Industrial Clusters, Knowledge Integration and Performance

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Summary. — Scholars examining the phenomenon of industrial clusters have begun to regard them as social communities specializing in efficient knowledge creation and transfer, in addition to neo-classical arguments focusing on the advantages of localization. We seek to contribute to this body of work by developing the argument that both the degree of knowledge integration between an industrial cluster's agents and the scope of their economic activities are key dimensions behind their economic performance. We present a model that incorporates a hypothesized relationship between these three dimensions and argue that a formal test of this hypothesis constitutes a promising area of future empirical research in this field.
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1. INTRODUCTION

That economic agents gather together in close geographic proximity and establish relationships with one another in order to better perform certain economic activities is a fact that can be traced back to the earliest urban developments. [1] Close-knit geographic clusters have remained a relevant economic phenomenon even at the dawn of the 21st century, nurturing some of the most successful players across a broad array of global industries, including—somewhat paradoxically—the same information technology industries that give us the ability to work and communicate virtually.

Active membership of an industrial cluster during the second half of the 20th century provided one of the best opportunities for small and medium-sized enterprises to survive and stay competitive on a regional, international and even global scale. At the same time, large international, multinational and global companies risked losing entire parts of the value chain in the key areas in which they competed—such as manufacturing, product design and Research and Development (R&D)—to nimble, formidable companies closely clustered in specific geographic locations. Some of these large companies were also able to leverage the enormous potential and capabilities that

industrial clusters offer. Typically they did this by locating key company operations in carefully selected industrial clusters around the world, or by using these industrial clusters as critical innovators, e.g., from the R&D, supplier or customer perspective.

In this paper we offer a knowledge-based framework to facilitate understanding of the key factors governing the way a cluster functions and its international success. Although there are many publications on the subject—or perhaps because of this—both the use of the term and the existing explanations of the underlying phenomena of clusters can be rather confusing. As a result, regional policy makers and businessmen alike often find it difficult to address the potential threats as well as the promising opportunities that these clusters provide.

In essence, we argue that two fundamental dimensions will allow both analyst and

practitioner to gain a real grasp of the cluster phenomenon. On the one hand, by looking at the nature and quality of a cluster's underlying social fabric, it is possible to understand its potential for knowledge creation and innovation. On the other hand, by assessing the reach and scope of a cluster's economic activities, it is possible to understand the forces driving its competitive and business logic. Altogether, social knowledge, economic factors and the forces of business competition provide a fundamental—if not exhaustive—understanding of clusters in a dynamic sense. The implications of this understanding for macro- and micro-economic policy design and implementation cannot be overemphasized. In addition, an understanding of what makes clusters work in practice is also critical for all firms competing in the global arena.

The paper is organized, as follows. In Section 2, we provide a definition of industrial clusters based on a comprehensive review of the major literature sources, from the early 20th century to more recent contributions. Significantly, in our definition of industrial clusters, social and knowledge-based elements are brought together more explicitly than they have in previous discussions.

Building on this definition, we discuss the major characteristics of industrial clusters in detail in Sections 3–8. These include: the social nature of an industrial cluster's knowledge interactions; the broad diversity of their social fabric—including much more than purely economic agents; the key importance of locally confined relationships and specialized economic linkages for efficient knowledge creation and transfer; the "common glue" that binds industrial clusters together; and the competitive scope of industrial clusters in today's increasingly interconnected, global milieu.

In Section 9, we introduce a knowledge-based taxonomy of industrial clusters that brings together the main elements examined in our previous discussions. This classification provides a way to assess the degree of knowledge integration of industrial clusters, which is understood to be a critical dimension behind their economic performance. In Section 10, we argue that the scope of competition of industrial clusters constitutes a second critical dimension in understanding their economic performance. Based on mainstream strategic management concepts, we develop a framework to appraise the scope of an industrial cluster's competitive dynamics from *external*

(market), *internal* (firm) and *social* (learning) dimensions.

Finally, in Section 11, we build on the foundations laid in the previous sections in order to postulate the hypothesis that is central to this paper, making a case for the link between knowledge integration, the scope of competition and the economic performance of industrial clusters. We conclude by arguing that a formal test of this hypothesis constitutes a promising, long-overdue area of future empirical research in this field.

2. WHAT ARE INDUSTRIAL CLUSTERS?

During the 1990s the explosion of specialized and popular literature on industrial clusters gave them an unprecedented relevance across a range of areas, including business management and economic, political, public and social policy. There was also a degree of confusion over what the various authors mean—and do not mean—by industrial clusters. Our first consideration therefore is terminology.

It is important to point out from the outset that we are not concerned here with the kinds of economic agglomerations found in large cities and urban developments of a certain size. As various authors have noted, large urban realities of necessity and almost inevitably provide opportunities for agglomerations of sorts to emerge, human first, social and economic next (Gordon & McCann, 2000). Indeed, it is obvious to those familiar with large cities and urban realities that economic interactions within these kinds of agglomerations are typically governed by the logic of large numbers and random events. But, two basic kinds of economic benefits that are important to our understanding of industrial clusters can also usually be found here.

On the one hand, large cities and similar agglomerations nurture *urbanization* economies—in other words, economic advantages that stem from factors or conditions that benefit *all* economic entities and agents that are part of the agglomeration. For example, the impressive air transportation facilities and infrastructure of a city such as London, the strategic geographic location of Athens for west–east logistical links and the multiplicity of linguistic skills present in Singapore can lead to economic advantages that can be enjoyed by all entities located in—or near—these large cities.

