate strands of the literature discuss capabilities as the determinants of two dimensions of productive transformation: the *patterns* as well as the *process* of structural transformation. Development economics, however, so far has failed to integrate these two perspectives into a growth and productive transformation model.[1]

Mainstream growth models have largely neglected capabilities. These models view economic development as a process of production factor and technology accumulation, assuming a mechanistic relationship between investment in productive capacities and growth, with market forces driving the accumulation and growth process. Robert Lucas (1988) summarizes this perspective in his article "On the mechanics of economic development". He distinguishes three accumulation models: "[A] model emphasizing physical capital accumulation and technological change, a model emphasizing human capital accumulation through schooling, and a model emphasizing specialized human capital accumulation through learning-by-doing. Two decades after Lucas published his article, the Commission on Growth and Development (2008, p. 37) concluded that economists still lack a good understanding of the link between technology, human capital, education and training on the one hand, and economic growth on the other one, that therefore "[researchers] may have the wrong model of growth" and that, due to country-specific capabilities, there is no "one size fits all" set of rules to guide policy-makers seeking to promote growth.

This chapter shifts focus from the *mechanics* to the *dynamics* of economic development by elaborating an analytical framework to better understand the process of catching up and the forces driving its dynamics. The framework introduces capabilities as a key determinant of catching up and economic development.

To date, however, despite the centrality of capabilities in the literature on productive transformation, the concept has remained a black box. Dosi, Winter and Nelson (2000, p. 1) note that "[t]he term 'capabilities' floats like an iceberg in a foggy Arctic sea, one iceberg among many, not easily recognized as different from several icebergs nearby". This chapter therefore develops a theory of capabilities to explain how capabilities shape the dynamics of catching up, where the different types of capabilities reside, how they are created and transformed, and the role of policies in promoting and shaping them.

[1] It is important to distinguish this "productionist" view of capabilities from the "humanistic" view developed by Amartya Sen (Chang, 2010). Sen developed a concept of human capabilities to provide a new measure for development. In contrast, the "productionist" view explains how collective capabilities at the level of firms and economies shape structural and technological change in the economy.

The theory consists of three components. First, a concept of catching up is elaborated which defines the phenomenon as a process of productive transformation reflected in diversification into new products and higher value added activities as well as in technological upgrading, the creation of more productive and better jobs and employment patterns that result in rising wages and poverty reduction. The catching-up concept views productive capabilities and productive capacities as two fundamentally different but interrelated concepts, integrates the structural change and process dimension of productive transformation discussed by distinct economic traditions, and elaborates the channels through which capabilities shape both dimensions of productive transformation and thereby determine growth.

With this in mind, the chapter develops a knowledge-based concept of capabilities, the second component of the theory of capabilities for productive transformation. The concept argues that the capabilities to drive and govern productive change are embodied in various collective, shared or aggregate forms of knowledge at the levels of enterprises, the labour force, economies and societies. Hence, while productive capacities reside in the "material" sphere of the economy (in tangible production factors and infrastructure), productive capabilities exist in the "non-material" or in the intangible sphere of knowledge.[2] Figure 4.2 depicts the knowledge-based capability concept linked to the catching-up framework.

The development of capabilities is therefore essentially a process of learning. Hence, there is a need to elaborate a concept of learning which explains how capabilities are generated. Economists, however, have only a limited understanding of the nature of the learning processes that lead to expanding capabilities for high-performing catch-up growth and economic development.[3] This chapter therefore elaborates a concept of learning which draws on explicit theories of knowledge and learning developed in different disciplines such as philosophy, cognitive science and sociology (e.g. Bandura, 1986; Boyd and Richerson, 1985; Polanyi, 1958), and applies them to the economic context.

This interdisciplinary approach shows that learning to catch up is a complex and costly process, involving the accumulation of different forms of knowledge,

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[2] This distinction between the material and the knowledge sphere in explaining economic development goes back to List (1909 [1841]), and was highlighted more recently by the "new" economic historians such as McCloskey, Goldstone and Mokyr (see Nübler, forthcoming).

[3] Economic growth and trade theories use concepts such as "learning-by-doing" or "knowledge spillovers". The learning process, however, is not explicitly modelled, but is assumed to occur as the result or "by-product" of production (Arrow, 1962), trade (Young, 1991) and investment in R&D (Cohen and Levinthal, 1989). Human capital theory assumes that learning by individuals takes place as a result of investment in education and training. Stiglitz (1999) discusses knowledge as a public good and public policy implications for the provision, use, transfer and dissemination of such goods.

characterized by distinct properties and acquired through fundamentally different learning processes – an observation that highlights the relevance of learning not only in schools but also in the production system and in social, cultural and organizational networks. Moreover, the concept demonstrates the relevance of learning not only at the level of individuals, but also at the collective level of social groups – in enterprises, organizations, the economy and society as a whole. In addition, learning itself represents a capability. Learning to learn is therefore a central feature of high-performing learning systems in a dynamic economic context. This concept of collective learning is the third component of the theory of capabilities for productive transformation.

The theory of capabilities contributes to a better understanding of the link between education, training and technological learning on the one hand and economic growth on the other hand. This link was identified as a knowledge gap by the Commission on Growth and Development (2008). The knowledge-based concept of capabilities linked to productive transformation shows that transformation of capabilities through individual and collective learning drives the dynamics of catching up by enhancing the range of options for diversification and the collective competences necessary to generate rapid and sustained processes of productive transformation.

The framework defines a wide scope for industrial policies as they are challenged with promoting the co-evolution of the two interrelated processes of building capabilities for productive transformation in a learning process, and accumulating productive capacities through investment in production factors, in existing as well as new and advanced industries. This chapter is focusing on policies to promote the evolution of capabilities in the knowledge sphere. The framework offers recommendations for an integrated learning strategy that creates capabilities for high-performing patterns and processes of productive transformation. Such a learning strategy embraces education, training, technology, R&D, trade and investment policies, promoting learning in all sectors, at all levels and in multiple locations, as well as fostering institutions to trigger, accelerate and sustain these learning processes. The learning strategy forms an essential part of an industrial and economic development agenda.

This chapter is structured as follows: Section 4.2 sets out a concept of catching up that focuses on the dynamics of economic transformation and introduces capabilities as a main driver of catching-up dynamics. Section 4.3 presents a knowledge-based concept of capabilities, explaining where capabilities reside (collective memories), and Section 4.4 explains how capabilities are generated (collective learning). Section 4.5 outlines a learning strategy for creating a high-performing process of capability development. Section 4.6 draws conclusions.

4.2 A dynamic concept of catching up

This section develops a concept of catching up by drawing on different traditions in development economics, ranging from the German historical school to institutional, evolutionary and structural economics. It recognizes the wide potential of developing countries to catch up in the light of their imitating or borrowing existing products and technologies from around the world, but also explains the limits developing countries face in exploiting these potentials.

4.2.1 Two dimensions of catching up

The concept maintains that the dynamics of catching up are determined by the structural change and process dimensions of productive transformation. The structural change dimension relates to the patterns of change in the economic structure (diversification, product differentiation and technological upgrading) while the process dimension relates to the pace and sustainability of this change. Performance in catching up is measured in terms of both patterns and processes of productive transformation.

Patterns of productive transformation – What you produce matters

The pattern of change in the economic structure is important as it determines the extent to which countries can achieve their development goals. Indeed, "... not all goods are alike in terms of their consequences for economic performance" (Hausmann et al., 2007, p. 1). Some patterns of structural and technological change and specialization in certain goods contribute more than others to improvements in productivity, income and wages, the generation of more productive and higher quality jobs, and opportunities for learning in the production process.

