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Global Value Chains, Technology Transfer and Local Firm Upgrading in Non-OECD Countries

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Abstract

The productivity and competitiveness of local firms in non-OECD countries depends as much on technological capacities and successful upgrading as in industrialized countries. However, developing countries undertake very little to no original R&D and primarily depend on foreign technology. Long-term contracts and subcontracting arrangements within global value chains are here very important forms of transnational cooperation and therefore also important channels for technology transfer, especially as the majority of these countries attract only limited foreign direct investment.

Drawing on innovation and growth models as much as on value-chain literature, we outline an analytical model for empirical research on local firm upgrading in non-OECD countries and technology transfer within global value chains.

Keywords: technology transfer, upgrading, innovation, non-OECD countries, global value chains

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Zusammenfassung

Wertschöpfungsketten, Technologietransfer und Kompetenzerweiterung lokaler Unternehmen in Nicht-OECD Ländern

Die Produktivität und Wettbewerbsfähigkeit lokaler Unternehmungen in Nicht-OECD Ländern hängt genauso stark von ihren technologischen Fähigkeiten und erfolgreichen Kompetenzerweiterungen ab wie in den industrialisierten Ländern. Allerdings unternehmen diese im Vergleich wenig oder gar keine eigene Forschungs- und Entwicklungsaktivitäten, und sind deshalb primär von der Nutzung und Anwendung ausländischer Technologien abhängig.

Langfristige Verträge und Subunternehmerarrangements innerhalb globaler Wertschöpfungsketten sind in Nicht-OECD Ländern die wohl wichtigste Form internationaler Kooperation und deshalb auch einer der bedeutendsten Kanäle für Technologietransfer.

Ausgehend von sowohl der Innovations- und Wachstumsforschung, als auch der Fachliteratur zum Thema Wertschöpfungsketten skizzieren wir in dem vorliegenden Artikel ein analytisches Modell für empirische Forschung im Bereich der Kompetenzerweiterung (upgrading) von lokalen Unternehmen in Nicht-OECD Ländern und des Technologietransfers innerhalb globaler Wertschöpfungsketten.

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Article Outline

1. Introduction
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3. Technology Transfer and Productivity
4. Local Firm Productivity: A New Theoretical Framework
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1. Introduction

International economic relations are characterized by globalization. Lead firms and suppliers form tightly knit networks across national borders. For years, a wide range of possibilities for interaction with international consumers has been open to firms; the following are the three basic, distinguishable strategies: the export of products via global trade, production (and services) abroad in the company's own subsidiaries via foreign direct investment (FDI), and the licensing of foreign firms (that is, contractual arrangements for the manufacturing of a company's own products).

When we look at manufactured goods and do not consider unprocessed natural resources, vertical cooperation through transnational value chains is the most important form of inter-

national integration for most developing and emerging countries. These collaborations are particularly characterized by an asymmetrical relationship between a lead firm, mostly located in an OECD country, and its suppliers, who produce in one or more non-OECD countries. In these cases, legally and economically independent firms form long-term relationships. The value-chain partners make relationship-specific investments (technology transfer, special machines); this, in turn, creates mutual dependencies.

The developments of recent years have shown that, increasingly, firms are globalizing their production with the help of international suppliers. Thus, the value-creation process is also being internationalized. These collaborations between firms play an important role for the individual firms in order for them to generate entrepreneurial growth, and to create and expand competitive advantages (upgrading) and synergy effects. Thus, transnational and situation- and cooperation-specific norms, which govern the conduct of the value-chain actors, come into existence. If legal independence is retained, firms are independent actors and are able to negotiate these norms with each other. The parameters of the norm-generating process are determined by various factors. Contractual weaknesses, the degree of asymmetry between value-chain partners, and the environment in which the value chain is integrated play a defining role. Just like lead firms and local suppliers, value chains are also embedded in civil society networks which, as a contextual factor, constitute a certain framework for norm-building processes within a value chain. For instance, relevant civil society actors—such as trade unions, nongovernmental organizations, associations, the epistemic communities, and credit or consumer organizations—play an important role in the value chain's internal negotiation and norm-building processes, even though they are located outside of the value chain. Here, a distinction is made between local (national) and international (global) actors and (norm-building) networks.

Nowadays, there is a consensus that differences in technology are a significant cause of performance and productivity differences between companies, sectors, and countries. In the research on value chains, technologies and technological capacities are also important:

1) The technological intensity of the economic sector/industry is determined by the complexity of the final and intermediate products.
2) The productivity of the value chain is determined by the specific investments of the value-chain enterprises in the consolidation and expansion of technological capacities; for example, lead firms provide their suppliers with technologies, while the suppliers invest in specific machines and processes.
3) The competence level of suppliers crucially depends on their technological capacities.

