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CLUSTER formation, institutions and learning: the emergence of clusters and development in Chile

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By exploring the emergence of new clusters, this paper departs from traditional research focused on established clusters and enriches recent studies on their development dynamics. The analysis of two successful clusters in Chile, one in agroindustry and the other in salmon aquaculture, highlights interactions between the state, local firms and multinationals, and the conditions enhancing collective firm learning. The argument is that the emergence of dynamic clusters depends on building institutions that enable coordinated learning among firms to improve capabilities, processes and products.

1. Introduction

The discussion on how to foster economic growth in developing countries continues moving away from the dominant view known as the 'Washington Consensus'.[1] One of the contemporary waves focuses attention on the creation of clusters as a way of encouraging economic development (Porter, 2000; Pietrobelli and Rabellotti, 2003).[2] Clusters are seen as the driving force for increasing exports, attracting foreign investment and catalyzing growth. Numerous international agencies and governments place promotion of clusters at the center of their development programs.[3] While the evidence shows the benefits of clusters, past analysis has focused on established dynamic clusters. Recent research identifies differences between the emergence and mature stages, raising questions about how and why new clusters start and thrive (Breschi and

[1]For two decades, discussion focused on economic reforms to liberalize trade, financial markets and exchange rates, among others. For the source of this term and a complete list of its proposition see Williamson (1990). For a discussion of the various dominant waves of ideas on development, see Lindauer and Pritchett (2002).

[2]Clusters are geographically concentrated industrial sectors or individual firms. Firms in the same or closely related industry locate in geographic proximity to each other (Porter, 1990).

[3]Enright (1999, 2000) cites examples in New Zealand, Ireland, Finland and the USA. For developing countries, see Altenburg and Meyer-Stamer (1999), Buitelaar (2000), Porter (2000), deFerranti *et al.* (2002) and Pietrobelli and Rabellotti (2003).

Malerba, 2001). This paper uses the larger framework of economic development theory to explore how a new cluster emerges.

In the last 10 years, research on regional clusters grew substantially. Academics from different perspectives have focused on the spatial dimension of economic activity, innovation and economic performance. For example, the 'new economic geography' literature emphasizes the increasing returns from clustering (Krugman, 1991, 1995). The business literature stresses the local sources of firm competitiveness, linking dynamic growth and location (Porter, 1990, 2000; Enright, 1999). Studies on regional innovation systems and the localized learning capabilities look at how local institutions support technological development within a defined geographical space (Braczyck *et al.*, 1998; Cooke and Morgan, 1998; Maskell and Malmberg, 1999; Cooke, 2001; Maskell, 2001). Finally, there is the research on industrial districts that emphasizes the role of cooperative institutions in the coordination of productive relations between firms (Piore and Sabel, 1984; Pyke and Sengenberger, 1992; Saxenian, 1996). There is also a growing literature showing that clusters in developing economies are common (Schmitz and Nadvi, 1999; Pietrobelli and Rabellotti, 2003). In some cases, wider economic development processes have been attributed to the growth of industrial clusters (Saxenian and Hsu, 2001).

A set of studies reveals that clusters in developing countries differ considerably. They exist in a wide range of sectors and their growth experiences vary widely: from stagnant and lacking competitiveness (Altenburg and Meyer-Stamer, 1999; McCormick, 1999) to dynamic and competitive (Schmitz, 1995; Nadvi, 1999). While some show active inter-firm collaborations, they are absent in others (McCormick, 1999; Nadvi, 1999; Lara, 2002). These works support the view that the presence of a cluster does not automatically give rise to positive external effects (Saxenian, 1996; Bresnahan *et al.*, 2001; Saxenian and Hsu, 2001). The mixed evidence from developing countries suggests the need to look beyond the role of geographical proximity and local factors, and to ask why some clusters prosper and what explains their success. Some observe there is a need for more empirical and analytical efforts to understand the conditions and the processes leading to the emergence and growth of new clusters (Breschi and Malerba, 2001; Bresnahan *et al.*, 2001).

Focusing on the formation of new clusters, this paper presents an argument that highlights the emergence of institutions that make possible learning-by-monitoring (LBM) as a key explanation for cluster growth. Institutions that foster LBM create a framework to coordinate relations between the state and the economy, and among firms, which enhances the conditions for individual and collective firm learning (Sabel, 1996; Helper *et al.*, 2000).[4] Learning means the process of firms' catching-up to the international standards of quality and productivity, which involves generating

[4]Institutions are rules, practices and arrangements that coordinate economic activity between actors at multiple levels: between the state and the economy, among and between firms (Wagner, 1994; Storper and Salais, 1997).

technical and organizational knowledge. In developing countries, learning is tied to upgrading, that is, making better products, increasing value adding activities and improving production processes. Monitoring refers to actors reviewing and evaluating partners' performance according to the agreed standards or goals between them. LBM refers to an underlying principle of coordination among actors, which brings new knowledge, identifies collective problems and assists joint strategies to resolve them (Sabel, 1996). Economic actors can create institutions that enable LBM by jointly setting goals, standards, and ways to evaluate progress and capacities to reach those targets.

In Section 2 there is a discussion on the theoretical links between the LBM view and other literature that also emphasizes the role of institutions as key to understanding growth, economic performance and innovation (Nelson and Winter, 1982; Piore and Sabel, 1984; Pyke and Sengenberger, 1992; Nelson, 1994; Stiglitz, 1994; Storper, 1996; Storper and Salais, 1997; Thevenot, 2002; Piore, 2003). Placing the discussion on clusters in the context of the concerns addressed by the literature on economic development offers insights for understanding cluster formation and growth. These works direct attention not on the existence of a cluster, but on the process of how a cluster develops. In turn, the empirical cases on the growth of new clusters offer a vantage point for thinking about the relationship between institutions and economic development.

I discuss in Section 3 two empirical cases in Chile. Compared with other Latin American countries, Chile is often cited as the top performer in the region. Its dynamic export performance was particularly outstanding in natural resource based sectors, such as forestry, agroindustry, fishing and mining.[5] The growth of many of Chile's successful natural resource based industries formed new clusters, as firms located in specific geographical regions.[6] The new clusters played an important role in the Chilean export success stories, providing us with a view of conditions that foster economic development in general and the growth of clusters in particular.

The two cases from Chile are based on the author's original field research and include: a cluster in agroindustry, and another in salmon aquaculture.[7] Section 3

[5]For a recent comparative study of Latin American countries, see deFerranti *et al.* (2002).