Empirical evidence shows that high productivity growth rates were achieved in countries that were able to shift production from traditional to modern activities, in particular to tradable and industrial products, and to develop relatively complex export goods (Hausmann, Hwang and Rodrik, 2007; Rodrik, 2009). Manufacturing has been identified as a "leading sector" in the process of productive transformation due to its economies of scale, strong backward and forward linkages, and widespread opportunities for technological progress and knowledge spillover. Furthermore, manufacturing generates a substantial

number of productive jobs, through direct effects as well as through indirect effects created by linkages to other sectors and income-induced effects.[4]

Ocampo, Rada and Taylor (2009) identify manufacturing as the sector with the highest potential for productivity and employment growth in low-income countries, although technological upgrading and diversification within agriculture are also important to support productive transformation. In contrast, in higher-income countries with rapid long-term growth, manufacturing has served as an engine for productivity growth, but not for job creation; here, net growth in jobs has come from the service sector. Roncolato and Kucera (2013) discuss the potential role of advanced services as a "leading sector" in economic development, highlighting competing perspectives among economists and arguing that the service sector can be a lagging complement to manufacturing, a leading complement to manufacturing or a substitute for manufacturing.

An emerging literature is analysing the impact of technological change on the properties of tasks and jobs and thereby on the quality of employment. Jobs and tasks are allotted to categories such as routine, non-routine, analytical, interactive, manual, cognitive, skilled or unskilled (Autor, Levy and Murnane, 2003; Balconi, Pozzali and Viale, 2007; Chandler, 1977). Since technologies and production processes used in different economic sectors differ in important economic properties such as fragmentability, factor intensity, modularization, automation of tasks, and knowledge base, they are associated with different job profiles. Consequently, the nature of technological change promoted in a catching-up strategy has important implications for the quality of jobs and the occupational structure of the economy (Nübler, forthcoming).[5]

Countries also need to strike a good balance in achieving multiple development objectives, taking account of potential synergies and trade-offs. Rapid technological deepening and the labour-saving nature of technological change drive productivity growth, but also destroy jobs. The challenge facing developing countries is therefore to diversify into a broad range of new economic activities (and promote domestic and foreign demand) in order to generate new jobs to achieve positive net employment effects. Comparative analysis of productive transformation processes in the Republic of Korea and Costa Rica during the 1960s and 1970s demonstrates that the Republic of Korea achieved significant higher growth rates in productivity and employment by simultaneously promoting industrial widening and technological deepening, while in Costa Rica,

[4] See Lavopa and Szirmai (2012) for a review of the literature.

[5] See, for example, Lall (2000); Pavitt (1984); Perez (1983); Nelson and Winter (1982).

industrial widening moved more slowly than technological deepening (Nübler, forthcoming).

These empirical findings suggest that countries' performance in terms of patterns of structural and technological change need to be assessed in the light of their development objectives and the aspirations of their societies. There is no "one-size-fits-all" pattern of high-performing productive transformation.

Processes of productive transformation – Pace and sustainability

In addition to high-performing patterns, countries need to develop a high-performing process of productive transformation. This is important in light of high unemployment rates, fast-growing numbers of young people entering the labour market and persistent poverty in many developing countries. High-performing processes are expressed in fast expansion of productive capacities and rapid productive transformation, absorbing technology and diversifying into a wide scope of different products and industries. Reinert (2009) finds that countries achieving a rapid pace of catching up jumped into leading technological paradigms which created "productivity explosions" through increasing returns, fast learning, synergies, innovation and rapid diversification.

High performance of processes is also measured in terms of sustainability. Countries can move from low to middle and then to advanced income levels only if they can sustain high growth rates in income per capita for a significant period of time. The recent debate on the "middle-income trap" suggests that moving from the middle to the advanced income level seems to be a challenge for many middle-income countries. Growth rates tend to decline as they approach the upper middle-income thresholds, and, thus, these countries risk falling into the middle-income trap.[6] While a growing body of studies explores empirically trends and factors that are related to declining growth dynamics in middle-income countries, development economics does not provide models or frameworks to explain the middle-income trap.

To summarize: the two dimensions of productive transformation and catching up are complementary, and therefore need to evolve together. Successful catching up requires high performance in both the structural change and the process dimensions of catching up.

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[6] See, for example, Agénor and Canuto (2012); Eichengreen, Park and Shin (2011); Foxley and Sossdorf (2011); Jankowska, Nagengast and Perea (2012).

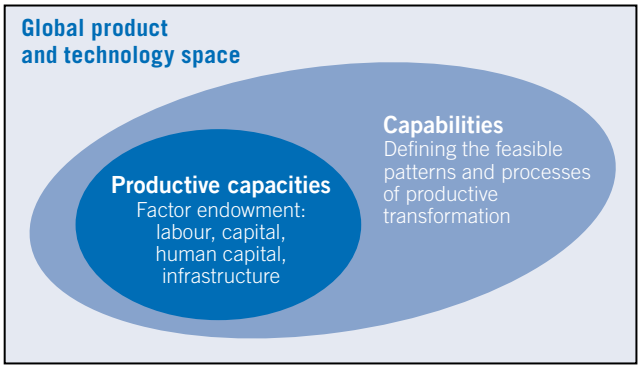
4.2.2 Productive capacities and productive capabilities

The concept of catching up elaborated in this chapter defines catching up as a dynamic process of productive transformation. This concept distinguishes between the "catching-up potential" and the "feasible" or "realistic" space for catching up. The gap between a country's portfolio of mastered techniques, activities and products and those available at the global level defines its "catching-up potential". In figure 4.1 the global product and technology space (GPTS) describes the technologies and products that exist in the world, while the productive capacities space describes a country's existing portfolio of technologies and products it masters at a particular point of time. Hence, a country's catching-up potential is benchmarked against the GPTS. Productive capacities are determined by the production factors accumulated in the country.

Gerschenkron (1962) views the gap between the GPTS and a country's productive capacities as the "benefits of backwardness", as it provides the potential for developing countries to develop rapidly by borrowing technologies from the rest of the world and imitating products already produced in more advanced countries. The challenge facing developing countries is to catch up within the GPTS, to imitate a wide range of different products, to expand the scope of their own economic activities and technologies within the GPTS, to navigate rapidly through this space and to sustain this process.

This concept of catching up argues that each country or society has developed a specific set of capabilities that determines its feasible scope for expanding productive capacities and catching up within the GPTS. They determine a country's realistic direction of change and the nature of the diversification, product differentiation and technological upgrading that a country can achieve. The feasible

Figure 4.1 A concept of catching up



scope or space for productive transformation is illustrated by the capabilities space in figure 4.1. The boundary of this space distinguishes those products and technologies that the country can easily adopt from those that are beyond the country's reach.

Capabilities also determine the pace and sustainability of the transformation process. Countries need to develop competences that enable firms and the economy to identify new opportunities for change, to invest and expand productive capacities into targeted new industries and technologies, and to manage rapid and sustained processes of structural and technological transformation. Developing countries differ in their abilities to expand productive capacities into new products, industries and technologies, manage the transformation process and exploit their catching-up potential.

Abramovitz (1986) introduces "social capabilities" as a variable to explain the differences in performance among today's developed countries during their historical catching-up phases. He concludes that the countries able to catch up rapidly with advanced technologies were behind technologically but advanced in social capabilities. The important contributions by Abramovitz are the insights that countries differ in capabilities, that capabilities determine a country's ability to implement economic and technological change, that these capabilities are embodied in society and that they are not given but acquired. Abramovitz labelled these *social* capabilities because they are embodied in society. This chapter, however, calls them productive or dynamic capabilities to stress their role in driving the dynamics of productive transformation and growth.

4.2.3 Capabilities are expressed in options and competences

The dynamic concept of catching up establishes two distinct links between country-specific capabilities and the dynamics of productive transformation. In the first place, capabilities are expressed in options for structural and technological change. The concept of options implies that country-specific capabilities are not automatically translated into productive capacities and productive transformation. Rather, countries need to translate options into productive capacities through investment in new production factors, infrastructure and R&D, and the reallocation of resources. The concept of options also implies that capabilities are preconditions for productive transformation and that the development of capabilities needs to precede transformation of productive structures and technological upgrading.