However, the technological capacities in value chains have yet to be systematically integrated into theory and explicitly researched. In most studies they are merely named as important components or implicitly considered in corresponding assumptions (Morrison, Pietrobelli and Rabellotti, 2008). Also, there is neither an established theoretical framework nor suitable data from the firm level for the examination of the firms' technology selection (Acemoglu,

Antràs and Helpman, 2007). Therefore, our paper particularly focuses on the issue of negotiation processes in the context of technology transfer and improving technological capacities, and on the issue of optimizing links between key firms and local enterprises.
The remainder of the article is organized as follows: Sections 2 and 3 provide an extensive review of the literature on value chains and endogenous growth, respectively. Section 4 then presents an outline of a theoretical model which tries to formalize the descriptive concept of upgrading by local suppliers and, thus, helps to identify the relevant variables for an empirical analysis. Finally, Section 5 concludes by sketching fruitful areas for future research and outlining the relevance and potential of such an analytical framework for the analysis of value-chain integration and upgrading in the Middle East and North Africa (MENA) and sub-Saharan Africa.

2. Cooperation through Value Chains

In current economic relations, cooperation between firms plays an important role in the generation of entrepreneurial growth, and in the creation and extension of competitive advantages and synergy effects. The existing research makes a basic distinction between four different types of cooperation models (Gereffi et al. 2005; Rauch, Hamilton, 2001):

1) *Market coordination*: characterized by *arm's-length* and short-term purchase-contractual relationships between legally and economically independent firms.
2) *Horizontal cooperation*: cooperative, stable relations between legally independent firms which are on the same level of market or value creation. Economically, there is a symmetric interdependency between them.
3) *Vertical cooperation*: long-term contracts between legally and economically independent firms. In these cases, mutual dependencies develop with time; unlike the case with horizontal cooperation, dependencies are here characterized by asymmetry between (one or more) *lead firm(s)*, which dominate the collaboration and lead it strategically, and (one or even many) small and medium-sized (SMEs), which have a supplier-purchaser relationship.
4) *Vertical integration:* SMEs are owned by the lead firm/s and thus economically and legally dependent.

The advance of globalization, the progress in information and communications technologies, and the concurrent reduction of transfer costs have promoted international vertical cooperation in transnational value chains, the most prevalent and widespread form of integration/cooperation in non-OECD countries and emerging markets. The majority of such collaborations are characterized by an asymmetrical relationship between a *lead firm*, based in an OECD country, and its suppliers, based in one or more non-OECD countries or emerging markets. In this paper we focus on this asymmetrical relationship between firms in the North and the South (for modeling such relationships see Acemoglu, Zilibotti, 2001; Keller, 2004). The central topic within this broader focus is technology transfer within value chains. As it is

usually assumed that the lead firm sets the norms in vertical cooperation, we will focus primarily on such a case and challenge this perspective.

Value chains and value-chain networks are, by definition, a hybrid form of organization in which legally independent firms cooperate on consecutive levels of the value chain. Often the value-chain approach is confused with the value-chain analysis according to Porter (1990), with which it is surely related but not identical. Studies in the tradition of Porter focus on primary and supporting activities within a value chain (Porter, 1990; Stern, Porter, Furman, 2000). This strand of the discussion will not be considered here as these studies lack empirical foundation, or focus particularly on horizontal relations or supporting activities. Numerous studies analyze local developments in industrial clusters (cf. Giuliani and Rabellotti, 2005; Schmitz, 2004; McCormick, 1999; Schmitz, 1999) and the "industrial divide," as well as the mutual relationships between chain members and spatial location patterns (Krugman 1996; Saxenian, 2006). Also, industrial clusters of SMEs are viewed as the basis for integration into value chains, with a particular focus on "joint action" and "collective efficiency" (cf. Schmitz 2004; Humphrey, Schmitz, 2002; Schmitz, 1999). Especially relevant here are those examinations that deal with relations between the state and the private sector; supporting facilities (for example, research facilities, business development services); and environments and networks (cf. Krugman, 1991; Saxenian, 2006; Camagni, 1991, Humphrey, Schmitz, 1998). Studies of environments and networks focus primarily on trust and the industrial setting of the local, epistemic community (cf. Polanyi, 1962; Camagni, 1991). Many of these analyses, published since the mid-1990s, concentrate on conceptual issues and place an empirical focus on various sectors (for example, the clothing industry and the coffee, fruit and vegetable trades) (e.g., Ponte 2008; Nadvi 2008; McCormick 1999).

The more recent discussion of value chains has arrived at a basic typology with four different dimensions (Gereffi/Korzeniewicz, 1994; Humphrey/Schmitz, 2002):

1) *Input-Output* structure: forms of cooperation within a value chain for the manufacturing of a product.
2) *Governance* structure: types of governance structures concerning the distribution of financial, material, and human resources within a value chain and their influence on the cooperation of firms.
3) *Spatial patterns*: distribution of value-chain activities across various regions or countries and their effects on the distribution of return flows and regional development.
4) *Institutional framework*: regulations for the interaction of individual levels of value creation in a national and international context.