[6]For example, a recent study characterizes Chile's copper mining industry as a cluster (Beckel, 2000). See also Casaburi (1999), Buitelaar (2000), Farinelli (2003) and Perez-Aleman (2003a).

[7]The information and data on the two Chilean clusters has been collected over several periods of fieldwork in Chile, during a two-year stay in 1994–1996 and a two-month stay in 2003. The author conducted fieldwork in the regions that concentrate the industries discussed here: Central Valley (known as Region VI and VII) and Puerto Montt area (known as Region X). The sample of firms includes the five largest agroindustrial processors, 20 small suppliers and the six largest farmed salmon exporters. Additionally, the author interviewed representatives from related government agencies (CORFO, PROCHILE, SAG, Fundacion Chile, SERNAPESCA, regional governments) and associations (FEPACH and APSTC). The interviews were open-ended, using a structured question guide. At least three different informants were interviewed separately and in repeated visits at each organization.

traces the historical development of these two successful clusters to understand the changes in the relationships among firms, and between them and the state, exploring the transformations of the institutions that coordinate economic activity.[8] The discussion centers on three interrelated processes contributing to collective learning among firms and the emergence of clusters: (i) role of the state; (ii) collective action among local firms; and (iii) linkages between local firms and foreign ones. The discussion elaborates how public and private actors create institutions through an interactive process that transforms their products, organizations, relationships and connections to global markets.

2. Clusters, institutions, learning and development

2.1 Geography and local factors for competing globally

The business literature on the role of geography in competitive strategy highlights local factors contributing to regionally increasing economies that influence the growth and performance of firms. From this perspective, the ability of firms to compete in wider national and international markets is possible because they draw major benefits from their location and participation in a regional cluster (Porter, 1990, 2000; Enright, 1999, 2000; Scott, 1999). Besides influencing firm performance, the conditions prevailing in the local cluster can enhance innovation (Porter and Solvell, 1999). Many of the existing theories of clusters of innovative activity focus on external effects and the resulting agglomeration economies as the key explanation for the concentration of firms and as the source of competitive advantage that cluster location offers.[9] A local external effect refers to anything that raises the return to particular firms located in a region as a result of the location of other firms in the same region. For example, proximity allows managers to learn about market or technical developments from colleagues in neighboring firms. Firms in closely related industries serve as one another's customers or suppliers. Clustered firms can obtain lower cost access to specialized inputs. In addition, key inputs such as skilled labor or venture capital are in abundant supply. These external effects generate positive feedback loops that become agglomeration economies when geographically concentrated.

The existing literature on clusters has several shortcomings. First, it emphasizes the role of proximity and local conditions, looking at clusters as self-contained entities. Recent research indicates, however, that external linkages are vital to establish and maintain a local network of relationships, for both emerging and established clusters (O'Riain, 2000, 2004; Saxenian and Hsu, 2001). External links allow access to knowledge,

[8]Success means the ability of the cluster as a whole to grow, through the expansion of new firms, increased exports and a sustained level of international commercial success.

[9]Some authors emphasize efficiency considerations such as reduced costs and the effects on economies of scale and scope. See, for example, Krugman (1991), Scott (1999) and Porter (2000).

skills, contacts, capital and information about new technological opportunities and new markets. These relationships allow upgrading of the industrial base and reduction of the risk of lock-in by keeping the cluster open to new ideas and technologies from outside. Recent work on developing and emerging economies also notes the importance of global connections (Rabellotti, 1999; Schmitz and Nadvi, 1999; Schmitz, 1999; Bair and Gereffi, 2001; Humphrey and Schmitz, 2003).

While the existence of external effects might explain why a region or a cluster is attractive and advantageous, it does not explain how regional clusters emerge and develop (Bresnahan *et al.*, 2001). Positive feedback in an existing, established cluster does not by itself explain how a cluster begins and how it grows successfully. In the early stages, when a new economic activity begins to attract firms, leading to their concentration in a particular industry, there are no existing external economies. External effects play only a small role in the early phases. Moreover, the mere growth in the number of firms located in a cluster is unlikely to give rise to those agglomeration economies associated with existing successful regions. The literature on clusters in developing economies highlights stories of stagnant clusters, even while others are dynamic (Altenburg and Meyer-Stamer, 1999; McCormick, 1999). Some clusters grow while others do not, and external linkages can or cannot contribute to upgrading (Bair and Gereffi, 2001; Humphrey and Schmitz, 2003). Similarly, regional economies in advanced economies that were competitive at one time can lose their dynamism (Herrigel, 2000). Non-competitive, non-dynamic clusters are stories that generally fall through the cracks of the business literature on clusters. The emphasis on the role of geographical proximity and local market factors for competing successfully in global markets does not explain how clusters emerge, or how a cluster might move from a stagnant situation, to a dynamic one.

2.2 Institutions and economic development

While the literature on regional clusters is mainly concerned with the specific local characteristics of regional economies as sources of competitive advantage, other perspectives emphasize the role of institutions as key to understanding growth, economic performance and the conditions that enhance learning and innovation. In particular, the literature on industrial districts (Piore and Sabel, 1984; Pyke and Sengenberger, 1992; Pyke *et al.*, 1990), which shares a common interest with the work on regional competitiveness, focuses on the institutions supporting technological dynamism. A central argument is that cooperation and competition in the relations among firms sustains innovation through norms that foster reciprocity. Similarly, Saxenian (1996) shows that external economies due to spatial proximity alone cannot explain the innovation and growth dynamic in Silicon Valley, emphasizing the relevant role of local institutions and culture to coordinate decentralized production. Institutions vary, and make a difference in the ability of firms in a cluster to build their capabilities and improve performance.

The work on economic development and the role of innovation also highlights the relevance of institutions in coordinating economic activity (Nelson, 1991, 1994; Lundvall, 1992; Metcalfe, 2001; Nelson and Sampat, 2001). This view emphasizes the interrelations between institutions, industrial structure and production organization. It highlights that economic growth and innovation follows from the nature of knowledge accumulation and the institutions that shape the growth of technological knowledge. Institutions matter because they support interactions between actors, and different patterns of interconnections. The interactions generate a flow of information appropriated in the learning process. Nelson and Sampat (2001) discuss the concept of 'social technologies' to refer to how institutions constitute means to share information and to support interactions that influence the growth of knowledge. Institutions influence the ways in which actors interact and coordinate economic activity (Nelson, 1994; Nelson and Sampat, 2001). In this view, given the collective nature of productive activity, firm performance depends on supporting institutions that foster learning and enhance firms' capabilities. This literature shows that firm performance, growth and innovation are dependent on institutions and the ways they influence how actors interact (Lundvall, 1992; Dosi *et al.*, 1998).