This concept of catching up suggests that even countries with similar factor endowments and comparative advantages may have developed different

capabilities and therefore have different options for productive transformation within the GPTS. This contrasts with mainstream economic theory, which implicitly assumes that all countries have developed all relevant capabilities, and as a consequence are all able to imitate each product in the GTPS. On this model, the selection of products within the GPTS that countries should target is determined by cost and comparative advantage. Thus Lin and Treichel (Chapter 2 in this volume) fail to take into account capabilities in their Growth Identification and Facilitation Framework and limit their analysis to productive capacities and comparative advantages. The concept of catching up elaborated in this chapter suggests that comparative advantages and capabilities are two distinct analytical concepts, and that the analysis of comparative advantages for diversification and productive transformation needs to be complemented by an analysis of capabilities and the options for productive transformation embedded in these capabilities.

In the second place, capabilities are expressed in collective competences to manage and direct the process of productive transformation. These competences play a central role in shaping the pace and sustainability of the catching-up process. They determine the performance of both individual firms and the economy as a whole in navigating through the GPTS and imitating new products and technologies in which they have no prior experience. The nature of competences countries have accumulated will determine their behaviour in translating options into economic diversification and technological change.

To conclude, the concept of catching up developed in this chapter defines catching up in terms of the two dimensions of productive transformation, and views capabilities as a major force driving the dynamics of both dimensions. Capabilities are expressed in the options defining the scope and nature of productive transformation, and in the competences that allow countries to translate options into productive capacities.

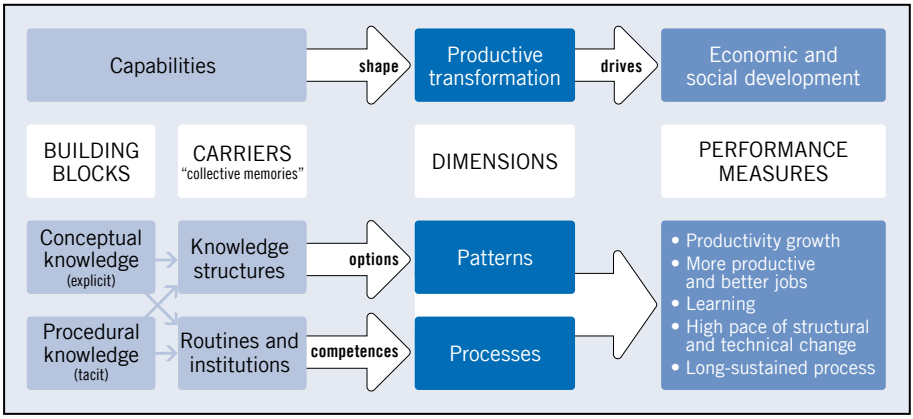
Furthermore, options and competences are complementary, and both need to be developed simultaneously to generate a high-performing catching-up process. The dynamics of productive transformation result from the co-evolution of options and competences for productive transformation as well as from the coordination of capabilities development with investment in productive capacities. Governments aiming at formulating a consistent economic development strategy need to align the development of capabilities with that of productive capacities. The continuous enlargement and transformation of country-specific capabilities is a central precondition and driver of sustained productive transformation and catch-up growth.

4.3 A knowledge-based concept of capabilities

Policy-makers aiming at promoting capabilities face the critical question: where do capabilities reside? That is, what are the "carriers" of options and collective competences for high-performing productive transformation? This section proposes a knowledge-based concept of collective capabilities. It suggests that capabilities for productive transformation reside in the sphere of knowledge, and therefore in the "non-material" sphere of the economy. Capabilities are intangible. The knowledge-based concept distinguishes between conceptual and procedural knowledge as distinct building blocks of capabilities (see figure 4.2).[7] Conceptual knowledge, or "knowing that", refers to abstract or general ideas, principles, rules and models. Concepts allow individuals to categorize and structure information and data, to analyse and interpret empirically observed phenomena, to gain understanding and meaning and to make choices.

In contrast, procedural knowledge refers to "knowing how to do", and it determines how well individuals, firms and economies perform in the work, production and learning processes. For example, the performance of a football team is not determined only by the conceptual and procedural knowledge of the individual players, but is essentially shaped by the collective procedural knowledge residing at the level of the team. The same could be said for teams of workers in an enterprise.

Figure 4.2 A theory of capabilities for catching up



[7] Chang (2010, p. 54) contends that "dynamics cannot be achieved by the isolated activities of individuals, but are created in the way individual competences are organized and coordinated within enterprises, in the knowledge which is created in a collective manner in the context of a complex division of labour".

The following two sections discuss knowledge structures and routines and institutions as distinct forms of collective knowledge and explains how conceptual and procedural knowledge shape options and competences for productive transformation in different ways. These two sections therefore establish the link between the knowledge and the material sphere of the economy, and the nexus of knowledge, capabilities and productive transformation.

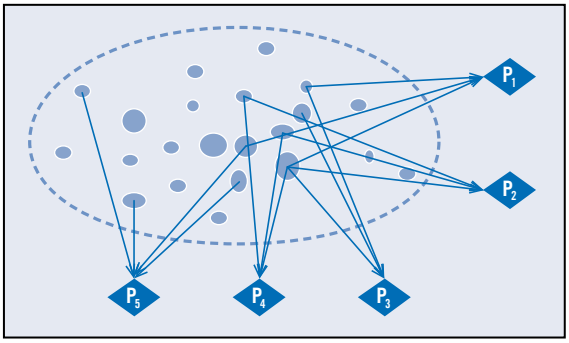
4.3.1 Knowledge structures: Carriers of options for structural and technological change

tEach social group builds up specific knowledge structures in the process of learning. As individuals acquire a broad range of conceptual and procedural knowledge, the social group develops a particular knowledge structure. These knowledge structures can be described by the particular nature, mix, diversity, variety and complexity of knowledge elements. The knowledge structure can be considered as a form of "collective memory".

The particular knowledge structure embedded in the labour force determines a country's options for structural and technological transformation within the GPTS. We define each product in the GPTS by a set of distinct but complementary tasks that need to be performed during production and by the distinct knowledge elements required for performing these tasks. Some products require similar knowledge sets, and the degree of similarity determines the relatedness of products. In contrast, products are considered to be distant when their production has few knowledge elements in common. Hence, we can structure the GPTS into technological knowledge communities, each one defined by particular knowledge sets underlying the tasks and products. Studies analysing the flow of workers and firms between economic activities and products within an economy support the idea that particular economic activities and products are related by similar knowledge and skills elements, and that products are related to distinct technological knowledge communities (Neffke and Henning, 2009; Newman, Rand and Tarp, 2011).

Figure 4.3 illustrates the idea of knowledge structures and options. The knowledge structure existing in the labour force is shown by the blue knowledge space within the broken ellipse, each dot representing a different knowledge element. P1 to P5 represent five different products, and the links to the dots represent the knowledge elements that need to be combined for their production. These five different products can be produced with the existing knowledge structure. We assume that P1, P2 and P3 are already part of the country's production portfolio.

Figure 4.3 Knowledge base of the labour force and options for productive transformation



Source: Nübler (forthcoming).

The country's options space is described by products P4 and P5. These products can be easily developed by combining and recombining the existing knowledge elements in the labour force.

Furthermore, we assume that P1 to P4 to belong to the same technological knowledge community as these products share similar sets of knowledge elements. The product P5 belongs to a different knowledge community which embraces the products P6 to Pn (not shown in the graph). P6 to Pn are not yet developed in the country because its labour force has not developed the complementary knowledge elements. The knowledge structure does not provide options to diversify into these products.