On the other hand, urban agglomerations lead to *localization* economies of scale. These are specialized economic advantages stemming from close geographic proximity that benefit specific industries only. To follow the previous examples, the City of London is one of the world's premier centers of financial talent in the form of tens—perhaps hundreds—of thousands of highly skilled finance professionals. This world-class talent pool presents obvious benefits for all financial services firms that decide to locate themselves in London. Similarly, Athens and its close surroundings is one of the world's leading hubs of people, firms, assets and infrastructure specifically related to the shipping industry. The same can be said of Singapore, except that its shipping hub is perhaps even larger than that of Athens, with a greater global reach.

The idea of localized economies of scale in geographic agglomerations has a long history in economics, going back to Adam Smith's early observations of labor specialization and to Marshall's (1925) explanations of why firms continue to localize in the same areas. Marshall highlighted three key explanations. First, firms get close together geographically because this allows them to develop a pool of specialized labor that is highly skilled for the specific needs of an industry and relatively easy for the firms in need of these skills to access. Second, these firms can provide nontraded input specific to an industry, i.e. by localizing themselves in close geographic proximity, the firms can experience economies of scale in developing and using common technologies or a particular capital infrastructure. Third, firms that join together geographically can generate a maximum flow of information and ideas. In other words, product, market and technological knowledge can be more easily shared and more effectively turned into valuable innovations between agents that are in close geographic proximity than between agents that are more geographically dispersed.

It is interesting—and to some degree quite paradoxical—that virtual communication technologies and developments in global transportation and logistics during the 20th century have made localization economies more—not less—critical to the competitive performance of firms. On the one hand, virtual communications and similar technologies have highlighted tacit knowledge and close personal relationships between economic agents as key determinants for the competitive success of firms. On the other hand, global logistics mean that access to basic production factors such as capital and nonspecialized labor are largely open to all, whereas flows of specialized knowledge and rich knowledge interactions that lead to valuable innovations remain stronger between agents in the same spatial group than among geographically dispersed firms.

Our definition of "industrial cluster" includes the Marshallian notions of urbanization and especially localization economies of scale, but it clearly departs from the concept of agglomerations in that the *knowledge interactions* within the cluster are not random but rather deliberate, socially constructed and determinant for its competitive survival:

> An *industrial cluster* is a socioeconomic entity characterized by a social community of people and a population of economic agents localized in close proximity in a specific geographic region. Within an *industrial cluster*, a significant part of both the social community and the economic agents work together in economically linked activities, sharing and nurturing a common stock of product, technology and organizational knowledge in order to generate superior products and services in the marketplace.

3. INDUSTRIAL CLUSTERS ARE SOCIAL ENTITIES

The first thing to note is that our definition of industrial clusters states that it is the nature, quality and strength of a cluster's underlying social fabric that determines how it integrates existing and new knowledge in order to create superior products and services. In essence, this is what more clearly differentiates industrial clusters from simple geographic agglomerations of economic agents. Gordon and McCann (2000, p. 520) observe:

> The strength of [an industrial cluster's] relationships is described as the level of "embeddedness" of the social network. In fact, all economic relations (even the "pure" market relations of the agglomeration model) are socially embedded in the sense that these depend upon norms, institutions and sets of assumptions shared among a group of actors and are not, in themselves, simply the outcome of economic decisions. [. . .] Industrial clusters (whether spatial or not) differ from the agglomeration model in that there is a belief that such clusters reflect not simply economic responses to the pattern of available opportunities and complementarities, but also an unusual level of embeddedness and social integration.

There is nothing inherently spatial about the social-network model although it has explicit spatial applications. This is because social networks are a form of durable social capital, created (and maintained) through a combination of social history and ongoing collective action.

Some authors in the sociological literature (Granovetter, 1992) have argued that industrial clusters can be considered as distinct from "social networks." Whereas the former are largely dominated by constellations of economic agents linked by contracts (Pitelis, 1993; Williamson, 1985), the latter—these authors argue—are dominated by intensive knowledge interactions between firms that are often stronger than intra-firm interactions. Although these views can be seen as a sociological response to neo-classical economic arguments in this area, conceptual parsimony would appear to be desirable for the purposes of the present study. Thus, in this research we prefer to consider social networks largely as a particular type of industrial cluster, in which knowledge integration between firms as well as institutionalized trust and personal interactions between economic agents are especially strong.

Furthermore, differentiating the quality and complexity of knowledge interactions within industrial clusters according to the type of industry—i.e. "high-tech" vs. "basic" or "mature"—seems to be based on rather feeble arguments and little empirical evidence. Indeed, a number of authors suggest that industrial clusters in central Italy formed around seemingly basic technologies such as tile manufacturing demonstrate knowledge interactions that are as socially complex, pervasive and innovative as any found in the biotechnology, telecommunications or computer software clusters (Gordon & McCann, 2000). The crucial difference in this context seems to stem from the degree to which the economic agents in an industrial cluster decide to engage in purposeful collaboration and continuous cooperation across critical activities that are of common interest to all—while keeping the competitive market dynamics intact. Simultaneous cooperation and competition in a clearly defined geographic area in turn requires a highly developed social fabric that engages and facilitates the integration of knowledge and communication exchanges as well as the fostering of a common sense of identity among economic agents. As a result—almost irrespective of the technological characteristics of any given industry—the degree of knowledge integration that can be found developing in industrial clusters can be rather complex.