Along with the emphasis on institutions, various theories put learning at the center of the analysis of economic development (Amsden, 1989; Stiglitz, 1994; Dosi *et al.*, 1998). Knowledge and knowledge-creation have become central for understanding firm performance and economic growth. Learning allows firms to create dynamic advantages by improving and producing better products and processes and facilitating their competitiveness. It entails a change in an organization's capabilities. This literature suggests that institutions either foster or constrain learning. Since learning is an interactive and socially embedded process that builds on knowledge from a wide variety of sources, this view implies that institutional arrangements play a vital role in facilitating (or hindering) firms' learning (Lundvall and Johnson, 1994). In this view, the growth of a firm, industry or cluster depends on how effectively institutions foster learning. Coincidentally, theoretical perspectives on development have moved away from seeing development primarily as process of capital accumulation, but rather as a process of organizational change and learning (Amsden, 1989, 2001; Stiglitz, 1994; Hoff and Stiglitz, 2001).

As development theory moved away from an exclusive focus on capital and technology, the emerging views spotlight institutions as the key element for fostering growth (North, 1990; Rodrik, 2000). In this line of thinking, the focus is on institutions that perfect property rights, which promotes competition. The assumption is they are exogenously given as they create an environment for individual firms. A recent analysis of economic development in Latin America notes that opportunities for rapid growth have been systematically missed because of a deficient 'learning capacity', which results from lack of institutions to facilitate knowledge creation and knowledge building (Maloney, 2002).

2.3 Learning-by-monitoring and conventions

While the literature discussed above clearly establishes the view that institutions are crucial for creating conditions for economic development, they leave open the question as to how those institutions develop and what characterizes them. These approaches take institutions as given or as pre-existing. Two sets of literature go beyond the notion of institutions as exogenously supplied meta-rules by emphasizing instead that actors create institutions (rules, conventions) to coordinate their interactions in the face of uncertainty. Sabel (1996) highlights institutions that address two central elements for achieving economic development: learning and monitoring. Learning refers to the process of firms' catching-up to the international standards of quality and productivity. Monitoring refers to actors continually assessing each other's performance according to the agreed standards. LBM is a relationship in which firms, alone or together with government, create institutions that help to meet the demands of learning and monitoring through mechanisms such as setting provisional goals, standards and evaluation (Sabel, 1996; Helper *et al.*, 2000). Actors make an effort to reach defined targets through continuous review of the partners' performances and capacities to reach those targets. Learning is an indeterminate process, in which both firms and government do not know in advance what has to change and how. No actor is dominant, no hierarchical center has definitive knowledge and there are no institutional prerequisites. Instead, actors learn from new information that arises through continuous discussion, interaction and experimentation.

The literature on 'economies des conventions' (Wagner, 1994; Storper, 1996; Storper and Salais, 1997; Thevenot, 2002) highlights the central role of institutions in solving the problem of coordination among actors. The starting point for this view is the uncertainty and interdependence that characterize economic activity. This requires coordination among actors, which comes about through agreements about what is to be done, called 'conventions' (Wagner, 1994; Storper and Salais, 1997). Instead of institutions being given, the economic actors create them in the process of interaction. The emergence of new productive activities will be related to the rules and standards which coordinate the relationship among actors involved in producing new products (Storper, 1996). This notion is particularly important in clusters given the interdependent production process among the local firms. Institutions can push firms toward new activities and to develop new and better products by creating new sets of expectations among the firms involved. They also help address problems of coordination that emerge in the initial stages of cluster formation, when firms face substantial challenges to become competitive in global markets.

The LBM view and the conventionalist argument expand the notion of institutions elaborated in the literature on economic development. Actors actively construct frameworks, agreements and expectations that can create conditions for development when they foster learning. In this sense, economic development is the

consequence of strategic and reflexive action taken to generate multiple options for survival and growth. Building on this view of institutions, the argument presented in this paper is that the growth of clusters, and the associated economic development, depends on the emergence of institutions that encourage and support learning processes among firms that contribute to build their technological and organizational capabilities.

3. Two cases from Chile

Chile is known as a successful exporter of products from natural resource-based industries, such as forestry, fishing, agroindustry and mining. During the 1980s, the country experienced a restructuring of its export basket. Traditionally a mining country, copper products accounted for half of Chile's exports in 1980 (Meller and Saez, 1995). By 1998, copper represented only one-third of Chile's exports (Montero *et al.*, 2000). The leading new export products are wood and pulp, farmed salmon, fruits and wine. In salmon farming, Chile experienced remarkable growth, becoming the largest exporter of farmed salmon in the world in nearly two decades [Asociación de Productores de Salmón y Trucha de Chile (APSTC), 2003]. Similarly, Chile became a major exporter of agro-industrial products, particularly fresh and processed fruit. In the case of the tomato agroindustry, Chile became one of the top six producers in the world in the 1990s (FEPACH, 2002). The dynamic industrial growth of both aquaculture and agroindustry evolved in a geographically concentrated manner, resulting in clusters.

As new and non-traditional activities, the two industries were created from scratch. Both cases illustrate that natural resource export growth was not a simple matter of comparative advantage. The transition from the early phase of emergence to a well-structured cluster entailed a long process of building organizational and technological capabilities and creating institutions that supported interactions that increased knowledge flows between firms in the early stages of cluster formation. Natural resource-related products often get incorrectly categorized as primary exports, masking the complexity of producing globally competitive products, even when the natural advantages exist. To meet international standards, the preparation of raw materials, their processing, preservation and packing require many changes and upgrading in production practices, involving many suppliers and firms.

3.1 Agroindustry cluster: tomato processing

Initial experiments: the state plants the seeds of a new cluster

The tomato agroindustry cluster is concentrated in an area that begins 100 km south of Santiago and expands 500 km further south, near Curicó and Talca. Of particular importance for the emergence of this agroindustrial cluster were the efforts initiated by the state that sparked a well-informed debate within government and among firms

as to the appropriate strategies to increase exports (Perez-Aleman, 2000).[10] In the late 1960s and 1970s the Chilean government encouraged the growth of new industries by pioneering research and entrepreneurial efforts to develop new export products. In particular, the Corporación de Fomento (Production Development Corporation, known by its acronym CORFO) led several experiments that in subsequent decades attracted both existing Chilean firms as well as new local and foreign firms. Fuelled initially by government funding to invest in ventures that experimented with new technology and new production organization, it became private-sector-led in the 1980s. The subsequent growth of firms and of the cluster became self-sustaining by the late 1980s and 1990s, as Chile's agroindustrial cluster became world competitive.