The concept of knowledge communities suggests that countries and firms find it relatively easy to diversify within a technological knowledge community in which the labour force has already gained significant experience and accumulated relevant knowledge sets. These knowledge elements can be easily recombined for the production of new goods. The literature provides many examples from different countries on the evolution of product lines and industries reflecting diversification within knowledge communities through the recombination of complementary knowledge elements (see Nübler, forthcoming). Moreover, firms have wide options to diversify within existing technological knowledge communities when the knowledge elements can be transferred to a wide range of different products. In contrast, knowledge communities which are characterized by product- or industry-specific knowledge tend to embrace few products as they allow firms to transfer these specific knowledge elements only to a limited number of products. For example, the skills profile of jobs in extractive industries is highly specific; therefore, many of the knowledge sets developed in the labour force in

this industry cannot easily be redeployed and transferred. Consequently, they provide limited options for diversification.

This framework explains the rapid development of the software industry in India. Over the course of a long historical process, India has developed a particular knowledge structure embracing formal knowledge provided by a school system and curriculum modelled on the British system, English-language skills (as secondary and tertiary education is provided in English), technical and engineering skills developed in high-level institutes of technology, and knowledge of information technology (IT) acquired through early experience in "body-shopping"[8] and working in the diaspora community, largely in Silicon Valley in the United States (see Chapter 8 by Vijayabaskar and Babu in this volume). This particular knowledge structure generated options for India to enter the software industry and enabled the country at the beginning of the 2000s to take advantage of the window of opportunity opened up by the high demand for software services due to the Year 2000 problem. We consider the software industry as a particular technological knowledge community which is defined by a wide range of different products using similar sets of knowledge elements.

While countries and firms find it easy to diversify within technological knowledge communities, they will find it difficult to enter new communities and to develop economic activities and products for which they have not yet developed the relevant knowledge elements. Countries therefore need to develop options to enter more advanced knowledge communities by enriching the knowledge base of the labour force with knowledge elements of strategic significance for entering such communities. Hence, the shift into more advanced knowledge communities for a sustained process of catching up may require countries not only to enhance, but also to fundamentally transform their knowledge structure if they aim at entering "distant" knowledge communities. They need to deliberately develop more sophisticated scientific and technological knowledge elements, teach strategic "core" skills such as discipline, precision, creativity or critical thinking; and support the development of belief systems and cultural knowledge elements that facilitate jumps within the GPTS.

This highlights the importance of learning outside the production system, in schools and training centres, as well as attracting foreign firms or developing "infant industries" as a source of advanced technical knowledge.

This knowledge-based approach explains both incremental diversification into related products within knowledge communities and jumps to distant products

[8] "Body shopping" is the practice of consultancy firms recruiting and training information technology workers in order to contract their services out on short-term basis.

in new knowledge communities. While learning within the production system explains in particular incremental productive transformation, learning outside the production system is critical for explaining jumps into new communities. The "product space" approach of Hausmann et al. (2011) explains mainly incremental diversification. While they recognize the relevance of productive knowledge in shaping capabilities, they implicitly assume capabilities to be largely created in the production system. Hence, they limit their analysis to the generation of capabilities that allow only incremental diversification patterns.

4.3.2 Routines and institutions: Carriers of competences for high-performing process

In addition to knowledge structures, social groups also build up routines and institutions. The knowledge-based concept of capabilities argues that both routines and institutions are established by a combination of rules (conceptual knowledge) and knowing how to do (procedural knowledge). [9] Procedural knowledge determines the performance of the social group in applying and implementing the rules. Routines and institutions are the "memory" in social groups of "knowing how to do". They cannot be designed, but need to evolve in a learning process.

The competences to generate high-performing processes of productive transformation are embodied in routines and institutions. Evolutionary economists argue that institutions and routines shape the behaviour of the economy and enterprises, respectively. Nelson and Winter (1982) take the perspective of the enterprise, arguing that "the behaviour of firms can be explained by the routines they employ". Hence, routines are the carriers of collective competences at the level of firms and organizations, while institutions are the carriers of collective competences at the level of the economy. High performance is achieved when the rules and procedural knowledge underlying routines and institutions meet standards of excellence.

The enterprise level

The competences of firms to switch to a new product or to adopt new technologies from the GPTS are critical for a dynamic productive transformation

[9] This definition of institutions expands the concept provided by North (1990) who defines institutions as "rules of the game" that guide and restrict behaviour of players. Institutions become carriers of collective competences when defined by rules and procedural knowledge ("knowing how to play the game").

process. Their ability to switch and to manage the transition process is embodied in routines that enterprises can transfer and apply to the new economic context. Competences with high dynamic value relate to the ability of firms to analyse options embodied in their labour force and to identify potential new activities that could be developed in light of given knowledge structures, to invest and adapt technologies, to identify and solve problems arising during the switching process, to create and manage knowledge, to manage resources in the light of requirements of the new product or process and to control quality of products and processes.

A study of Viet Nam analysing the entry, exit and switching behaviour of enterprises shows that a significant number of enterprises are switching – that is, entering a new activity and abandoning their past activity (Newman, Rand and Tarp, 2011). Most importantly, the study shows that switching firms have an advantage over newly established firms entering the market in that their productivity levels tend to be above those of newly entering firms. This supports the argument that switching firms can transfer already established routines, while new firms need to build up such routines. Still, switching firms show lower productivity than incumbent firms in the new sector, a discrepancy which reflects procedural knowledge and competences acquired through substantial experience in the sector.

In addition, the Viet Nam study shows that the propensity to switch is greater among domestic firms than multinational enterprises. This observation highlights the important role of domestic enterprises in driving the transformation dynamics as initiators and catalysts of structural transformation and of enhancing procedural knowledge in domestic enterprises for achieving a rapid and sustained catching-up process. In fact, low capabilities in domestic firms to switch into new economic activities may be viewed as one factor explaining the middle-income trap. This supports the argument of Amsden (2009) that ownership of business makes a difference, as domestic firms make contributions to economic development distinct from those of foreign firms.

The economy level

Institutions are important carriers of collective competences at the level of the economy. Different economic traditions highlight distinct functions of institutions that are relevant in a dynamic context. Market theories stress the market-enhancing function of institutions as they coordinate activities, collect and disseminate information, guide and restrict behaviour and choices, and reduce the risk attached to entrepreneurial activities. Institutions promote growth as they create incentives to engage in new economic activities and invest in productive capacities such as new technologies and skills (North, 1990) and in

"self-discovery" (Hausmann and Rodrik, 2003). Institutions promote knowledge-related processes such as the creation and sharing of knowledge in research and development by facilitating cooperation between a wide variety of complementary actors such as firms, public and private educational institutions, and training and research organizations (Brown, 1999).

Schumpeter (1911) argues that a society's "entrepreneurial spirit" and "pioneer" entrepreneurship form a central driver of the process of "creative destruction", productive transformation and growth. He further argues that entrepreneurship is created by the institutional structure of society. Societies with a high level of entrepreneurial spirits are those that have developed institutions that reward entrepreneurial activities. Nelson (2008, p. 9) argues that "long-run economic change must be understood as involving the co-evolution of technologies in use and the institutional structures supporting and regulating these".

Moreover, institutions building relationships of trust and social consensus have high dynamic value, as they support reforms and the acceptance by both winners and losers of economic changes (Franck, 1998; Schubert, 2009).

4.3.3 Complementarity of knowledge structures, routines and institutions

Options and collective competences are complementary, and successful catching up requires building up rich and diverse knowledge structures in the labour force, as well as "smart" routines and institutions in firms and the economy. Promising options for productive transformation that are not simultaneously complemented by the development of domestic collective competences cannot result in a sustained and long-term catching-up process.

Costa Rica provides an example. Following a rapid expansion of the education system, in particular of secondary education, during the 1960s and 1970s, the country had accumulated options for developing a wide set of manufacturing products in subsequent years. These options were indeed exploited, in particular from the 1990s, by developing institutions successful in attracting foreign direct investment (FDI) and promoting exports. The country, however, failed to develop institutions that would promote the development of capabilities in domestic enterprises. This strategy resulted in a fundamental transformation and sophistication of Costa Rica's export structure but not of its overall production structure (see Chapter 6 by Paus in this volume). Such a strategy also risks losing the dynamics of structural transformation, as the country is missing out on the diversification and switching activities of domestic firms.