2.1. Governance

Particularly since the mid-1990s, the studies of *governance* structures have received the largest degree of attention of the four dimensions. A conceptual distinction is usually made between

the *governance* of a value chain and its coordination (cf. Schmitz, 2004). Whereas *governance* describes the power relationship between the actors and other participants, at least in the context of the value-chain approach, coordination refers more to the transition management of tangible goods and products at the segment interfaces of a value chain.

Governance of a value chain refers to four steps in the value-chain approach (Kaplinsky/ Morris, 2001: 67-73): the setting of rules, support of the other actors in a chain in order to facilitate compliance with the rules, the monitoring of compliance with the rules, and the punishment of violation of the rules. Opinions differ on whether individual firms or several actors set the parameters. Humphrey and Schmitz (2002) and Gereffi, Humphrey and Sturgeon (2005) claim that in modern value chains individual firms' domination over others gives rise to the development of asymmetrical relationships. The governance of value chains occurs via the setting of parameters concerning the product, processes, and logistics. Other studies point out that *one* firm does not have the power to set norms; rather, *several* actors have a significant impact on the shaping of specific chains (e.g., Raikes et al. 2000; Jansen, 2007).

Global commodity chains (GCCs), as defined by Gereffi (1995) and Gereffi/Korzeniewicz (1994), focus predominantly on the description and analysis of the current situation of value chains with regard to *governance* and input-output structure (cf. Giuliani and Rabellotti, 2005). In global production networks (GPNs) (cf. Ernst, 2002), large corporations from industrialized countries dominate the exchange of goods. The lead firms are often companies which have withdrawn from performing their own manufacturing. Increasingly, their core competencies are the skill-intensive activities—such as market forecasts, design, product and brand development, and management—and also globally sourcing work and specific resources (cf. Kaplinsky 2000). Papers on GPNs deal with issues such as upgrading, appropriation of rents in the chain, barriers to entry, and governance structure (cf. Kaplinsky 2000).

Gereffi, however, makes a distinction between two types of hierarchical chains: *buyer-driven value chains* and *producer-driven value chains*. *Buyer-driven value chains* (BDCs) are labor-intensive production chains in which the producers hold a subordinate position to the lead firms. These lead firms are, in most cases, global trade or marketing chains and brand producers. They produce the design and organize the marketing, which plays a key role in these chains. The decentralized production networks are predominantly located in developing and transition countries as the entry barriers are relatively low. Often, lead firms have no production facilities of their own. According to Gereffi, BDCs consist of, among others, the clothing and toy industries and foodstuff producers. In *producer-driven value chains* (PDCs), according to Gereffi, multinationals (lead firms) play the dominant role. Here, it is a matter of capital- and technology-intensive production, for example, the manufacturing of cars, airplanes, and computers. PDCs may consist of thousands of companies. The lead firms themselves handle the largest part of the capital-intensive production. Subordinate firms manufacture more labor-intensive or standardized parts. The lead firms usually belong to global oligopolies.

In more recent accounts, a further typology of value chains based on their governance structure, that is, the type of relations among the actors within the value chain, has been developed. The two most well-established distinctions, by Humphrey and Schmitz (2002) and Gereffi et al. (2005), are based on one another and highlight three different forms of value chains as relevant types:

1) *Modular value chains:* These develop in cases where products have a modular architecture, that is, their elements are, to a large extent, produced separately and assembled on the basis of standardized interfaces. The suppliers produce customized products, retaining, however, full responsibility for the process technologies used.
2) *Relational value chains:* Here, complex interactions between buyers and sellers are in place; often, they lead to a high degree of mutual dependence. Mutual trust, family ties, and ethnic ties support the function of these chains.
3) *Captive value chains*: Smaller suppliers depend to a great extent on large clients. Changing to other buyers would induce prohibitive costs. These chains are often characterized by a high degree of monitoring and control by the lead firms.

Table 1 summarizes the discussion and the different cooperation models, providing an overview of the value-chain typology according to *governance* structure (cooperation form) (cf. Ernst, 2002).