There are certain costs associated with industrial clusters that sometimes serve as obstacles to growth. Although there is certainly a degree of increased competition and congestion on both the demand and supply sides, industrial clusters can also experience high rates of employee turnover and noncooperation between firms, which can jeopardize the entire cluster. As mentioned, the way in which an industrial cluster's agents manage to orchestrate mutual cooperation while at the same time fostering greater competition might become crucial to the cluster's long-term economic survival (Swann & Prevezer, 1996).

4. WHO BELONGS TO INDUSTRIAL CLUSTERS?

Our definition of industrial clusters includes a close-knit social community of people and a broad set of economic agents, not just firms. Studies that look at Emilia Romagna's industrial districts in Italy offer some of the most striking characterizations of cohesive *social communities* actively underpinning the economic strength of clusters (Becattini, 1990, p. 39):

The most important trait of [an industrial district's] local community is its relatively homogenous system of values and views, which is an expression of an ethic of work and activity, of the family, of reciprocity, and of change. To some extent all the main aspects of life are affected by this. The system of values which prevails in the district develops more or less quickly through time, in ways which are still to be explored: it constitutes one of the preliminary requirements for the development of a district, and one of the essential conditions of its reproduction. This does not imply that only one combination of values is compatible with the beginning and the growth of the district, but rather that some combinations are apparently admissible, while others are not. Under no circumstance, however, can the system of values be such as to discourage enterprise or the introduction of technical change. If that were the case, the district could not be an entity which persisted through time, and we would have instead an area of social stagnation.

Parallel to this system of values, a system of institutions and rules must have developed in such a way as to spread those values throughout the district, to support and transmit them through generations. The market, the firm, the family, the church and the school are some of these institutions; but they also include the local authorities, the local structures of political

parties and of unions, and many other public and private, economic and political, cultural and charitable, religious and artistic bodies.

Industrial clusters also include a population of *economic agents*—firms as well as individuals—with specialized skills or knowledge relevant to the linked economic activities that are carried out. In addition, these economic agents comprise institutions such as universities, research centers, industry associations and technological institutes, which foster mutual economic cooperation and the sharing of technological knowledge among the members of an industrial cluster. These kinds of institutions have been referred to as comprising an "associational economy" (Schmitz, 2000) or constituting a "meso-level" (Meyer-Stamer, 1999) between the macro-level of economic policy and the micro-level of a firm's competition. [2]

The available empirical evidence suggests that close-knit social communities are a significant factor behind the economic strength and sustainability of industrial clusters (Pyke, Becattini, & Sengenberger, 1990). In addition, associational or meso-level agents have been found to be effective in promoting cooperation for "good purposes" which is considered to have a significant performance-enhancing effect for firms located in advanced country regions. This is particularly the case for firms seeking to compete successfully in international and global markets (Hudson, 1998).

5. WHY IS GEOGRAPHIC CLOSENESS SO IMPORTANT?

Furthermore, our definition of industrial clusters stresses the notion that the members of such a cluster are localized in close proximity within a particular geographic region. We are therefore concerned here with the types of economic advantages strictly stemming from a high degree of geographic concentration among firms. These types of economic advantages have been well described in the classical and neoclassical economic tradition examining *industrial complexes* (Czamanski & Ablas, 1979; Feser & Bergman, 2000). As in the case of industrial clusters, industrial complexes can develop internal economies of scale in terms of specific trading links and customer–supplier relationships. Conversely, innovative firms can be heavily dependent on local networking or

linkages to support their novel products and services. Note that both of these advantages are strictly dependent upon the close geographic proximity of the firms localized within an industrial cluster. This is different from the typical *globalization economies*, which reduce the importance of traditional localized factors of production, or from the types of innovations relying on inputs that are unlikely to be locally confined (Simmie & Sennett, 1999).

It must be noted, however, that geographic proximity could bring as many disadvantages to the members of industrial clusters as it provides advantages. Disadvantages include the poaching of specialized labor between firms, greater competition (which can also, however, be an advantage), faster imitation of both technology and product innovations by competitors, and shared market intelligence among firms. Gordon and McCann's (2000) study of the effects of geographic proximity on related activities by industrial sector in London concludes that—out of 17 sectors examined—only printing and publishing and financial services show clear net advantages of proximity. This type of empirical evidence raises a fundamental issue: how do members of industrial clusters work together to balance the disadvantages and advantages of geographic proximity?

6. HOW DO MEMBERS OF INDUSTRIAL CLUSTERS COMBINE?

Our definition of industrial clusters highlights that its members work together in related or linked business activities. Indeed, the scale- and knowledge-based advantages generated within an industrial cluster stem from both the number and the nature of the particular linkages between its members. In a well-developed industrial cluster, these linkages can be numerous, unique and specialized to the industrial cluster, including:

—common customers (both firms and individuals);
—common suppliers and service providers;
—common infrastructure such as transportation, communications and utilities;
—common pool of human talent such as skilled professionals or specialized labor;
—common educational, training and coaching facilities and approaches for workers;
—common university, research center and technology institute specializations;
—common risk capital markets.

It has been shown that the number and economic value of these kinds of links can provide an adequate indication of an industrial cluster's strength (Feser & Bergman, 2000). For example, empirical research by Swann and Prevezer (1996) suggests that clusters in industries where multiple linkages can be created among the member firms (such as the computer industry) present significantly stronger growth patterns than clusters in industries with much lower linkages between member firms (such as the biotechnology industry).