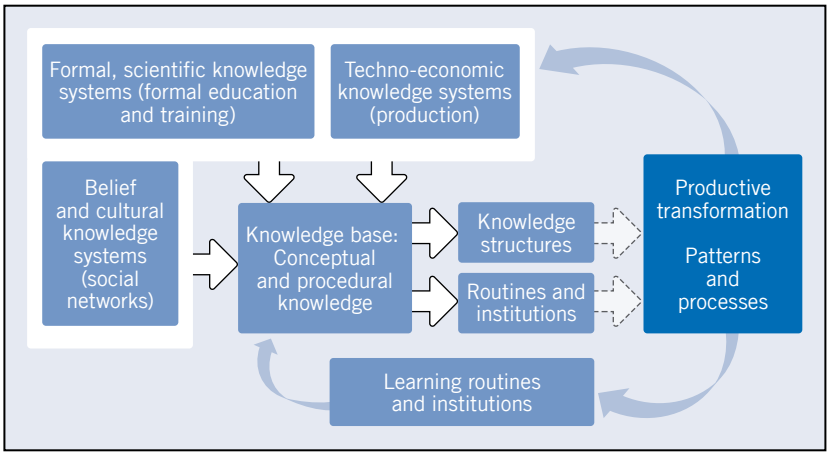
In contrast, the Republic of Korea has followed a strategy of simultaneously enriching the knowledge structure of the labour force and improving routines in domestic enterprises. This strategy resulted in a high-performing process of transformation of both production and export structures and high growth rates in productivity and employment throughout the 1960, 1970s and 1980s (Nübler, forthcoming).

4.4 A concept of collective learning

Theories of learning developed in various disciplines explain that individuals, but also enterprises, organizations and societies, learn by accumulating conceptual and procedural knowledge. Applying these different theories to the accumulation of capabilities suggests that learning at the collective level means essentially enriching and transforming knowledge structures embedded in social groups, and developing increasingly complex and "smart" routines and institutions. Knowledge structures, routines and institutions, identified above as the "collective memories" of social groups, evolve in a process of learning.

The development of capabilities is an evolutionary, cumulative and gradual process. The learning process involved in shaping knowledge structures, however, is different from that involved in building up routines and institutions. Hence, options and competences for productive transformation are shaped in different

Figure 4.4 A concept of collective learning for productive transformation



processes which highlight the relevance of learning at different levels and in multiple places. Figure 4.4 shows the main elements of a concept of collective learning for productive transformation.

4.4.1 Evolution of knowledge structures

Knowledge structures in a firm or economy are built up in a cumulative process. They are formed from conceptual knowledge elements which can be articulated and codified, stored in books and computers, and therefore easily communicated. Individuals develop concepts by organizing and categorizing information and integrating new information into existing concepts, thereby building increasingly complex knowledge structures and mental models. In addition, individuals develop procedural knowledge in a process of experience and practice. Procedural knowledge or "knowing how to do" is tacit knowledge which cannot be articulated. The nature, complexity and diversity of education, training, work experience and socialization to which individuals are exposed shape their mental models, and therefore also the particular mix of knowledge held by the labour force and society.

Shared and socially provided knowledge and belief systems are critical in determining knowledge structures at collective levels (see figure 4.4). The national curriculum taught in the formal education system and the type of technologies applied in the production system, as well as cultural knowledge systems (e.g. ideologies, philosophies, religions) that are prominent in the social system are major determinants of the nature, diversity and complexity of knowledge structures embedded in social groups. The knowledge structure embedded in the team of a firm or in the national labour force changes as advanced formal, technical, business and management knowledge elements and non-traditional cultural knowledge and beliefs are integrated into the existing knowledge system. With the ICT revolution, the Internet and social networks have become major factors influencing knowledge structures.

Countries aiming at transforming their knowledge structures to enhance options for productive transformation face the particular challenge of influencing and transforming shared knowledge systems.

4.4.2 Evolution of routines and institutions

Routines and institutions evolve as social groups engage in a collective learning process. This process involves the adoption of rules (explicit knowledge) and the accumulation of tacit procedural knowledge by repeatedly applying these rules while performing tasks. The social group learns to perform the various tasks by applying the rules and principles, e.g. of sequencing and coordinating tasks. With increasing practice and experience, the team accumulates increasingly complex knowledge of "how to do". This procedural knowledge represents the tacit element of routines and institutions because it can become established only when the social group ceases to focus consciously on the rules, and increasingly shifts focus on to the process as a whole. High performance evolves in a process of practising while aiming to meet standards of excellence set by those who have already mastered the process and themselves demonstrate high performance. The evolution of high-performing routines is reflected in learning curves identified by many studies exploring the impact of learning by doing and experience on the team's productivity. Likewise, routines enabling firms to plan, manage and implement high-performing processes of diversification and technological change are acquired in a learning by doing process.

This concept of learning suggests that enterprises learn to switch into new sectors by "practising switching". They learn to transfer their production routines to a new economic context and to manage this process effectively by repeatedly performing this task. At the level of societies, institutions evolve as they adopt rules such as laws and regulations, and adapt them to the changing environment (adaptive learning), and learn to apply these rules and to develop procedural knowledge while aiming at meeting standards of excellence. Empirical evidence shows that while a country may adopt rules that have been applied successfully in other countries, it requires substantial experience and practice at the societal level to learn the procedural knowledge required for high performance in applying and following these rules.

4.4.3 The dynamics of collective learning: Learning to learn to catch up

This learning concept argues that the productive sphere and the knowledge sphere are interrelated, and that productive transformation represents a major driver of the learning process. The concept highlights two channels through which the productive system becomes the catalyst of the learning process. On the one hand,

the productive system is a major site of learning, and therefore the nature of products produced and technologies applied in the production process determines the technological, business and vocational knowledge elements involved and the nature and complexity of the routines that workers and the enterprise team can learn. Furthermore, productive transformation influences both the formal and the cultural knowledge sets indirectly, for example, through rising income levels, specific human capital and skills needs. Hence, productive transformation has the potential to enhance capabilities, which in turn widens the range of options and increase competences for productive transformation. This highlights the importance for a dynamic process of catching up of providing increasingly complex learning opportunities in the productive environment, and of fuelling a dynamic process of learning. This relationship is indicated in figure 4.4 by the arrow pointing from the production system to the various shared knowledge systems. The impact of the productive system on the various knowledge systems highlights the importance for a dynamic process of catching up of providing increasingly complex learning opportunities in the production system, but also to enhance employment, wages and income.

The learning concept highlights the circular causation and virtuous circle of learning and productive transformation, which represents an important driver of the dynamics of catching up. Industrial policies are therefore charged not only with driving the investment process and structural transformation for high productivity and jobs growth, but also with targeting economic activities and technologies in industries, agriculture and the service sector that continuously open up learning opportunities in increasingly complex products and technologies.

On the other hand, shaping effective, rapid and sustained learning processes requires workers, firms, governments and societies to learn to learn. Such "meta" routines and institutions are at the heart of learning organizations and learning societies. The concept of learning to learn implies both the adoption of rules that facilitate and accelerate learning (for example, monitoring of progress and rapid feedback mechanisms), and the evolution of learning procedures (knowledge of "how to learn"). Such procedures represent tacit knowledge and therefore can only be acquired in a process of practising learning, while aiming to meet standards of excellence in learning. At the level of enterprises, learning procedures are embodied in learning routines. At the level of society, they are embodied in institutions supporting learning at different levels and in different places.

4.5 Design and implementation of learning strategies

Countries are challenged with developing a comprehensive and consistent learning strategy in order to generate high-performing capability development processes aligned with their productive transformation strategies. In this section of the chapter, important elements of a national learning strategy to effectively build up capabilities for productive transformation are discussed.