Table 1: Overview of Cooperation Models

Cooperation models	Description	Cooperation forms, governance structure	Sectors (examples)
Market coordination	Arm's-length sales contract		
Horizontal cooperation (networks)	Cooperative, stable relations; legally independent, but economically dependent firms; symmetrical dependency	Joint ventures: establishment of a joint, legally independent firm	Car industry
		Strategic alliance: contractual agreement	
Vertical cooperation (value chains, strategic networks)	Long term between legally and economically independent firms; mutual dependencies develop with time; asymmetrical dependency	*Modular value chains*: Lead firms set product and quality guidelines; smaller firms, however, produce independently and take full responsibility	pharmaceutical industry, IT, consumer goods, electronics
		Relational value chains: Complex interactions leading to strong mutual dependencies	Consumer goods, biotech
		Captive value chains: Characterized by a high degree of monitoring and control by one or more lead firm(s); small suppliers are, to a great extent, dependent on lead firms (licensing and franchising contracts, Keiretsu)	Car industry, consumer goods, foodstuff, clothes
Vertical integration (hierarchy)	Integration causes loss of legal independence of hitherto only economically dependent firms; asymmetrical dependence		

Source: Authors' own compilation.

We will furthermore identify and elaborate on three crucial factors (cf. Gereffi et al., 2005) in the prevalence of a particular *governance* structure in a specific value chain:

1) The complexity of the transaction. Transaction costs are especially high when complex and customer-specific products are produced by different companies which have to coordinate their activities with each other.
2) The possibility of coding information and knowledge to facilitate economical and efficient transfers.
3) The existing level of supplier competence. The higher this is, the more likely it is that the lead firm will attempt to avoid learning costs and delegate decisions to the upstream actors in the chain.

Following these lines of discussion, we attempt to consider the social context in which a value chain is embedded. This relationship, a contextual factor, constitutes a certain framework for the norm-building processes within a value chain. External actors beyond the value chains—trade unions, NGOs, federations of commercial enterprises, the epistemic communities, and credit or consumer organizations—are not an immediate part of the value chain's internal negotiation and norm-building processes; nevertheless, they play an (indirect) role. Thus, we differentiate between local (national) and international (global) external actors and (norm-building) networks.

2.2. Interactions within Value Chains

On the one hand, SMEs enjoy advantages due to their commitment to value chains and the formation of long-term obligations that improve planning reliability and facilitate learning and synergy effects (cf. Table 2). Active cooperation (for example, through technology and transfer of knowledge) reduces transaction costs and creates trust (Rauch/Casella 2001; Murphy, 2002). Depending on the type of value chain (cf. typology), entrepreneurial risks and costs (additional training, technologies) are reduced through participation in a value chain. SMEs do not have to tackle the challenges necessary for upgrading, such as activities and investments, by themselves. Instead, the lead firm actively supports them as a partner and, in fact, profits from spillover and external effects. In addition, firms without such links more often risk remaining in the informal sector and pursuing only very minimalist and risk-averse strategies (cf. Ishengoma, Kappel, 2007; Ranis, Stewart, 1999). On the other hand, value-chain integration causes the SMEs (additional) costs.

Table 2: Interaction within a Value Chain

Interaction within a value chain	Intentional support of partners: Active, purposeful transfer of knowledge and technologies (usually) by lead firm	Transfer of technology, personnel development, additional training
	Spillover effects: Unplanned, not immediately intended transfer of knowledge and technologies	Learning by observing, learning effects, re-engineering, spin-off products
	Specific investments by the SME in order to facilitate or guarantee close cooperation with lead firm. The prerequisite for this is the SME's trust in the longevity of the value chain. Otherwise it would have *sunk costs*.	Special machines, tailor-made processes, personnel, locations

Source: Authors' own compilation.

The interactions between the actors within the value chain are neither entirely market based nor unidirectional. On the contrary, learning processes come into existence (cf. Giuliani and Rabellotti, 2005, Marshall, 1982; Krugman 1991). So far, two important forms of interaction have been identified:

1) The *intentional support of partners*: Active transfer of knowledge and support of supplier competencies are part of the lead firm's *value-chain governance,* with the intention of combining the advantageous flexibility of outsourcing non-core competencies with the secure supply of high-quality intermediate products. Also, the necessary implementation of increasingly important standards leads to learning effects along the chain (cf. Kaplinky, Redman, 2001: 28 – 33).
2) *Spillovers in formalized partnerships*: In special cases, lead firms establish development partnerships with suppliers in non-OECD countries and, if necessary, local research and development (R&D) institutions in order to, for instance, adapt international technologies to the local conditions. Then, in addition to the immediately intended learning and upgrading processes, downgrading, unplanned technological spillover, and spin-off effects may occur.[1] However, not in every case do lead firms necessarily intend learning effects along the value chain. Companies at the far end of the chain can acquire skills and knowledge that still belong to the core competencies of the lead firm through demonstration effects and learning by observing. SMEs, however, often have to make specific investments that would be sunken costs if they were outside of the value chain. For the SME, participation in a vertical collaboration essentially depends on a cost-benefit analysis. However, one has to bear in mind that there is a lack of other options, especially for SMEs in non-OECD countries. The criteria for the lead firms to integrate an SME into a value chain are far less obvious and remain far less researched.