7. WHAT BINDS INDUSTRIAL CLUSTERS TOGETHER?

Next, our definition stresses that members of an industrial cluster must share and nurture a common stock of product, technology and organizational knowledge. Indeed, some authors have described this critical characteristic of industrial clusters as constituting a "social glue" (Porter, 1998) that binds the cluster together. Others have referred to a "common glue" or an "organizational glue" that socially amalgamates diverse structural agents and integrates key knowledge across cultural, organizational and functional boundaries (Evans, 1993; Morosini, 2002).

On the one hand, Porter (1998, p. 88) highlights that:

> The social glue that binds clusters together also facilitates access to important resources and information. Tapping into the competitively valuable assets within a cluster requires personal relationships, face-to-face contact, a sense of common interest, and "insider" status. The mere collocation of companies, suppliers, and institutions creates the potential for economic value; it does not necessarily ensure its realization.

On the other hand, Morosini (2002) identifies five key capabilities that need to be in place to build this "common glue" that realizes economic value within—and across—economic organizations. When applied to industrial clusters, these key capabilities can be characterized as follows:

(a) *Leadership*—Well-functioning industrial clusters are deliberately amalgamated by groups of key individuals with explicit roles fostering mutual cooperation, knowledge sharing, leadership coaching and arbitration of disputes that are seen as benefiting the common interests of the members of the cluster. These individuals are identified and their roles are explicitly accepted by *all* the agents that belong to the cluster. Many authors have documented these leadership roles in the context of different industrial clusters. For example, in his role as industry association representative during the 1990s, the president of a large textile manufacturing company in southern Brazil's Santa Catarina region led a five-year radical transformation that turned the area from a fiercely competitive to a closely collaborative industrial cluster in this sector (Meyer-Stamer, 1999). Other authors have observed that CEOs and senior executives of established technology firms in Silicon Valley continuously identify promising young entrepreneurs and spend time coaching and growing their leadership talents—often helping to appoint them to senior positions in competing firms (Leonard & Swap, 2000). Moreover, leaders of large and small firms in Mexico's Guadalajara footwear cluster were seen to have worked closely together in the 1980s and 1990s to design and implement a comprehensive joint effort to overcome the dramatic effects of a series of macro-economic shocks such as large currency devaluations (Rabellotti, 1999).

(b) *Building blocks*—Well-functioning industrial clusters have typically developed a clear, common stock of organizational knowledge that is shared by all members, across functional, cultural and firm-specific boundaries. These building blocks typically include strong sociocultural ties among the local economic agents, creating a *common code of behavior* that facilitates trust and active collaboration; a *common language*, not just in the literal sense but also encompassing common technological, business and organizational terminology; a *common industrial culture* and atmosphere; a common philosophy and approach to developing *human talent and specialized labor*; a *common business understanding* of the basic competitive dynamics of their industry; and *common approaches to competitive performance measurement* (Meyer-Stamer, 1998; Rabellotti, 1995; Simmie & Sennett, 1999). Empirical evidence suggests that a common system of sociocultural and economic values, along with a well-defined system of institutions that supports and spreads those values, is

associated with economically strong and more innovative firms in an industrial cluster (Pyke *et al.*, 1990).

(c) *Communication rituals*—Within well-developed industrial clusters, there are regular communication events, interactions and approaches that continuously foster a common sense of identity among all members of the cluster. Meyer-Stamer (1999) describes some of these communication *events* in the context of Brazil's Santa Catarina textile manufacturing industrial cluster, which are fairly typical of such events in similar clusters elsewhere (Porter, 1998; Schmitz & Nadvi, 1994). In 1996, for example, the president of one of the largest textile manufacturing firms in the area (mentioned earlier) organized key events such as visits for local owners and managers of textile firms to Italy's textile clusters in order to learn best practices in interfirm relations and see world-class examples of supportive meso-level institutions. Communication *interactions* that support the development of a common sense of identity in industrial clusters include proactive industry associations, common interest groups to lobby local or national governments and building a common image through public relations initiatives and the like. Finally, typical communication *approaches* that foster a common sense of identity among the members of an industrial cluster *vis-à-vis* the outside world include developing a common product- or quality-brand, as well as common and explicit quality standards. Empirical studies have found that industrial clusters with well-developed communication events, interactions and approaches have higher levels of interfirm cooperation and are more adaptable to abrupt changes in the macro-economic and competitive environment (Pyke *et al.*, 1990).

(d) *Knowledge interactions*—Well-functioning industrial clusters muster a series of regular, explicit and highly developed mechanisms for sharing key technological and business knowledge among all members. Typical examples include continuous benchmarking task forces (both within the cluster and across clusters); research centers, technological institutes, universities, think-tanks, executive education and worker training schools that actively promote mutual cooperation and technology transfers within the industrial cluster and between firms; joint R&D, product design, manufacturing or co-marketing efforts between firms; and export and trading organizations both locally and abroad. In well-developed industrial clusters, meso-level institutions such as industry associations usually play a key role as both initiators and managers of these coordination mechanisms. It is important to note, however, that this role is substantially different from the conventional collective bargaining, political lobbyist or contact and networking roles that these kinds of associations typically play within industries or inside less developed industrial clusters (Swann & Prevezer, 1996). The available empirical evidence suggests that industrial clusters with well-developed coordination mechanisms show a significantly higher level of cooperation between firms. In turn, co-operating firms within the cluster tend to perform better than noncooperating ones (Schmitz, 2000). Cooperation between firms can often be facilitated by the economic complementarity between a cluster's agents, which can extend upstream to suppliers, downstream to customers or laterally to manufacturers (Porter, 1998). This allows for increased efficiencies (e.g. technologies, marketing channels), as well as additional benefits (e.g., the reputation of certain regions for industry excellence benefits all of its members) and synergies (e.g., consumers of hotel services will value the entire experience according to the quality of each component). [3]