4.5.1 Educational attainment structures and options for productive transformation

The education challenge in a catching-up context is to shape a knowledge structure in the labour force that opens up a wide set of options for productive transformation. The educational attainment structure (EAS) developed in a particular country indicates the nature and complexity of formal knowledge accumulated in the labour force. EAS are defined by the share of the different educational categories (no school attendance, primary, lower secondary, upper secondary, tertiary) in the labour force. Since individuals build up conceptual and procedural knowledge in a cumulative process, each educational category reflects particular sets of knowledge elements, with higher education levels reflecting higher levels of complexity and specialization. Hence, the shares of the different educational categories indicate the nature and diversity of formal knowledge in the labour force.

Elsewhere I have developed a typology of educational attainment structures (EASs and their links with feasible options for productive transformation patterns embodied in the labour force (Nübler, 2013). Comparative analysis across countries as well as case studies of high-growth countries demonstrate that the educational attainment structure shapes the feasible patterns of technological and structural transformation (ibid., forthcoming). These findings have important implications for education policies and underline the need to see productive transformation, education and industrial policies as closely related.

The typology of EAS include: (a) strong middle, (b) missing middle and (c) L-shaped.[10]

"Strong middle" EAS are those with high shares of the middle education categories (lower and upper secondary education). These provide the widest range of options for developing and diversifying manufacturing activity. Such structures

[10] See Nübler (2013) for a more detailed typology embracing six different educational attainment structures.

dominate in Asian countries and in particular in the successful catching-up countries. Analysis of countries with high growth rates over a significant length of time shows that these countries expanded education in a particular sequence during the catching-up phase, first increasing the share of primary, followed by lower secondary and finally upper secondary education as the highest educational share in the labour force. This approach built up a broad base of formal knowledge and created options for developing a wide industrial base, as indicated by a high share of manufacturing in total GDP (Nübler, 2013).

Governments played an important role, using various instruments, in shaping these favourable education structures. The Republic of Korea provides an interesting case of enforcing quotas limiting the entry of secondary education graduates to the tertiary level (see Chapter 7 by Cheon in this volume). The government was keen to expand the share of secondary education to prepare the labour force for entering targeted industries that demanded a high share of clerks, technicians, machinists, etc. – all occupations that require secondary education.

"Missing-middle" EAS are those with low shares of secondary education but high shares of primary and tertiary education. Tertiary education shares in missing-middle structures exceed upper-secondary shares by at least 20 per cent. Missing middle structures provide limited options for developing a broad manufacturing base. Rather, the relatively high tertiary education share provides options to develop medium- and high-technology products within a small manufacturing base as well as in high-level service sectors. Missing-middle EAS are found mainly in Latin American countries but also in Thailand and South Africa. Such structures allow countries to grow into the middle-income levels, but not to develop the high and sustained dynamics of catching up that characterize strong middle EAS.

Education policies in these countries face the challenge of transforming the EAS from a missing to a strong middle structure if they aim to develop options for a broad manufacturing base and for subsequent technological deepening thereof. This requires promoting initially lower secondary education and, at a later stage, upper secondary education. Depending on the existing structure, this may entail shifting resources from tertiary to secondary education and decreasing the share of tertiary education.

"L-shaped" EAS are characterized by large shares of non-schooling and primary education, but very low shares of lower and upper secondary and tertiary education. These structures are found largely in the least developed countries (LDCs), and they predominate in African countries. Policies in many poor countries over the past 20 years, in particular those guided by the Washington Consensus, focused on basic education to the neglect of secondary and tertiary education. These countries, as a consequence, are unable to develop even low-technology,

labour-intensive industry such as garment manufacturing (Nübler, forthcoming). Educational policies need to transform these structures rapidly into strong middle structures by enhancing the share of lower and upper secondary education. This will shape a knowledge structure with options to enter low- and medium-technology manufacturing. To accelerate this process, policies need to target the formal education of young people and also to provide incentives and opportunities for adults to upgrade their educational attainment levels, in particular to the secondary level.

To conclude, getting the educational attainment structure right, and strengthening and reshaping these structures for a sustained process of productive transformation, pose one of the most important challenges of a learning strategy and of education policies in a catching-up context.

4.5.2 Industrial policies shape opportunities for economy-wide learning

The nature and complexity of production structures and technologies existing in a country determine not only productivity, growth and jobs, but also the opportunities for learning in the production process. Production structures and technologies differ in the knowledge, skills and occupational profiles of jobs and in the complexity of technological and organisational processes. They therefore determine the nature and complexity of knowledge sets workers can acquire in the production sphere and of the routines enterprises can accumulate. Thus the pattern of structural and technological transformation determines the nature and speed of technological learning in the labour force and in enterprises. Furthermore, continuous structural and technological change expands the opportunities for workers and firms to learn to learn, that is, to gain experience in learning and develop effective learning routines.

This argument suggests that countries need to shift deliberately into economic activities, products and technologies that create steep learning curves, and to design paths of structural and technological change that result in a high-performing, dynamic, rapid and sustained learning process at all levels. Manufacturing has been identified by Lall (2000), Chang (2010) and, early on, by List[11] (1909 [1841]) as a type of economic activity that creates great potential

[11] "If we regard manufacturing occupations as a whole, it must be evident at the first glance that they develop and bring into action an incomparably greater variety and higher type of mental qualities and abilities than agriculture does" (List, 1909 [1841], p. 161).

for learning in a broad variety of complex activities. Hence, industrial policies that promote manufacturing are important elements of a national learning strategy. By promoting economic activities in advanced knowledge communities, they create opportunities for workers to acquire new sets of technological and business knowledge. This generates and expands options for enterprises to diversify into new products within this community. In addition, promoting technologies that provide opportunities to domestic firms to build up increasingly complex technological and organizational routines enhances firms' competences to switch into new products in existing knowledge communities and to also jump into new knowledge communities.

Trade, investment, technology, R&D and exchange rate policies are discussed as important forms of industrial policy that shape and may accelerate or retard learning in the production sphere. Import protection has been the traditional instrument (applied by all successful catching-up countries) to foster infant industries aiming to provide opportunities and incentives to acquire advanced skills and knowledge systems and to become competitive. Recent research has analysed the relevance of tariffs in supporting learning: Nunn and Trefler (2010) have found tariff structures that protect education-intensive activities (the "skill bias" of a country's tariff structure) to be positively correlated with long-term per capita GDP growth.

Export promotion, too, has the potential to support learning.[12] Increasing integration into the world economy through exports, in particular at the early stages of trade exposure, promotes "learning to export", for example, by creating opportunities for firms to acquire knowledge of export markets, and accumulating tacit knowledge of "how to export" through experience. In addition, some studies suggest that trade liberalization has the potential to induce "learning-by-exporting" effects. They show that productive domestic firms, as they become exposed to trade and competition, improve productivity, and that this effect may be due to learning rather than to self-selection of more productive firms into export activities. In contrast, wide evidence shows that rapid trade liberalization, for example in many African countries during the 1990s, contributed to a stagnant or declining industrial sector, which since then has provided extremely limited learning opportunities.

These different variants of trade policy – import protection, export promotion and trade liberalization – play different roles in a learning strategy for catching up. While import protection creates opportunities for learning in the production process, gradual trade liberalization creates pressures to learn and to meet

[12] For a review of the literature on learning by exporting and learning to export, see Silva, Aricano and Afonso (2010).

the quality and performance standards set by international markets. Finally, subsequent export promotion expands production and the learning space within the industry, providing learning opportunities to a wider share of workers and domestic firms.

Exchange rate policies have the potential to promote the growth of more sophisticated and learning-intensive industrial sectors, contributing to faster learning by workers and firms. This strategy is particularly relevant in view of the limited policy space catching-up countries have to apply trade policies. Astorga, Cimoli and Porcile (Chapter 3 in this volume) show the importance of combining real exchange rate policies with industrial and technology policies for creating such learning effects. While competitive exchange rates enhance competitiveness and export demand, active technology and industrial policies promote structural change and diversification of production towards technologically advanced sectors. The combination of these policies creates a virtuous cycle of increasing productivity, technical upgrading, the generation of more sophisticated and productive jobs, and learning. The authors provide empirical evidence from Latin American countries to show that, without the support of industrial and technology policies to create and accelerate learning processes, depreciation of real exchange rates would sustain a labour absorption pattern that is unable to close the technology gap.