[1] Cf. Maskell, Malmberg, 1999; Krugman 1996; Smarzynska Javorcik, 2004; in this context, spillover means unplanned learning effects through third actors. Spin-offs means unplanned, commercially applicable results from R&D work.

2.3. Upgrading

Despite partially grave asymmetry in the relationships between lead firms and SMEs, an increasing number of firms in non-OECD countries and emerging markets are entering into such cooperation. From the perspective of the SMEs, the interest in doing so is essentially linked to the increased possibilities of improving their own competence levels (upgrading).
This study focuses primarily on the creation and extension of technological skills and capacities within a transnational value chain. We differentiate between two fundamentally different types of upgrading:

1) The expansion of the technological skills and capacities of a subcontractor (*firm upgrading*). These development opportunities are generally open to every company, regardless of their integration into the value chain. The following belong to this category:
- *Process upgrading:* The reorganization of production processes, or the introduction of new technologies, results in higher efficiency, constituting a competitive advantage.
- *Product upgrading:* New products are launched, or old products are improved more quickly than by competitors. Thus, firms can move up to higher-quality product lines.

2) The upgrading of a subcontractor function within the value chain (chain upgrading); integration into the value chain is the prerequisite.
- *Functional upgrading:* Overall improvement of a firm's abilities and skills through its assumption of a new field of responsibility and, possibly, the termination of activities in previous fields.
- *Intersectoral upgrading (or chain upgrading)* means changing from one chain to another. This can occur due to the utilization of specific competencies which are transferable from one sector to another. Thus, for instance, the ability to manufacture television screens can serve as a starting point for involvement in the higher-quality computer sector.

Even though the concepts regarding upgrading, the significance of technological competencies, and the improvement of competencies are very prominent and well-established arguments in the value-chain debate, they are mostly viewed as exogenous determinants for SMEs.

3. Technology Transfer and Productivity

The economic debate has arrived at the consensus that differences in technology are a significant cause of differences in the performance and productivity of firms, sectors, and countries (Acemoglu, 2007). Robert Solow (1956, 1957) presented the first economic model to explain the process of capital accumulation and emphasize the significance of technological progress as the "ultimate" source of sustained economic development. Not until the beginning of the 1990s did various authors succeed in correcting Solow (Aghion and Howitt, 1992; Grossman and Helpman 1990; Romer 1990), who had not explained how technological progress is generated. The "new" theorists describe technological progress as the result of suc-

cessful innovation processes, that is, the investments of market-based firms in R&D. This category of endogenous growth models has, therefore, laid the microeconomic foundation of macroeconomic growth theory and caused a wave of research on innovation processes and productivity differences.

Ever since, the majority of models and studies in this tradition have focused on the innovation processes and R&D activities of firms, particularly in the high-tech sector (aviation, space travel, pharmaceuticals, nano- or biotechnology) as these demonstrate the greatest investment in R&D and technology intensity. Indeed, innovations in the high-tech field and in leading international research have proven to be an extremely important source of productivity. However, it is mainly reserved for highly industrialized countries, predominantly those of the OECD. Furthermore, high-tech industries are a very small sector. Even in the leading country for this sector, the USA, the production of high-tech goods constitutes only 3 per cent of the gross national product (GNP). In most non-OECD countries and emerging markets this sector does not exist at all.[2]

Therefore, the focus of the productivity debate in the context of non-OECD countries has shifted, in essence, from the development of productivity-increasing technologies to their accessibility (Arora and Vamvakidis, 2005; Coe and Helpman, 1995; Dollar and Kraay, 2004; Feenstra, 2004; Frankel and Romer, 1999; Keller, 2002). For countries without or with only limited indigenous research activities, there is, according to the consensus, the comparably easy possibility of using the existing technologies on the global market as a source of productivity—especially through channels such as international trade and the revolutionized information and communications technologies.

In 1998 Basu and Weil (1998) critically addressed the "technology bias" to which firms in non-OECD countries that want to use foreign technologies are exposed. Technologies are developed in the highly industrialized countries and are designed for their corresponding climate, personnel, and financial circumstances, which most often are not appropriate in the context of non-OECD countries. Thus, argue Basu and Weil, the development of countries' capacities for the adaptation and utilization of existing technologies is at least as important as access to these technologies. More recent quantitative analyses (cf. Acemoglu and Zilibotti, 2001; Los and Timmer, 2006) underline the significance of this approach. Hausmann and Rodrik (2003) expand Basu and Weil's argumentation. They directly compare the technological adaptation process of firms in non-OECD countries with the innovation process in industrialized countries. Here, technological adaptation is described as an entrepreneurial process which has the same relation to costs as the innovation process. Keller (2004) compares various channels of international technology transfer and points out that, despite extensive offers of foreign technology, local technological endeavors particularly increase the productivity of accessible technologies.