(e) *Professional rotations*—Within highly competitive industrial clusters, there is typically a significant pool of human talent specialized around business and technological knowledge that is specific to the cluster's main economic activities. The degree of crossfirm mobility of these professionals largely takes place within the geographic boundaries of the industrial cluster. Perhaps the most conspicuous example of this phenomenon is in Silicon Valley, where the talented and entrepreneurial individuals that seem to abound in this cluster tend to be extremely mobile, either across firms (after relatively short work experience, on average, in any given organization) or in order to start up their own enterprises. But, these moves usually take place *within the geographic boundaries of the Valley* (Leonard & Swap, 2000). These characteristics have certainly helped give Silicon Valley some of its legendary clout and reputation in most people's

minds. A flow of talented and skilled professionals continually moving within an industrial cluster provides an effective and efficient vehicle for sharing tacit expertise (Bortagaray & Tiffin, 2000), best practices and experiential knowledge across firms. No less importantly, it contributes to the development of new knowledge as well as technology transfers, combinations and replications across the cluster's economic agents. Indeed, in this area empirical studies suggest that firms in industrial clusters are more likely to be innovative when there is a high degree of *own-sector* employment in the cluster's home region (Baptista & Swann, 1998). [4]

8. THE GLOBAL SCOPE OF TODAY'S INDUSTRIAL CLUSTERS

Finally, our definition stresses that the ultimate goal of industrial clusters is to generate superior products and services that are valuable to customers in the marketplace. There are at least two crucial points to be made about this notion. First, although an industrial cluster might benefit from some protective measures at the outset, in the long-term, selection mechanisms that reflect the dynamics of business competition must be in place (Porter, 1998). Otherwise, an industrial cluster will simply not survive, or it will do so as a result of economic transfers that are not necessarily market related, e.g., in the form of state subsidies or fiscal incentives.

Second, industrial clusters have not only proved extremely successful at creating real economic value nearly everywhere but have also—during the second half of the 20th century—emerged as formidable global players in their own right across an astonishing variety of industries. Therefore, although these industrial clusters are tightly confined geographically, their scope of competition is increasingly global, not local. Whereas the market focus of some of these industrial clusters might remain local, global competition can nevertheless take place in the form of new entrants—which often include industrial clusters as well. Rabellotti (1999) describes the case of a Mexican shoemaking cluster which during the 1990s was partly displaced in its main (local) market by cheap competing products from Chinese shoemaking clusters.

The global scope achieved by industrial clusters during the 1990s went far beyond the export potential and international appeal of a specific product range that in the past typically made the fortunes of industrial clusters such as northern Italy's tile manufacturers, tool machinery producers or shoemakers. At the dawn of the 21st century, industrial clusters were taking over entire areas of many global industries, such as manufacturing, R&D and product design. As a result, leading multinationals in industries ranging from computer hardware, semiconductors and automotive manufacture to textiles, medical equipment and watchmaking found themselves increasingly using industrial clusters to their benefit or— quite often—simply to enhance their chances of competitive survival. These multinationals would typically involve industrial clusters either as leading suppliers or as key customers and innovators in key areas of their value chain.

9. A KNOWLEDGE-BASED CLASSIFICATION OF INDUSTRIAL CLUSTERS

Some of the approaches developed in the past to understand the phenomenon of industrial clusters include templates for applied regional cluster analyses (Feser & Bergman, 2000), descriptive frameworks for strategic and competitive analyses (Carrie, 2000) and empirical classification models (Gordon & McCann, 2000; Porter, 1998). What appears to be a common characteristic of these approaches is that they rely on the notion of economic linkages among a cluster's economic agents to categorize and analyze both its nature and strength. In addition, authors such as Carrie (2000) look at the nature and diversity of the institutional fabric of the clusters under study, whereas Gordon and McCann (2000) study the net economic advantages stemming from geographic proximity. But, these types of approaches seldom include an industrial cluster's knowledge-based elements as an explicit part of their underlying frameworks, templates or classificatory models.

A relatively different approach looks at the concept of clusters as a factor in competitive advantage (Porter, 1998). With this approach, the strength of a cluster depends on a series of interacting factors that can be grouped under the categories: firm strategy, structure and

rivalry; firm conditions; related and supporting industries; and factor conditions related to climate, labor supply, government fiscal and incentive policies, *etc*. Although this approach pays more attention to knowledge-based elements as key determinants of a cluster's strength (as in Porter's, 1998 notion of ''social glue''), it still overwhelmingly relies on the notion of economic linkages when categorizing a cluster's competitive dynamics and characteristics.

Knowledge-based elements as key determinants of a cluster's strength and performance do receive a considerable amount of attention within qualitative and case-based research studies (Meyer-Stamer, 1998; Rabellotti, 1999). Although these studies do not typically provide explicit frameworks for a structured understanding of a cluster's strength and performance, they do offer both the necessary conceptual basis and the associated empirical evidence. Based on the existing approaches, in Table 1 we summarize a series of key variables that ought to be included in a more holistic, knowledge-based framework for understanding an industrial cluster's strength and dynamics.