When CORFO first advanced the idea of developing an export-oriented agroindustry in the late 1960s, during the Frei administration, Chile's processed tomato industry was in the hands of small-scale firms. The firms used reconditioned second-hand equipment, and procured second-rate raw material on the spot market. Enterprises used local tomato varieties inappropriate for industrial purposes and the volumes produced were insufficient to achieve a relevant presence in export markets. Processors and raw material producers then concentrated in a region north of the capital city, Santiago.

The Chilean government encouraged the development of the processed tomato industry after a foreign mission to the UK established foreign demand for this product.[11] CORFO began to explore what had to be done to become an exporter of this product. It started by comparing existing Chilean industrial practices and conditions to those of the major established foreign competitors, California, Italy and Portugal. These had well-developed processing industries with the latest plant equipment and the best industrial tomato varieties, and used modern agricultural techniques. This discovery defined the government's initial strategic efforts to promote the development of new exports by adopting and adapting foreign innovation. This was not a simple wholesale imitation of their competitors, but an incorporation of those aspects of foreign experience that served locally appropriate strategies.

In view of what CORFO learned about foreign competitors, it developed projects to tackle Chile's major deficiencies. These public initiatives began a process of working out a distinct set of institutional arrangements to coordinate productive activity in the agroindustry. The national goal to produce exports for rich country markets led to a process of developing new ideas about products, production organization and technology that challenged existing norms and relations among private firms.

[10]As is well established now, the growth of Chilean exports was not simply a result of trade liberalization, but rather the fruition of government efforts initiated in the 1960s in the Chilean fishing, agricultural and forestry sectors, along with the efforts of local private firms. Among the various works that elaborate on the government's role in building Chilean export industries see ECLAC (1986), Jarvis (1992), Pietrobelli (1993), Stumpo (1995), Perez-Aleman (2000), Maggi (2002) and Farinelli (2003).

[11]Since we are talking about recent development, it is still possible to talk to the key players in the history, so I conducted interviews with professionals who had worked at CORFO in the 1960s.

The notion of producing an industrial product for foreign markets required changes in existing production norms. The old norm relied on spot market discard-quality tomatoes as raw material. Several projects began to address the challenge to obtain higher-quality input. Joint public–private experiments attempted to adapt foreign tomato industrial varieties from California, Italy and Portugal. These experiments, conducted in different geographical zones around the country, led to the discovery of new areas suitable for industrial production, particularly in the southern Central Valley. Through these experiments, the state played a role in defining a new product and providing Chilean firms with ideas about the changes needed to move beyond their traditional domestic products to produce industrial exports.

Adopting the world's best industrial tomato varieties for use in Chile was not a simple process of imitation. As CORFO attempted to develop a tomato processing industry, local debate began on how best to organize raw material production to replace the existing procurement system. An export industry needed to ensure sufficient quantities of raw materials to produce large volumes of processed product for foreign markets. It also required modern processing technology to replace the dated equipment and practices that existing firms used. During the early 1970s, CORFO advocated a new production organization in Chile that sparked the emergence of institutions that influenced the cluster's formation. The established competitors from California had a model of large-scale monoculture that Chilean officials did not imitate. They wanted a system that would incorporate the newly created sector of small producers, who were recent beneficiaries of Chile's agrarian reform, a parallel project of then governing Frei administration.[12] Thus, CORFO created the Malloa enterprise to foster the widespread diffusion of new varieties and agricultural practices, while adopting the latest food processing technology with large volume capacity. Malloa exemplified a decentralized production model in which a leader processing firm relied on a network of small producers as suppliers of raw materials whom the firm assisted in their adoption of foreign agricultural technology. The new enterprise was state-owned with the intention of becoming privatized later. The state's initial investment was matched by a loan from the Inter-American Development Bank.

Another technological innovation that reinforced the benefits of CORFO's idea about production organization centered on crop rotation and cultivation scheduling. Rotating crops to avoid soil degradation, and shifting agricultural production to take advantage of the variety of microclimates, could extend the production season and ensure a longer raw material production period to supply the processing plant (author's interviews with engineers in Production Division at Nieto and Malloa). This model supported the building of ties with small producers to form an extensive network

[12]Frei's government had as a key developmental objective the modernization of small producers. This goal was tied to the simultaneous implementation of an agrarian reform program in the largest, best irrigated and most economically important properties of Chile's Central Valley. For analyses of the agrarian reform, see Brown (1989) and Kaufman (1972).

of suppliers rather than monoculture in large tracts of land, as exemplified its California competitors. These new practices contributed to the emergence of new arrangements that became characteristic of Chile's tomato processing industry and that fostered the cluster's formation.

The state created spaces for experiments that gave local firms the opportunity to learn about different ways of organizing production but without state determinism. Much remained for firms to work out, especially building their capabilities in quality control, procurement, logistics and management of relations with suppliers. The experience of the pioneer firms reveals that a great deal still had to be learned. After the pioneer enterprise Malloa was privatized, in the 1970s under the Pinochet government, it experienced both production and commercial failures in its attempts to produce export products. For nearly a decade, private firms faced grave problems in this new industry: low yields; poor quality products; rotting of highly perishable raw material; irregular process flow and untimely supply; and low final product volumes.[13] The turning point for the new Chilean tomato industry came in the early 1980s, as it began to produce international quality products. That shift was a result, in part, of growing experience. The most significant change, however, was the emergence of LBM among firms, and between firms and government that supported collective learning.[14] Driven to increase exports, Chilean firms searched jointly for ways to improve their current practices, forming networks across firms.

Ties to foreign firms as customers spark new local institutions

Chilean-owned firms prevail in the agroindustry cluster. Eight of the nine large tomato processing firms are Chilean. Foreign firms, however, had a role in the cluster's development both as source of foreign demand and of new ideas to improve products. The efforts to build indigenous entrepreneurial capacity met with a key market opportunity: two Chilean firms established export connections to a sizable but exacting source of demand in Japan.[15] The ties established with Japanese multinationals helped Chilean firms in their quest to improve their products through the adoption of new quality management practices. One outcome of these relations was the emergence of a new set of institutions to coordinate relations between processors and suppliers.

[13]For a further elaboration of the coordination problems that Chilean firms faced and the changes in the institutional arrangements, see Perez-Aleman (2000).