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[2] Some authors do consider innovation activities but at the same time, however, deny any growth relevance or production-increasing effects (Futagami and Ohkusa, 2003; Segerstrom, 1991; Zeng, 2001; Archibugi and Michie, 1997).

Particularly in value chains, technologies and technological capacities play a central role on different levels, as mentioned above. However, technological capacities in value chains have so far neither been systematically integrated into theory nor explicitly researched. The majority of studies and models merely name them as important components or implicitly consider them in corresponding assumptions.

So far, as mentioned before, the concept of upgrading has not been clearly described, but the different versions of endogenous growth models discussed in this paragraph may possibly be suitable for further differentiation and stronger formalization. Additionally, however, we have to take a look at some important differences between cooperation that occurs through value chains and other forms of cooperation (cf. Table 1 and Table 2) in the value chain-technology discussion: (1) The value-chain actors are bound by long-term contracts, unlike the participants in the hitherto assumed market relationships (arm's-length relationships) between suppliers and producers of end products (lead firms). (2) Suppliers receive support for the adaptation and selection of technologies. They do not have to bear the costs or risks alone. (3) The productivity of the value chain (and, thus, the final product) depends to a great extent on the specific investments of the value-chain actors (technology spillover effects). The investments can only be partially defined by contracts. Technology transfer within a value chain takes place between economically dependent, legally independent, non-state actors. Hence, this is clearly different from

1) technology transfer in the context of official development aid (ODA), which is, to a large extent, conducted by state actors;
2) technology transfer within multinational firms (MNFs) where the lead firm legally owns, completely or partially, its suppliers; and also
3) public-private partnerships.

Due to the sharp increase in the significance of trade in intermediate products in recent years and the increase in the number of foreign subsidiaries and amounts of FDI (Grossman, Helpman and Szeidl, 2006; Helpman, 2006), research on the integration strategies of MNFs has boomed. The classic differentiation between horizontally and vertically integrated MNFs has been replaced in more recent models (Helpman, Melitz, and Yeaple, 2004; Yeaple 2003) with more complex organizational strategies. These take into account the empirical observation that most MNFs display vertical and horizontal integration in some form and focus on various aspects of the "make-or-buy" decision. For instance, Helpman (2006) describes optimum integration strategies which depend on the transport costs of final or intermediate products. In contrast, Antràs and Helpman (2004) concentrate on differences in productivity between lead firms and relate these to ownership structures and location decisions. Lead firms weigh the advantages of low variable production costs (in non-OECD countries) and lower fixed costs (in the home market) against the advantages of ownership through the vertical integration of the suppliers and arm's-length market relations (incentives with independent

suppliers). The results show that the decision largely depends on wage differences in the North and the South, property rights abroad, the distribution of negotiating power between the lead firm and suppliers, and the necessary "headquarter intensity" of the final product. At the same time, Antràs and Helpman point out that, unlike market relations between producers and suppliers, contracts for transnational supply relations are continuously increasing. Systematic analyses of subcontracting are, however, not yet available. Antràs (2005) assumes that the international organization of production does not constitute a choice of location in the classical sense but rather a decision on the type and extent of control over production.

Even though this field of research, by and large, deals with vertical integration, there is nevertheless a crucial link to our topic, norm-building processes. For the first time, the form of the firm's internal organization is endogenized. Therefore, a combination of the value-chain approach with these research papers allows us to analyze the influential factors that lead to different organization or governance structures, discussed earlier in this paper, and to systematically clarify their connections in a formalized context.

For the first time, Acemoglu, Antràs, and Helpman (2007) have established a formal theoretical connection between the two approaches of (i) the endogenization of firm-specific production and (ii) the endogenized selection of organizational forms when contracts are incomplete. They examine the influence of contractual incompleteness and the technological complementarity of suppliers on the selection of technology.

The authors assume that all supplier activities are relation specific and cannot be fully governed by contracts. Even so, the authors point out that, so far, there has been neither an established theoretical framework nor suitable data at the firm level for the examination of firms' technology selection (Acemoglu, Antràs and Helpman, 2007).

Despite the existing consensus that differences in technology are a significant cause of differences in the performance and productivity of firms, sectors, and countries—and despite the significance attributed to these differences in the context of the value-chain debate—technological capacities in value chains have yet to be systematically integrated into theory and explicitly researched (Morrison, Pietrobelli and Rabellotti, 2008).

4. Local Firm Productivity: A New Theoretical Framework

In recent years, the quantity and methodological diversity of studies analyzing internationally organized value chains have increased sharply. These studies have increasingly focused on value chains combining industrialized and non-OECD countries. In spite of this, many research questions remain unanswered, as shown in the aforementioned conclusions.