10. SCOPE OF COMPETITION OF INDUSTRIAL CLUSTERS

As previously mentioned, a second critical dimension for understanding a cluster's competitive and business logic is the reach and scope of the economic activities carried out by its member firms (Porter, 1998). These activities can be grouped according to three broad factors (Morosini, 1998): (a) those that are largely *external* to the firm, i.e. customers, product markets and the macro-level demographic, regulatory and legal frameworks governing these customers and markets; (b) factors that shape the *internal* characteristics of the firm, such as its resources, processes and capabilities; and (c) factors that govern *social* approaches to learning, articulating knowledge and creating a distinct sense of identity and cultural behavior.

A firm's external, internal and social factors are obviously conditioned, driven to change and influenced by a series of environmental and competitive forces (Rumelt, 1984). As previously observed, within an industrial cluster some of these drivers are inherently local—or at least their scope of influence is predominantly local. Thus, *external* factors such as customers and product markets can be geographically localized either within the cluster or nearby. In these cases, the relevant demographic trends and regulatory frameworks will also tend to be local ones. By the same token, many of the key resources and core competencies that are *internal* to the firm can be largely driven by local forces (Prahalad & Hamel, 1990). For example, in many industrial clusters most firms overwhelmingly rely on local sources for human capital in the form of individuals with specialized knowledge or knowledge about key customers. Similarly, innovation processes by firms in certain industrial clusters tend to be heavily driven and largely stimulated by what neighboring competing firms are doing. Finally, a firm's particular *social* approaches to learning and knowledge creation, as well as the cultural norms and behaviors it values and enacts, can be heavily influenced by the surrounding socioeconomic system of local cultural values and the institutional fabric of an industrial cluster. [5]

Conversely, in certain industrial clusters a firm's external, internal and social factors can be largely driven by the globalization of the world economy. This phenomenon has particularly accelerated since the 1970s, involving an increasing internationalization, greater competition between firms, more instability and uncertainty in product markets, as well as shifting patterns of competition where knowledge intensity carries a premium (Gordon, 1996; Veltz, 1993). Globalization has had a great impact on industrial clusters, though not in the direction that some might have thought at first (Granovetter, 1973). Although it has reduced the importance of traditionally localized factors of production, globalization has perhaps increased the importance of localized industrial clusters across the entire range of a firm's external, internal and social activities. For example, firms in many industrial clusters tailor *externally* to a global clientele and to global product markets. Similarly, an increasing number of industrial clusters compete globally for key *internal* resources, and develop key processes and capabilities within a global competitive landscape. Finally it has been the case that *social* approaches to learning, knowledge sharing and cultural behavior of firms within an industrial cluster were radically influenced and changed—i.e. from fiercely

Table 1. *Knowledge-based classification of industrial clusters*

Key constructs	Main references
I—Institutional fabric	
Social community	
—Relatively homogenous system of values and views	Amin and Thrift (1992), Becattini (1990), Gordon and
—System of values and view encourages initiative and technical change	McCann (2000), Ingley (1999), Porter (1998), Pyke *et al.* (1990), Rabellotti (1995), Saxenian (1994)
—System of institutions that spread system of values within the cluster	
Economic agents	
—Relative number of individuals with specialized skills and knowledge	Arni (1999), Brusco (1999), Czamanski and Ablas (1979), Feser and Bergman (2000), Gordon and
—Relative number of firms in geographic proximity	McCann (2000), Hudson (1998), Meyer-Stamer (1999),
—Relative number of economically linked firms	Muller-Glodde (1991), Piore and Sabel (1984), Ramos
—Relative number of international and multina-tional firms	Campos, Nicolau, and Ferraz Cário (1999)
—Relative number of "meso-level" institutions	
—Diversity of "meso-level" institutions	
—Quality of "meso-level" institutions	
II—Geographic closeness	
—Net internal economies of scale advantages	Berardi and Romagnoli (1984), Camagni (1991),
—Net specialized labor advantages	Cheshire and Gordon (1995), European Commission
—Net interfirm knowledge sharing and networking advantages	(1999), Keeble and Wilkinson (1999), Lazerson (1990), Marshall (1925), Piore and Sabel (1984), Porter (1998),
—Net interfirm technology transfer advantages	Sabel (1982), Simmie and Sennett (1999), Swann and
—Net shared market intelligence advantages	Prevezer (1996)
—Net product-, technology- and managerial-inno-vations advantages	
III—Economic linkages	
—Common customers (both firms and individuals)	Amin and Thrift (1992), Arthur (1994), Becattini
—Common suppliers and service providers	(1990), Becker (2000), Cheshire and Gordon (1995),
—Common infrastructure such as transportation, communications and utilities	Cooper and Folta (2000), Feser and Bergman (2000), Gordon (1996), Lazerson (1990)
—Common pool of human talent such as skilled professionals or specialized labor	
—Common educational, training and coaching facilities for workers	
—Common educational, training and coaching approaches for workers	
—Common university, research center and technol-ogy institute specializations	
—Common risk capital markets	
IV—"Common Glue"	
Leadership	
—Explicit leaders of the cluster	Buck, Crookston, Gordon, and Hall (1997), Evans
—Explicit leaders are accepted by all of the cluster's economic agents	(1993), Leonard and Swap (2000), Meyer-Stamer (1999), Rabellotti (1999), Rosenberg (2002)
—Explicit leadership roles include:	
—Knowledge sharing coordination	
—Coaching future leaders of the cluster's firms	
—Dispute arbitration	
—Vision and driving change	