[14]Learning involves many tacit elements that are not bought or transferred like physical products. Much of the knowledge underlying firms' capabilities is tacit knowledge (Nelson and Winter, 1982). Only a small portion of technology is codified in manuals, textbooks and blueprints. Learning requires purposive and active efforts to acquire new knowledge, crate new skills and practices and build relationships. Firms may not know how to build up the necessary capabilities, so there is also a process of 'learning to learn' (Stiglitz, 1987).

[15]The two firms were Nieto and Isasa. This section is based on author's interviews with the production and general managers of these two firms.

The Japanese companies had expertise in managing suppliers, and gave Chilean firms access to new information and skills that helped to improve their existing production capabilities. Chilean processors and suppliers were facing coordination problems that severely undermined the quality of their product. Existing practices focused on evaluating the incoming raw material characteristics, and rejecting it if defective. Japanese firms provided tutelage to Chilean firms on how to improve product quality and the management of the supply chain. Japanese experts worked side by side training Chilean personnel for a five-year period. Teams of engineers, operations and quality control experts arrived to teach Chileans how to address quality control from the raw material production stage to the final product. Foreign guidance combined with detailed foreign contracts at the two Chilean firms served to develop local managerial and organizational capacity to upgrade production.

The focus on providing quality checks and diagnostic information at every stage of the production process helped solve crucial coordination problems that led to long-term quality improvements.[16] As Chilean firms began to direct their attention to the whole production process, new institutional arrangements for working with suppliers emerged. For example, Chilean processors agreed to provide technical assistance throughout the whole agricultural production cycle to ensure timely problem identification. Suppliers, in turn, agreed to follow a strict planting scheduling to ensure a regular flow of raw tomato to the processing plants, thereby eliminating supply peaks and drops. These mutual obligations substantially improved product quality and industrial productivity.

In the long term, the new arrangement contributed to build global competitiveness and cluster growth. Other Chilean firms were attracted to and entered the industry, following the new model. In 1985, the tomato agroindustry had two large firms working with 210 suppliers. By 1995, nine large companies worked with 5000 suppliers (Perez-Aleman, 2000). The cluster grew rapidly during the late 1980s and early 1990s, fueled in part by new sources of demand, particularly from Asia and Europe. This growth phase was private-led but catalyzed by government funding. The industry continued to attract new foreign customers. By the early 1990s, Chilean firms became major global producers.

Local organizing and institutions for collective problem-solving

Another contributing factor to the growth of the cluster was the formation of the Federation of Agro-industrial Food Processors (Federacion de Procesadores Agroindustriales de Chile - FEPACH) in 1989. Firms actively organized to coordinate many aspects of their productive endeavors to improve their product quality. Coordination was done mainly by the joint creation of new product standards and by setting a framework for competition among the large firms (Perez-Aleman, 2003b). The creation of FEPACH provided a space to work out arrangements to solve coordination problems across the growing number of firms and suppliers.

[16]See Winter (2000) on the relation between quality improvement and organizational changes.

Through group-based discussions, firms set new standards that fostered collective learning by providing information and supporting the diffusion of new practices (Perez-Aleman, 2003b). From a learning point of view, standards contributed to the process that converts tacit knowledge into explicit form (Antonelli, 1999). The specifications for new products and new process characteristics became concrete guides for making improvements for the firms attempting to adopt the standards. Simultaneously, this coordination provided a space for group-based learning. In particular, since much of the knowledge was tacit, the group discussions on how to make quality improvements contributed to unveil much of this implicit information. Firms were able to understand the production process in a new way, and then find alternatives to address the problems. The firms' goal to increase exports was a motivating factor to engage in the efforts and investments to improve existing production practices.

Large firms agreed to reciprocity by setting limits on firm behavior, which took two forms as the number of enterprises and suppliers grew. First, as competition for fresh tomato input increased, processing firms would bid up prices in an effort to get suppliers to jump ship and sell a competitor's supply to them. This created problems as the rival firm had invested in its own suppliers, financing seeds and providing technical assistance. Large firms agreed to coordinate raw material price-setting to limit unbounded market competition. Second, the processors as buyers of raw material would force down prices at the height of the harvesting period when tomato supply was abundant. Suppliers would lose under this uncertain arrangement. Facing this problem together, processors and suppliers agreed to establish yearly contracts with forward prices that would ensure a profit to the producers while creating price stability. These new agreements contributed to coordinate vertical and horizontal inter-firm relations while reducing uncertainty and risk.

Coupled with firms' efforts, the state fostered highly interactive exploratory spaces that facilitated knowledge spillovers typically associated with cluster dynamics. To increase exports in the post-1982 period, the state used funding incentives to prod firms to engage in collaborative efforts to design and improve production processes, and upgrade or develop new export products. It offered public grants through the state agency PROCHILE.[17] The Export Promotion Fund, with a yearly budget of U$5 million in the mid-1980s, provided financial resources to co-finance (50/50) export projects proposed by groups of collaborating firms in the same sector (author's interviews with PROCHILE representatives in Santiago, Chile). PROCHILE promoted the association of firms into sector-specific export committees that would then define a project. Projects fell into two categories: those focused on improving quality to meet international standards and/or those to develop new products.

Once a project was approved, PROCHILE supported the export committees by providing specialized services that firms needed to develop their exports: acquiring

[17]PROCHILE is the Export Promotion Bureau of Chile, and is part of the Ministry of Foreign Affairs. It was created in 1975.

information on foreign standards; organizing trips abroad to visit the factories of foreign competitors, as well as product discovery missions; and providing information on market trends. These committees provided a base from which firms could discuss the building of new local standards and new product ideas acquired during visits to trade shows or to potential foreign clients. These activities proved valuable to managers who lacked export experience, or exposure to foreign markets. The networks of firms emerging from these interactive spaces contributed to the rapid diffusion of technology and collective learning.

3.2 Salmon industry cluster

Aquaculture currently represents one of the most important exporting sectors in Chile. Revenues from aquaculture more than doubled in the last decade. They accounted for 56% of total fishing exports in 2000, compared with only 28% in 1990 (Aquanoticias, 2001). Within Chilean aquaculture, salmon accounts for 95% of total export product volume (Aquanoticias, 2001). Chile's salmon exports increased from U$38 million in 1989 to more than a billion dollars in 2003, making Chile the world's top exporter of farmed salmon (APSTC, 2004).[18] In 1981, Chile was not even among the top five world producers, but by 2000 it accounted for 25% of the world production of farmed salmon, ranking second after Norway (Aquanoticias, 2000). In 1990 salmon production for export was 23,800 net tons. By 2000, salmon production had increased ninefold, with Chile producing 206,000 net tons (APSTC, 2001). Chile's salmon industry emerged in a territory known as the Tenth Region, located 1000 km south of Santiago.[19] Of registered fish farming centers in Chile, 81% (or 324 sites) are in the Tenth Region, accounting for 85% of the total volume exported (Aquanoticias, 2001).