One significant point of criticism is that, so far, no analytical framework has been developed that systematically combines the value-chain debate with innovation and growth research. Technological capacities built through the transfer of technology, spillovers, and learning effects remain largely unstudied.

Even though the significance of technological capacities for upgrading and for governance structure is explicitly emphasized in most studies, the following issues exist:

1) The concept of upgrading remains relatively vague. Additionally, Morrison, Pietrobelli and Rabellotti (2008) point out a contradiction in logic: upgrading is often used as a synonym for innovation and, at the same time, as a result of the innovation process.
2) The transfer of technology and knowledge, and its effectiveness, is usually regarded as exogenously given for local SMEs.
3) It is normally suggested that the governance structure of a value chain and the strategy of a value chain's lead firm determine the extent and direction of the transfer of technology and knowledge.

In this section, we therefore outline a theoretical model as an analytical framework that systematically endogenizes the creation and extension of technological capacities in local SMEs. Endogenous innovation and growth models are the basis for our model.[3]

In order to take into account the special characteristics of the innovation processes in non-OECD countries—which are, as mentioned above, pointed out by several authors such as Hausman and Rodrik (2003), Basu and Weil (1998), Keller (2004)—the OECD innovation and growth models need to be adjusted to the situation of the non-OECD countries. Hausman and Rodrik provide an important basis for our analysis, which is based on the assumption that the technological adaptation process (that is, the adaptation of existing technologies rather than the new development of technologies) occurs analogously to the innovation process in industrialized countries. This entrepreneurial process is not cost-neutral; on the contrary, it requires investments in physical and human capital. This process is characterized by insecurities and considerable entrepreneurial risk.

A correspondingly adapted endogenous growth model, as outlined in the next section, makes it possible to break open the hitherto rigid assumption that "technology is exogenous to local firms" and delineate the concepts of innovation and upgrading clearly.

Table 3 summarizes the interrelations of concepts, actors and their interactions in table form:

[3] The model relates to and builds on Grossman and Helpman (1991) and Aghion and Howitt (1999).

Table 3: Summary

		Supported/promoted by							
	Actor	SME		*Lead firm*		Exter-nal			
		Intentional			Unintentional		Governance structure / Form of cooperation		
		SME's own effort	Specific investment	Support of partner	Spill over effects	External effects	Captive	Modular	Relational
Development opportunities for SMEs	Increase in competence level: – *process upgrading* – *product upgrading*	+	+	+	+	?	Set by lead firm, profits from spill-overs	Depend-ent on SME's own initiative	Matter of negotiation within margins set by lead firm
	Promotion within a value chain: From primary to supporting activities (*functional upgrading*)	+		+	+	?	Set by lead firm	Depen-dent on SME's own ini-tiative	Matter of negotiation within margins set by lead firm
	Change into a higher-quality value chain (*chain* or *inter-sectoral upgrading)*	+	+	-	+	?	Very unlikely	Possible, in related sector	Rather un-likely
Implementation of development opportunities through innova-tion processes	Process innovation	Increase in efficiency/ reduction of costs							
	Product innovation/ product differentiation	*Quality increasing*							
		Variety expanding							

Source: Authors' own compilation.

4.1 The Model

Building on the literature and our argumentation, we present a draft model of technology transfer and upgrading processes within a transnational value chain where the lead firm only produces (or assembles) the final product and all intermediate products are provided by small and medium local suppliers.

We assume that the value-chain output Y^{final} is produced according to the production function of the value chain

$$Y^{final} = A_{leader} K_{leader}^{\gamma} D^{\eta} L_{leader}^{1-\gamma-\eta}, \text{ with } \gamma, \eta > 0, \gamma + \eta < 1 \quad (1)$$

where A_{leader} is the positive constant technology parameter of the lead firm, K_{leader} is the capital of the lead firm, L_{leader} is the total employment of labor in the final production by the lead firm, and D is a composite index of intermediate inputs produced by SMEs.

γ and η denote the capital share and the share of intermediates, respectively. Depending on the degree to which the lead firm is a buyer or producer, these parameters vary. However, the shares of capital, labor, and intermediates are always positive.

The index of intermediate goods depends on the output of each local SME *i* consisting of vertically differentiated goods *x* of vintage q_m

$$\log D_i(t) = \log\left[\sum_m q_m x_m\right] \tag{2}$$

Each SME produces only one product at different vintage levels for one sector, and does not diversify across different sectors.

If we assume that only the products at the highest quality level are suitable for use within the value chain, the SME value-chain output function yields the following form:

$$\log D_i = \log \lambda^{m_i} x_i \text{ with } \lambda > 1, m > 0 \ , \tag{3}$$

where *m* is the vintage level and λ an exogenous constant, common to all SMEs that depend on the sector of the value chain. That is, λ denotes the distance of quality ladders and thus the technological effort necessary to reach the next quality level. 1/λ is the degree of technological difficulty and complexity of the sector.