Table 1—*continued*

Key constructs	Main references
Building blocks	
—Strong sociocultural ties across boundaries	BRITE (2001), Dominguez-Villalobos and Grossman
—Common code of behavior among the cluster's economic agents	(1992), Humphrey and Schmitz (1998), Leon (1998), Leyshon and Thrift (1994), Lorenz (1996),
—Degree of trust among the cluster's economic agents	Meyer-Stamer (1999), Morris and Lowder (1992), Piore (1990), Rabellotti (1995), Simmie and Sennett
—Attitude of mutual collaboration among the cluster's economic agents	(1999), Zhang (2001)
—Common language	
—Common industrial culture	
—Common industrial atmosphere	
—Common approaches to developing human capital	
—Common business understanding and mindset	
—Common competitive performance approaches and measurements	
Communication rituals	
—Regular communication events	Pyke *et al.* (1990), Porter (1998), Schmitz and Nadvi
—Regular communication interactions	(1994); Amin and Thrift (1992), Granovetter (1973),
—Regular communication approaches	Magplane (2001)
Knowledge interactions	
—Benchmarking task forces across the cluster's firms	Boston Consulting Group (1998), Saxenian (1994)
—Roles of research centers, technological institutes, universities include	
Executive education of the cluster firms' employees	
Mutual cooperation initiatives across the cluster's firms	Bagchi-Sen (2001), Brusco (1999), Christensen (1997), Keeble, Lawson, Moore, and Wilkinson (1999), Leon
Technology transfers across the cluster's firms	(1998), Lorenz (1996), Pedersen, Sverrisson, and van
Joint R&D initiatives across the cluster's firms	Dijk (1994), Porter (1998), Saxenian and Hsu (2001),
Joint manufacturing initiatives across the cluster's firms	Schmitz (2000)
Joint product design initiatives across the cluster's firms	
Joint sales and marketing initiatives across the cluster's firms	
—"Meso-level" institutions' roles include	
Initiating coordination mechanisms inside the cluster	Amin and Thrift (1995), European Commission (2002), Keeble *et al.* (1999), Sanchéz, del Castillo, Lacave, and
Managing coordination mechanisms inside the cluster	Terras (2000)
Professional rotations	
—Degree of own-sector employment within cluster's home region	Athreye (2001), Becker (2000), Baptista and Swann (1998), Bortagaray and Tiffin (2000), Brusco (1999),
—Degree of interfirm mobility within cluster	Keeble *et al.* (1999), Leonard and Swap (2000), Lorenz
—Degree of spin-offs/start-ups by cluster's employees	(1996), Paija (2001)

competitive to highly cooperative—once global competition became the norm within the industry.

In Table 2, we summarize a series of key parameters that can serve to characterize the competitive scope of an industrial cluster's

Table 2. *Scope of competition of industrial clusters*

Extent to which the competitive drivers of an industrial cluster's firms are mostly local or global according to these factors

Key construct	Main references
External factors	
—Main customers	Brusco (1999), Feloy, Gordon, Lloyd, and Roe (1997),
—Main product and services markets	Lazerson (1990), Mishan (1971), Sanchéz *et al.* (2000),
—Key demographic trends	Schmitz (1995)
—Main legal and regulatory frameworks	
Internal factors	
—Key resources (i.e. human capital, financial capital)	Porter (1998), Simmie and Sennett (1999), Rabellotti
—Key processes (i.e. innovation, product	(1995), Puri and Hellmann (2000), Saxenian (1994)
development, supply chain management)	
—Key competencies and capabilities	
(i.e. key technologies, speed of innovation)	
Social factors	
—Learning (i.e. about customers, products,	Brusco (1999), Keeble *et al.* (1999), Leonard and Swap
technologies, managerial approaches)	(2000), Rabellotti (1995) Sanchéz *et al.* (2000)
—Knowledge creation	
—Knowledge sharing	
—Cultural behavior and norms	

firms according to *external*, *internal* and *social* factors.

11. LINK BETWEEN KNOWLEDGE INTEGRATION, SCOPE OF COMPETITION AND THE PERFORMANCE OF CLUSTERS

A broad array of existing empirical evidence (some of which is referenced in the previous sections) suggests that *both* the degree of knowledge integration and the scope of competition are co-evolving factors that are crucial to explain the economic performance of industrial clusters. Although the empirical evidence remains slightly fragmented, it suggests that firms in industrial clusters that present a high degree of knowledge integration and compete globally innovate more, present stronger growth patterns, adapt to changing environmental conditions more rapidly and have a more sustainable economic performance than firms in less integrated clusters that tend to compete within strictly local geographic boundaries (Meyer-Stamer, 1998; Porter, 1998; Pyke *et al.*, 1990; Rabellotti, 1995; Schmitz, 2000; Simmie & Sennett, 1999). These kinds of empirical evidence underlie the following hypothesis:

The higher the degree of knowledge integration between member firms, and the higher the global scope of competition of member firms, the higher the economic performance of industrial clusters.