Initial experiments: the state uncovers the seeds of a new industry

Chile's performance in farmed salmon is remarkable since commercial farming started only 25 years ago. Unlike the other current major exporters (Norway, UK, Canada and USA), salmon is not a species native to Chile, and was previously unknown in the Tenth Region.[20] It was only introduced after much experimentation in the 1970s, when it was established that salmon could grow domestically in Chile.

[18]With respect to dollar value, salmon exports accounted for 1.8% of total Chilean exports in 1991, increasing to 5.4% in 2000 (APSTC, 2001). Excluding copper exports, salmon exports represented 8% of exports in 2000.

[19]It includes an area south of Lake Llanquihue, Puerto Montt and the archipelago of Chiloé. Salmon farming requires particular water temperature ranges and excellent water quality. This limits the industry to specific geographic locations.

[20]The discussion on the farmed salmon cluster is from interviews with officials at CORFO and Fundación Chile, and managers in the six largest exporting firms—Marine Harvest, Salmones Antartica, Aquachile, Salmones Multiexport, Invertec and Salmon Fjord—all located in Puerto Montt, Chile.

The state played a key role in changing the notion of products from fishing. Chile had a fishing industry based on extraction of existing fishing stock for the domestic market. Chilean government programs created spaces to experiment and evaluate the feasibility of salmon farming in Chile. Out of these experimental projects emerged new information and ideas about farmed salmon as an export product. In 1969, a joint venture between Chile's National Fisheries Service (Servicio Nacional de Pesca, SERNAP) and Japan International Cooperation Agency (JICA) sparked the beginning of a serious salmon farming program (Fundación Chile, 2000).[21] This program, which started with foreign technical assistance in the late 1960s, continued until 1987. It was then followed by another cooperation agreement begun in 1988 that involved CORFO (through its affiliate Fisheries Development Institute, IFOP) and JICA.[22] These programs served to identify suitable rivers and ocean sites for salmon and trout farming activity in the Tenth Region.[23] They also created opportunities to acquire experience with ocean ranching and cultivation techniques, particularly those related to nutrition, disease control and fish transport. While the initial natural resource conditions explain why the industry concentrated in this region, this advantage did not assure automatic economic success. Farming presented several technological challenges due to the salmon's lifecycle, its nutrition requirements, disease susceptibility and environmental management that Chilean producers were required to learn.[24]

The state practiced a decentralized approach that contributed to the cluster formation. Rather than centralize investment and ideas, it nurtured their quick flow to private firms. The public research program became an important source for independent firm start-ups by new groups of entrepreneurs, who drew on the knowledge and skills developed in the public sector. In 1974, professionals who had worked in the government programs of SERNAP and IFOP formed their own aquaculture companies for commercial purposes (Fundación Chile, 2000). This move helped the transfer of skills and information from the public to the private sector. With a government loan from CORFO in 1975, for example, the Sociedad de Pesqueria Llanquihue started up as the first commercial farming venture in Chile. It was eventually the first to export to Europe.

[21]The Chilean government initially focused on open fishing development. It tried to populate the area with salmon for future open fishing (i.e. artificial wild), not 'farming'. Ocean ranching came later.

[22]IFOP (Fisheries Development Institute) is the fishing industry development agency established in 1965 as part of CORFO, the government development corporation. IFOP focused on technological research for production.

[23]Salmon farming is complex, requiring hatchery production in sweet water with later growth in salt water. The industry has been limited to geographic locations that meet the suitable conditions, such as North America, Norway and Scotland. Chile is the most recent addition to the list of producing countries.

[24]During the 1950s and 1960s salmon aquaculture emerged for the first time in Japan and the USA. Fish farming was consolidated in the late 1970s (Barton, 1997: 313).

At the same time, the government's venture capital agency, Fundación Chile, invested capital to create a firm that transferred foreign technology and developed local know-how.[25] During the early 1980s, the technical development input of Fundación Chile and its operations wing, Salmones Antártica, contributed to the take-off of salmon aquaculture. Fundación Chile broke new ground when it began to put hatchery-reared smolts (juvenile salmon) into cages in the sea for their main phase of growth.[26] It facilitated the transfer of aquaculture technology, such as the floating net pen used in Scotland and Norway to Chile. It also adopted new techniques, such as rearing in tanks instead of in the open river (Achurra, 1995). The Fundación acted as technical consultant to private firms interested in entering this activity, and conducted research continuously.

These initial ventures uncovered new business possibilities, and had significant demonstrative effects on local firms. The idea of producing farmed salmon became attractive as two commercial ventures demonstrated success. Consequently the number of domestic firms in salmon farming grew significantly in the 1980s. The first generation of investors was mostly local entrepreneurs or Chilean economic groups from other sectors (industry, construction, forestry and fishing) (Montero *et al.*, 2000). In 1980, there were three private enterprises;[27] by 1985, there were 36. Many of these were started by professionals who had worked previously in the public salmon research program. By 1987, some 120 firms were involved in ocean ranching; of these, about 42 enterprises accounted for 85% of total production (Achurra, 1995). By 1997, there were 219 firms exporting salmon (Bjorndal, 2002). In addition to firms engaged in production, other firms entered the industry in the Tenth Region, to become involved in egg hatcheries, feed production, cage manufacturing, product processing, refrigerated containers and transport services (Maggi, 2002).

Local association and institutions for collective learning

While salmon could be cultivated in Chile, Chilean firms had little experience producing this product, and did not have the competitive advantage of leading producers like Norway, Scotland and Canada. At the beginning, the firms were small enterprises trying to produce for export markets. Both volume and reputation were necessary factors for selling their product abroad. In the early cluster formation stage, firms wanted to connect with diverse foreign markets, where Chilean salmon was unknown (Maggi, 2002). Establishing a 'Chilean' brand was beyond the reach of one individual firm. Only by coordinating their productive activity could the small firms reach the vol-

[25]On the role of the Fundación Chile, a quasi-government development agency created with mixed public–private funding to support local entrepreneurial development, particularly in the fruit, vegetable and fish industries, see Huss (1998).

[26]Cages are floating structures, like the cage boats developed in Europe, Japan and North America. Fundación Chile conducted experiments to cultivate both Pacific and Atlantic salmon.

[27]Mares Australes (Mytillus), Sociedad Llanquihue and Fundacion Chile's Salmones Antartica.

umes and quality branding necessary to become globally competitive. Their interdependence led firms to invest effort in creating rules and agreements to upgrade their product.