The total output of all SMEs *i* within the value chain add up to the composite index *D*

$$\log D = \log \sum_i D_i = \log \sum_i \lambda^{m_i} x_i \tag{4}$$

Given the production function of the value chain, we now turn to the process of upgrading, that is, the identification of technologies in order to improve the intermediate inputs at the SME level.

Until now, m_i, the quality level at which the SME *i* is producing, has been considered to be exogenous (cf. equation 3). However, each SME *i* is able to improve (upgrade) the quality level of its products; therefore, the quality level m_i is endogenous and yields the following form.

$$m_i = m_i(\iota_i) \tag{5}$$

is the number of successful quality improvements, which depends on the research intensity or technological activity ι of SME *i*. Local producers who are not integrated in a value chain do not profit from any value-chain spillover effects. In this case SME upgrading corresponds to the research intensity of Grossman and Helpman (1991),

$$\iota_i(\mu, L_i, a_i) = (1-\mu)\frac{L_i}{a_i} - \mu\rho \tag{6}$$

where ρ is the exogenous rate of time preference and μ is the exogenous degree of technological complexity of the products that depend on the sector. Recall that according to equation

(3), $\mu \equiv \frac{1}{\lambda}$, L_i is the employment of labor in the production of intermediate goods by SME *I*, and a_i is the productivity of SME *i*.

In the next step we consider the upgrading processes of SMEs that are integrated in a value chain and therefore, in addition to their own efforts, profit from spillover effects and technological support from the side of the lead firm. The model covers process, product, and functional upgrading simultaneously.

With value chains, the technological efficiency of SME *i* ι_i^{WK} is given as

$$\iota_i^{WK} = \iota_i^{WK}(\iota_i, ITT, SI_i, SPE) \tag{7}$$

where ι is the individual technological efficiency of SME *i* explained in equation (6). ITT is the effect of the intentional technology transfer provided by the lead firm, SI_i the specific investments on the side of the SME *i* demanded by the lead firm, and SPE external spillover effects.

All three additional factors are, as mentioned above, value-chain specific. All of them—the extent and kind of intentional technology transfer (ITT) provided by the lead firm, the extent and amount of special investments (SP) expected from the SME, and the manner and modalities of the use of spillover effects (SPE)—can be considered to be internal value-chain norms and depend on the negotiation process between the lead firm and local supplier SMEs.

4.2 Regression Equations

Internal value-chain interactions are neither entirely market based nor unidirectional, as discussed earlier in this paper. However, the following estimation equation can be deducted from the theoretical models, which help to account for these learning processes and spillover effects. The SME's negotiation power (np) is as follows:

$$np_i = c + \beta_1 \iota_i^{WK} + \beta_2 LN + \beta_3 \mu + \varepsilon \tag{8}$$

whereby the degree of technological complexity μ is to be inserted from equation (6) and the research intensity ι_i^{WK} from equation (7). *LN* depicts the strength of the local civil network.

The successful upgrading of an SME (UP) is correspondingly modeled with a dependence on the branch-specific degree of technological complexity μ, which models the research intensity ι_i^{WK} of the value chain, the distribution of the lead firm's negotiating power np_{lead}, and the individual SME np_i

$$UP_i = c + \beta_3 \iota_i^{WK} + \beta_4 np_i + \beta_5 np_{lead} + \beta_6 SP + \varepsilon \tag{9}$$

Herein, the following endogenosity has to be considered. Also, in reverse, the research intensity of the value chain depends on the research intensity of every SME, the IIT (intended technology transfer), the special investment (SI), and external spillovers:

$$\iota_i^{WK} = c + \beta_1 \iota_i + \beta_2 IIT + \beta_3 SI_i + \beta_4 SP + \varepsilon \quad (10)$$

In each of the estimation equations c represents the intercept, $\beta_1,...,\beta_{10}$ the estimation parameters, and ε the error term.

5. Conclusion

The original contribution of this article is (i) to present an analytical framework which incorporates an endogenous process of innovation and technology adoption into the transnational value-chain approach and related models, and (ii) to provide an integrated research method which relates the governance structure of the value chain to both internal value-chain factors and national contextual factors.

Drawing on this framework, future research can focus more on understanding technological capacities and upgrading in non-OECD countries in general and SME integration in global value chains in particular. Applying this framework could be especially useful in better understanding and utilizing the economic potential of those countries in the Middle East, North Africa and sub-Saharan Africa that are currently benefiting the least from international capital and FDI inflows and where value-chain integration is among the most effective and most promising means of integration in the global economy.[4]

[4] Collier/Gunning, 1999; Ajayi, 2008; Brach 2008; Cammett 2007.

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