Public investment policies also have the potential to provide space and incentives for learning by local workers and domestic enterprises. Infrastructure development projects promote learning by establishing tendering and procurement rules that ensure engagement of the domestic labour force and local enterprises in the production of infrastructure (Nübler and Ernst, 2014). Domestic firms' incentives to learn in such projects are high when governments ensure that opportunities to redeploy the newly developed competences will emerge in future public and private investment projects.

4.5.3 Transforming belief systems

Belief systems such as cultural knowledge, philosophies, ideologies and religions play an important role in the process of shaping capabilities for productive transformation. Belief systems are socially constructed, and provide commonly shared attitudes, values, preferences and work ethics. They influence behaviour by restricting or expanding the choices of individuals.

Belief systems play an important role in technological and economic development. According to the "New Consensus" in economic history, the growth of

modern capitalism cannot be adequately explained by "material" factors alone. It argues that industrial development in Western countries was triggered by a major change in social knowledge and belief systems (McCloskey, 2010; Mokyr, 2002). What created modern capitalism was a change in how people thought about business, exchange, innovation and profit; human liberty and dignity; and education and training. The new ideas of the Enlightenment gave human reason supremacy over religious beliefs. An emerging "Engineering Culture" and the "Bourgeois Revolution" drove the creation of new scientific and technological knowledge and its wide diffusion. Most importantly, these new belief systems also rewarded entrepreneurship, which supported the rapid adoption of technologies in the economy, resulting in the emergence of dynamic industrial sectors.

In a catching-up context, economic dynamics require a culture of innovation, creativity, imagination, and openness towards change and new ideas. These traits become increasingly important as countries move from the imitation to the innovation phase. Education systems therefore are challenged with promoting critical thinking, curiosity and diversity (see Chapter 7 by Cheon in this volume). Florida (2002) identifies tolerance, technology and talent as the three Ts of development. He argues that a commitment to tolerance and openness to diversity across all segments of the population is necessary to shape a creative class in a country.

Furthermore, social knowledge and belief systems shape individuals' choices regarding education, training and occupations. These choices are critical determinants of the knowledge structure in the labour force and the options for technological and structural change in the economy. Evidence shows that such choices cannot be explained by rational choice models. Denzau and North (1994) argue that individuals develop mental models through their own experience and social learning. Choices which individuals make only infrequently are guided by socially provided belief systems. This implies that belief systems, through the value and prestige which they ascribe to different types of education, fields of study, occupations and jobs, significantly influence educational and occupational choices. Brock and Durlauf (2001) argue along similar lines. They explain discrete choices in a social interaction model, and explain how expectations of social groups shape individual choices and the demand for education.

Hence, in a catching-up context, governments are challenged with supporting the transformation of shared belief systems in a direction that motivates students to choose education and occupations that open options for further structural change. Institutions need to be developed that help societies to reshape social expectations and the perceptions of various types of education, fields of study and professions. Reshaping social expectations and values involves a long-term process of socialization, in which social dialogue, promoted by the International Labour

Organization as a form of governance, has the potential to reconcile conflicts between the interests of governments in transforming the knowledge structure for technological catching up and the interests of students, their families and workers seeking to enter occupations with high social prestige (Nübler, 2008).

4.5.4 Institutions, standards and networks: Accelerating and sustaining learning processes

"Knowing how to do" and "smart" tacit procedural knowledge can only be accumulated in a process of experience and practice. This is true at the level of individuals (e.g. learning to develop a software programme) and at the level of firms (e.g. learning to develop high-performing technological or quality control procedures). This learning process can be significantly enhanced and accelerated by working side by side and in direct interaction with experts and experienced teams. The worker or team is able to observe the routines that high-performing experts or expert teams follow and to imitate them. Throughout this process, the learners receive feedback from the experienced workers and teams and improve by practising and aiming to meet their demonstrated high standards. Institutions play an important role in creating such learning conditions.

Apprenticeship is the traditional mode of vocational training where a young person acquires the broad set of vocational knowledge and skills of an occupation by working side by side with a master craftsperson in a workshop or enterprise. Apprenticeship, however, in order to function as a high-performing learning network, needs to be embedded in an institutional framework that defines the rules and standards of training and enforces them in all enterprises. The institutional framework needs to ensure that both employers and young people are motivated to participate in apprenticeship, and that the apprentice is trained in all relevant competences and skills to the set standards. These standards are defined by experts and are enforced within formal or informal networks. In medieval Europe such apprenticeship systems were organized by the guilds, which had received from the state the privilege of regulating and monitoring vocational training in the workshops. Today, they take place within formal national apprenticeship laws and organizations charged with defining and monitoring training ordinances and standards, for example in Germany, Austria and Switzerland; or through informal or customary rules provided by informal associations of craftspeople in many developing countries.

Organizational networks across firms clustered in a region, such as industrial parks and export processing zones, across firms within the value chain and in joint

ventures, have the potential to become important learning networks. Many successful catching-up countries considered foreign firms to be an important source of knowledge crucial for the development of domestic firms. They applied investment policies that attracted FDI, acquired firms in foreign countries in strategic industries, promoted joint ventures, established routines for collaboration, and ensured that domestic and foreign enterprise teams worked together closely. This resulted in the transfer of technological and organizational routines and rapid learning in domestic enterprises. Such strategies were applied in the Republic of Korea and China, and as a result of rapid learning in domestic enterprises these countries have developed important domestic industries and learnt to compete in international markets, e.g. the automobile industry in the Republic of Korea and, very recently, the solar panel industry in China.

Value chains, too, may become important places of learning for domestic subcontractors if lead firms enter into vital parent–affiliate relationships. Such parental supervision generates the continuous transfer of technological competences, management techniques and quality control procedures to keep sourcing networks at the competitive frontier in the international industry (Kinoshita, 2000). The auto component industry in India provides an example of value chains where the parent firms' insistence on standards and certification has become a major instrument to manage the flow of knowledge within the value chain and to create a learning network, both vertically and horizontally. International assembly firms supplying the world market created joint ventures with domestic enterprises and developed a network of local firms feeding into the value chain. An in-depth study of 101 auto component firms in India shows that even small enterprises operating in the informal economy are often required by parent firms to apply standards and to obtain certification. Unni and Rani (2008, p. 116) note that:

> ... to become a sub-contractor or supplier, it has become mandatory for firms to follow certification procedures like ISO 900:2000 and TS-16949, which maintain and improve quality. About 40 per cent of the firms had ISO certification and a few more were in process of getting it. ... There is increasing pressure by the parent firms on the small firms to get certification, without which they could lose their contracts. The pressure from large firms was basically because they wanted to become TS-16949 companies. For a firm to have TS-16949, it is mandatory that all its sub-contractors have ISO certification.

Experience in the Republic of Korea, China and India contrasts with that of countries such as Mexico and Costa Rica, which have not been able to develop

high levels of competences in most domestic enterprises. In Mexico, many efforts to promote a domestic car industry during the past decades have failed, largely because policies and institutions could not create learning processes at the level of domestic enterprises. Even a large proportion of the subcontractors in the auto industry are foreign-owned (Nübler, forthcoming). Chapter 6 by Paus in this volume shows how the development strategy implemented in Costa Rica since the 1980s has created powerful institutions to attract FDI and promote exports in increasingly sophisticated goods and services, but has failed to develop equally strong institutions that could support learning and the accumulation of competent procedures at the level of domestic enterprises.