New ways of coordinating production emerged. Chilean firms directed efforts to establish horizontal networks and alliances to improve their ability to compete internationally. In 1986, 17 firms formed the Association of Salmon and Trout Producers of Chile (Achurra, 1995; APSTC, 2002). The APSTC currently has 42 affiliated enterprises that account for 85% of salmon production (APSTC, 2002).[28] The APSTC emerged with the goal to ensure that foreign customers would see Chile as a source of high-quality product, with the capacity to ensure sufficient volumes, and thereby develop a reputation for Chilean salmon abroad.

Through the APSTC, firms established an institutional framework to coordinate productive relations that facilitated the flow of ideas across enterprises. A 'quality seal' certification that defined product standards and self-monitored processing emerged as a central agreement between them. As firms strategized to establish a reputation in this early stage, the newly developed standards classification and quality certification processes guided product improvements to develop exports. Through the APSTC, firms jointly developed the strict and detailed 'Code of Standards for Chilean Salmon' that defined how to evaluate each stage of product farming and processing (Achurra, 1995). It established a quality control to administer the quality certification seal to those firms that met the strict standards of the Association. Different classifications (Premium, Grade I and Industrial Quality) with a seal attached to the exterior of each box indicated which category the product met (author's interview with Executive Director of APSTC in 2003). This self-imposed quality certification seal became a key institutional mechanism for supporting relationships between firms based on LBM. The APSTC standards applied to both association members and non-members, and were designed to rigorously control the quality of the fresh and frozen salmon exports.[29] The mutually agreed standards constituted commitments on the part of each firm to make every effort to reach that goal. APSTC promoted the adoption of the quality seal that was given after an inspection conducted by private independent certifying companies. In this process, they diffused information to all firms about how to improve performance. As firms increased their knowledge and improved their product quality, both salmon exports and the cluster of firms grew significantly.

The government supported the private firms' collective initiatives by financing the implementation of quality certification (Maggi, 2002). It also used the firms' agreement as the basis for making national regulation inspired by the industry set standards. The

[28]The Asociación de Productores de Salmón y Trucha de Chile (APSTC) changed its name recently to Asociación de la Industria del Salmón, or SalmonChile.

[29]A critical area was the adoption of strict hygienic and sanitary standards with extensive training programs for workers operating the plants. The APSTC engaged in the development of standards for hygiene, sanitary management, and quality of the processing and final product in the plants.

APSTC standards were later adopted by the SERNAPESCA, the public authority in charge of fishing regulation, making them into mandatory quality norms for any plant operating in Chile (Montero *et al.*, 2000). Prior to this point, there was no state regulation or enforcement of salmon production standards.

Besides standards and quality control that helped to conceptualize an export quality product, the APSTC addressed the issue of the sustainability of the industry, particularly the challenges of fish disease control, and environmental contamination from feed and chemical treatments (Barton, 1997). Maintaining pristine water quality and prevention of disease transmission are crucial requirements for sustaining salmon farming growth. The problem of disease control requires that firms in close proximity address the problem jointly. The Association established the Salmon Technology Institute (INTESAL) in 1993, with 45% of the cost being met by CORFO (Barton, 1997). INTESAL focuses on how to improve production practices to reduce disease. The APSTC uses this information to influence its member companies to establish the latest disease management and sustainable production strategies. The companies in APSTC also moved to certify the environmental performance of their farming centers since 2000, according to the Code of Good Environmental Practice (Aquanoticias, 2001).

Another collective effort that contributed to the growth of the cluster was the ability of firms to connect with diverse foreign markets. Collaborative strategies led to innovations in approaching markets. For example, some Chilean firms formed an association to commercialize salmon beyond their two major markets, USA and Japan, where they faced decreasing demand in the early 1990s. This is the case of Salmoexport; in 1990, 13 Chilean enterprises that accounted for 30% of salmon production joined to commercialize and market their product together (Achurra, 1995; Maggi, 2002). This alliance, which lasted three years, aimed to improve the international market positioning of Chilean salmon. Chilean firms felt at a disadvantage compared with multinationals, which had their own marketing departments as part of the multidivisional structure of their parent companies. This collective initiative contributed to give visibility to Chilean producers, and opened new markets in Asia (Taiwan, Singapore, China), Europe and Latin America, further diversifying demand for their products.

Local and foreign firms intertwined: demand, competition and diversity

By 1995, Chilean salmon industry ranked second in the world after Norway. The cluster formed and grew with mostly Chilean-owned firms cultivating and processing salmon for exports. Chilean firms relied on imports of key inputs such as eggs, feed and pharmaceuticals produced by foreign multinationals. In the mid-1990s, however, foreign multinationals invested in the cluster, mainly through acquisition of Chilean firms (Maggi, 2002). Globally competitive Chilean firms attracted foreign companies to invest in the cluster. At the same time, European and North American firms faced Chilean competition by acquiring indigenous firms. By 2002, five of the top 10 exporting firms in Chile were foreign owned (APSTC, 2003). As the largest multinationals

from leading salmon-producing countries (Norway and Scotland) set up operations in the Tenth Region, they contributed to further the growth and to change the structure of the aquaculture cluster. In contrast to the initial cluster formation period, the entry of foreign firms through acquisitions increased the presence of large firms in salmon production (Maggi, 2002). Compared with 1997, when the 20 largest firms accounted for 65% of Chilean exports, by 2002 their share of total exports amounted to 85% (Bjorndal and Aarland, 1999; Aquanoticias, 2003). Small firms increased their presence as specialized service providers.

Among the multinational corporations (MNCs) that established in the cluster, the world's leading fish feed producers stood out (Achurra, 1995; Montero *et al.*, 2000). Initially concentrated in the supply of critical inputs such as eggs and feed, in the mid-1990s, foreign MNCs began to engage in salmon production, integrating forward by buying Chilean firms engaged in cultivation and processing. For example, Nutreco, a Dutch multinational that is the largest fish feed producer in the world, purchased Marine Harvest and Mares Australes companies. Nutreco (Marine Harvest) is currently the largest exporter of Chilean salmon to the USA and the largest producer in the world, accounting for 17% of the world's farmed salmon production (APSTC, 2002).

In the Chilean salmon cluster, the entrance of foreign MNCs does not represent the classic case of a cluster that forms around one dominant foreign MNC, nor an example of the commodity chain view in which an MNC buyer dominates a cluster of subordinate local companies (Altenburg and Meyer-Stamer, 1999; Bair and Gereffi, 2001). Rather, foreign direct investment followed substantial indigenous industrial development efforts, which benefited from foreign technical assistance.

Chilean entrepreneurs and MNCs have become more interdependent, increasing the flows of ideas, capital and organizational resources. Increasing foreign competition in the local cluster has put pressure on Chilean firms to move into areas where foreign firms have been dominant. In this sense, foreign firms serve as a source of ideas to push Chilean firms' own technological development. For example, some Chilean companies have entered feed and egg production, which in the early stages of the cluster development only foreign companies produced. Currently, four of the five largest salmon feed producers are foreign firms (Maggi, 2002). The Chilean company grew from a production alliance between four Chilean firms that created a new enterprise, Salmofood, to produce feed (Montero *et al.*, 2000). It has become a successful exporter with current sales above U$50 million per year. There are other alliances established to produce salmon food, such as Huillinco (Montero *et al.*, 2000). Similarly, Chilean firms began developing locally produced salmon eggs, a crucial industry input, by innovating in biotechnology research.[30] The largest Chilean exporters are currently self-sufficient in eggs. The increasing local–global interdependence resulting from growing foreign investment is pushing Chilean firms to innovate in new areas while increasing local diversity in the sources of ideas.

[30]Interviews at Aquachile particularly highlighted this experience.

4. Conclusions

The comparison of Chile's tomato processing and farmed salmon clusters reveals similarities in the three factors discussed in both cases. First, the state's role in the initial stage was to provide a space for exploration of new business ideas and productive activities. The state contributed to set new expectations and its experiments helped to develop new products. These exploratory projects sparked the beginning of a new industry. In both cases, the relations between the state and the economy followed an institutional arrangement that nurtured a decentralized industrial development that evolved over time into a cluster. The common practice was to create interactive spaces with private firms, to support their entrance into the new activity, and to facilitate the formation of horizontal and vertical networks. The new ideas uncovered by public experiments were quickly transferred to the private sector.

Second, in both cases, the formation of associations among Chilean firms was crucial to move from the early stage when firms entered the new activity to the point of reaching a critical mass of globally competitive firms. Through associative networks, firms created institutions that pushed product performance improvements and facilitated the flow of ideas across firms. In both cases, firms generated agreements focused on product and process standards to govern their productive activity. The interactions to define and implement new standards increased opportunities for collective learning.

Finally, in both cases, foreign firms have been the main source of demand and an important source of new ideas. Both clusters prospered by selling products to advanced countries, and their success was based on efficient high-quality production. While the state's role was crucial in the initial stage of cluster formation, the process of becoming globally competitive required diverse sources of ideas, which Chilean firms acquired through networks that included foreign firms.

The two empirical cases from Chile highlight that a central element of the cluster formation process is the emergence of institutions that make possible LBM, relationships between the state and firms, and among firms, which facilitate improvements in products, processes and capabilities. Institutions that make possible LBM create new sets of expectations among the actors involved, pushing firms toward new economic activities and new products. LBM does not create clusters, but rather supports their emergence by enhancing the conditions for collective firm learning, and for building firm capabilities to create products that will compete in global markets. As firms build their capabilities and connections with foreign market demand, the conditions develop for clusters to form and take-off (Bresnahan *et al.*, 2001). The dynamic interaction between the state, local firms' collective action and the linkages to global actors through institutions that foster learning are key factors in the emergence of the new production system that over time forms a cluster.

In the start-up stage, the state sets off local processes to experiment with new productive activities that help transform old practices and organizations. New activities entail uncovering new sources of demand, new products and new resources. In the initial

stages, LBM relations between the state and firms support the process of firms moving to compete globally in new industries. The state establishes linkages to a wider set of knowledge inputs, and provides financing to firms to produce new or higher quality products. Crucially, the state supports the emergence of inter-firm networks based on new sets of expectations. Through experimental projects, the state contributes to generate information to enter into new economic activities. Information flows and financing from the state support new interactions between previously unconnected actors. Through the emerging interactions new rules steer improvements in products, processes and performance. In the process, the relationships between the state and firms, and among firms, reshape into a partnership focused on improving collective organizational and technical capabilities to increase exports. This study converges with recent views on the nature of the state's role in development processes, focused on stimulating learning in networks of firms (Sabel, 1996; Perez-Aleman, 2003; O'Riain, 2004).

As important, local firms can engage in a process of upgrading their productive capabilities and the quality of their products by setting new standards that make explicit the demands of foreign markets. Jointly, firms create new standards and arrangements to push product improvements and skill building among the community of enterprises that enter the new industry. The standards set new expectations about product quality, production processes, and become benchmarks against which firms can evaluate their performance. This process involves a collective effort in which firms persuade and encourage each other to upgrade their products and to innovate in production organization to compete globally. Collectively, firms create agreements and monitoring mechanisms that hold them accountable to each other. The information that arises from this monitoring allows firms to learn what needs to improve in their current practice (Helper *et al.*, 2000). Systematic efforts to improve production processes contribute to generate and diffuse information by making explicit the tacit aspects of technology. Without these institutions, quality and coordination failures would lead to low export performance and stagnation, rather than survival and growth. Collective associations, as shown in various works, play a key role by allowing the creation of shared rules (Sabel, 1996; Sabel and Zeitlin, 1997; Nadvi, 1999; Doner and Schneider, 2000; O'Riain, 2000; Perez-Aleman, 2003b). The emergent rules foster the flow of ideas that provide conduits of relevant knowledge to build firms' capabilities.

Finally, this study supports the view that local–global interactions are important for understanding the emergence and growth of clusters (Bair and Gereffi, 2001; Breschi and Malerba, 2001; Bresnahan *et al.*, 2001). Foreign investors and customers can positively affect the growth of the clusters. When multinationals from the leading producing centers link with local firms, as suppliers of key inputs, as customers that assist technological upgrading and as actors locally embedded, clusters develop by linking and tapping into sources of demand, knowledge and capital in distant regions (Saxenian and Hsu, 2001). Local upgrading and growth, however, depend on substantial indigenous efforts, rather than the classic story of multinationals transferring technology to a passive recipient setting.

This study advances the views that highlight other factors, beyond external effects, affecting the conditions for a cluster to emerge, take off and grow (Breschi and Malerba, 2001). The implication of the approach elaborated in this paper is that growth and development associated with clusters will depend on building institutions that foster collective learning and firm capabilities. These institutions emerge from the interactions between private and public actors as they collectively explore possibilities, identify problems and strategize to resolve them. The cluster grows as actors transform products, organizations and connections to markets through local processes of institutional innovation.

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