Standards constitute an important institution that supports, enforces and directs the learning of procedural knowledge and the building of high-performing competences in enterprises. Standards define what is considered a high-performing process and a competent performance of tasks. Standard-setting and enforcement mechanisms support the learning process and accelerate the process of building tacit collective procedures. National and international agencies set labour standards but also technical, quality or process-oriented standards, and monitor, assess and benchmark the performance of enterprises against those standards.

Certification upon mastering of processes according to standards provides an important incentive, if the certificate has economic value, for workers and firms to learn. This was noted above in the example of the Indian auto component value chain, where ISO certification was a prerequisite for domestic enterprises to access value chains. Also, the Indian software sector provides an interesting case of how standard setting and certification at different levels have driven the learning process of Indian firms and their increasing competitiveness in the global software market and in value chains. Currently, India is home to the largest number of firms holding quality certifications such as ISO-9001/9000–3 and the Software Engineering Institute's 5-level Capability Maturity Model (SEI-CMM). These international certifications signal the competences of Indian software firms and therefore have high economic value.

To conclude, professional and organizational networks have the potential to become powerful learning networks, to stimulate learning and to develop collective competences at the enterprise level. However, realizing this potential requires governance institutions at the sectoral or economy level that provide incentives and pressure as well as support to achieve high-performing learning processes in joint ventures and value chains.

4.6 Conclusions

This chapter has developed a theory of capabilities for productive transformation to provide a framework for the analysis of catching up, the forces driving its dynamics and policies to enhance and transform capabilities for high performance in economic development. Catching up is defined as a process of productive transformation which embraces both technological change and diversification into new economic activities and sectors. The dynamics of productive transformation is described in terms of the structural change dimension (the pattern of technological change and diversification) and the process dimension (speed and sustainability). Collective capabilities are identified as a key driver of both dimensions of productive transformation. As a result, catching up and growth are determined not only by the accumulation of production factors, and the changing factor endowment structure, but also by the transformation of country-specific productive capabilities embedded in society.

Furthermore, a knowledge-based concept of collective capabilities is elaborated which argues that capabilities are embedded in the knowledge structure as well as in the routines and institutions developed by social groups such as teams of enterprises or the national labour force. Knowledge structures are the carriers of options, as they define the range of products and technologies that can realistically be imitated. They therefore determine the feasible patterns of productive transformation. In contrast, routines and institutions are the carriers of competences to translate these options into investment and to achieve rapid and sustained processes of catching up. Finally, a concept of collective learning is proposed. Learning for capabilities is viewed as an evolutionary process of transforming and enriching knowledge structures, routines and institutions. The development of high-performing learning procedures (learning to learn) is at the heart of learning societies.

The dynamics of catching up and economic development results from the interrelationship between productive transformation and collective learning. A high-performing dynamics is achieved by the simultaneous evolution of the material and the knowledge spheres, in which structural and technological change and the transformation of capabilities reinforce each other in a circular and cumulative process, creating a virtuous circle of capabilities development and productive transformation. This dynamics is enhanced by the evolution of high-performing learning routines and institutions in enterprises and societies that accelerate learning and thus drive the processes of economic transformation, growth, job creation and development.

High performance in catching up is expressed in structural change patterns that help countries to achieve development objectives and aspirations of their societies, and in rapid and sustained processes of change. This concept of catching up is distinct from the definition used by mainstream economics, which measures catching up in terms of productivity increase and GDP growth rates, and it expands the evolutionary perspective of technological catching up by taking into account also the product space and structural change perspective. The catching-up concept developed in this chapter therefore argues that catching up is a complex, non-linear and cumulative process of economic and social development.

Capabilities are introduced as a complementary criterion to comparative advantages in guiding countries in the selection of economic activities and catching-up paths. Even countries with similar factor endowments may differ substantially in the capabilities and therefore in the options and competences they have for implementing structural change and adopting new technologies. Hence, the analysis of (latent) comparative advantages for "optimal" catching-up paths (see the GIF framework outlined in Chapter 2 of this volume) needs to be complemented by an analysis of country-specific capabilities and the feasible options and competences embedded in these capabilities.

Furthermore, the catching-up concept shifts focus from growth to multiple development objectives, arguing that synergies and trade-offs may arise between the fundamental development objectives of productivity increase, the generation of productive and good jobs, and rapid and sustained learning processes. Countries therefore need to develop patterns of productive transformation that strike a good balance in promoting these objectives simultaneously. This challenges economists to develop a better understanding of the impact of different patterns and paths of technological and structural change not only on productivity, but also on the quantity as well as on the types and quality of jobs generated, and on learning effects generated in different sectors and by different technologies.

Recognizing that the development of capabilities is as important to productive transformation as investment in productive capacities considerably broadens the definition and the scope of industrial policy. Industrial policies need to foster the process of building both productive capabilities and productive capacities. In this context, the development of capabilities in domestic enterprises is of strategic importance for diversification. Domestic enterprises, in particular smaller ones which are often tied to their region, tend to switch into new activities as a survival and growth strategy, thereby driving the diversification dynamics.

Moreover, the capability concept suggests that productive transformation processes pass through different phases as economies shift into new and increasingly complex technological knowledge communities. This implies that countries, as

they catch up, also need to transform the nature of their capability sets in order to open up the new options and develop those competences required to enter more advanced knowledge communities and related activities. The failure to achieve a fundamental transformation of options and competences may explain the empirically observed middle-income trap. The framework suggests that middle-income countries developed capabilities that enabled them to catch up to some extent; however, they may have failed to develop in time those other capabilities (e.g. R&D competences, belief systems etc.) that are required to shift from the imitation to the innovation phase of catching-up. The capability framework of catching-up suggests that the middle-income trap may in fact be a capability trap.

The concept of collective learning suggests a comprehensive learning strategy. Capabilities are created in distinct learning processes at different places and levels. Industries are an important place of learning. The development of sophisticated technologies, industries and jobs is instrumental in enhancing the dynamics of the learning and capability development process as they provide opportunities to acquire a whole new set of knowledge in the production system. In this view, expanding opportunities for enterprises, the labour force and societies to learn in the production system provides a major justification for developing countries to defy comparative advantages during the catching-up phase. It was Friedrich List (1841) who, on the basis of his historical analysis of the development process of different nations, concluded that the (efficiency) losses arising from policies to support learning and the development of capabilities (productive powers) are justified by the economic development benefits arising from these capabilities in future periods. This argument has been taken up more recently by Chang and others. In this tradition, the theory of capabilities explains that strategies defying comparative advantages and deliberately promoting industries and technological knowledge communities with high learning opportunities have the potential to yield large benefits in terms of catching-up dynamics, growth and employment generation.

Capabilities are also shaped by education and training in schools. The high value of education for economic development lies in its ability to teach the labour force advanced technological concepts and skills, and to reshape social belief systems, even when the economy is still at a low level of technological development. This allows countries that still specialize in low-technology products to enrich the knowledge base of the labour force, to transform the knowledge structure and to develop the options to enter more sophisticated products and technologies or even leapfrog into advanced technological knowledge communities.

Governments have a key role to play in promoting, directing and accelerating the learning process. Policies to promote the development of productive capabilities relate to different areas and require a comprehensive and coordinated strategy.

Education, training, trade, investment, R&D, technology, exchange rate and migration policies can all play an important role in this learning strategy as they contribute to transforming and enriching knowledge structures in the labour force and support the evolution of routines and institutions. Again, synergies and trade-offs may arise when setting these policies to address multiple development objectives.

Finally, "meta" institutions trigger, accelerate and sustain learning processes as they support the development of high-performing learning procedures in the labour force, in enterprises or in economies. An institutional framework reflecting high competences to support rapid and sustained processes of learning and capability development generates incentives and pressure to learn, encourages experimentation and learning from it, rewards critical thinking and creativity and provides direct support measures for such activities. Such competences are themselves built up in a learning process. Societies develop learning procedures (institutions) as they gain experience in learning and build up high competences to learn. These competences are at the heart of learning economies and learning societies.

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