Figure 1 provides a graphic illustration of our hypothesized effects, postulating a comparative taxonomy of industrial clusters across a diversity of industries and geographies, which we assessed within the context of our research. This hypothesized taxonomy is included here for illustrative purposes only. It is based, however, on an examination of over 2,000 pages of archival data, academic and specialized publications as well as expert opinion gathered through a series of field visits and interviews with industrial cluster agents (e.g., entrepreneurs, association representatives, practitioners) in southern Brazil, Brazil's Amazon State and northern Italy. Both the literature review and the expert interviews we carried out were tightly structured around the templates and constructs outlined in Tables 1 and 2 (see Appendix B). Our analyses focused on the mid-1990s, for which a relatively large body of empirical data exists on industrial clusters along the following dimensions: degree of knowledge integration, scope of competition and economic performance (e.g., Becattini, 1990; Feser &
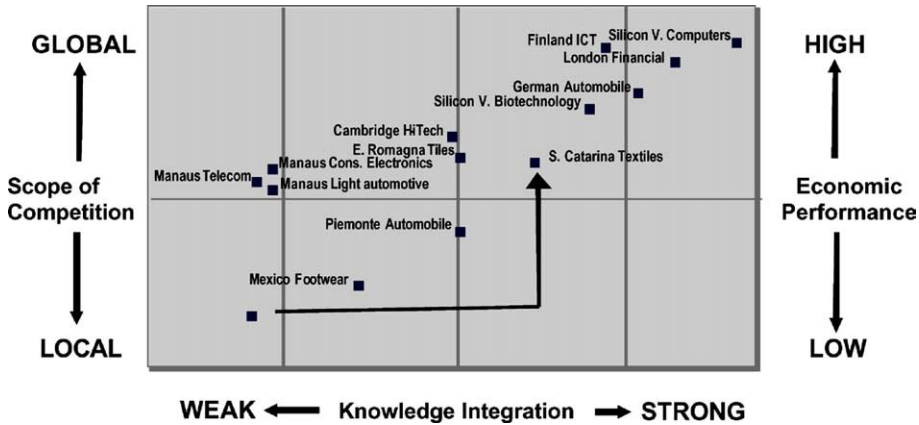
Figure 1. *Hypothesis: knowledge integration, scope of competition and performance of industrial clusters.*

Bergman, 2000; Gordon & McCann, 2000; Meyer-Stamer, 1998; Rabellotti, 1999).

Figure 1 thus illustrates a number of overall patterns that seem to emerge quite clearly from the growing—albeit fragmented—empirical literature on industrial clusters over the last two decades of the 20th century. These patterns unveil a multitude of characteristics that appear both to explain and determine the economic performance of industrial clusters. Some of these characteristics have to do with competitive factors that are inherent in the industrial sectors in which the clusters operate. Others have to do with factors concerning an industrial cluster's institutional fabric, geographic closeness, economic linkages and "common glue," and here the scope for positive intervention is arguably greater for the macro-economic policy maker and the business planner alike.

An empirical test of the hypothesis we have developed, remains, however, a challenging step for a better, holistic understanding of the major factors that both explain and determine the economic performance of an industrial cluster. We suggest that this empirical test, conducted along the constructs developed in Tables 1 and 2, could contribute to this understanding in a way that encompasses the economic and social aspects that appear to be equally important to the competitive functioning of industrial clusters.

12. CONCLUDING REMARKS

We have looked at industrial clusters from an economic and a social perspective. The complexity and richness of this phenomenon seems to be as great as its potential to contribute economic value to both the economic agents and the social communities involved. We suggest that by looking at the crucial dimensions of knowledge integration and the scope of (global) competition, much of the underlying functioning fabric of industrial clusters can be captured in ways that are meaningful to both the economic policy maker and the business executive. No less important, the analytical frameworks and testable hypothesis developed in this study can also highlight and strengthen the many social dimensions that are so central to explaining the unprecedented economic success and unique competitive advantages that industrial clusters have come to realize at the dawn of the 21st century.

NOTES

1. A "cluster" of Sumerian cities along the Fertile Crescent (an elongated valley between the Tigris and Euphrates rivers, in today's southern Iraq) is commonly regarded by archaeologists as the world's first urban development, the very cradle of humankind. Early 20th- century excavations in these ancient cities, which date back to 4000–3500 bc, unveiled astonishing remnants of entire districts devoted to well-defined artisan activities, as well as specialized markets with highly developed rules and laws governing the production and exchange of

goods and services. Most surprising of all, clear evidence of the commercial reach of these districts was found as far away as Anatolia (today's Turkey), Asia Minor (in modern Syria) and Egypt.

2. Becattini's (1990) description of an industrial cluster's "institutional system" is certainly a more holistic notion than either "meso-level" or "associational" conceptions. This applies both to the range of institutions that an "institutional system" encompasses and to the inherent purpose of these institutions, i.e. social *and* economic as opposed to strictly economic.

3. The role of different government bodies as initiator, promoter, coordinator and manager is relevant to a number of industrial clusters today. A description of the types of action taken by government is given in Appendix A.

4. A variable that increasingly seems to affect the ability of a cluster to attract or retain human talent is its quality of life. This includes factors such as housing costs, amenities, commuting time and clean environment, and has been used to explain the growth of "second tier" clusters when quality of life declines in the original cluster (Bortagaray & Tiffin, 2000).

5. See an introduction by Drucker (1997).

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APPENDIX A. THE ROLE OF LOCAL, NATIONAL AND REGIONAL GOVERNMENTS

The role that local, national and—increasingly—regional governments play in both the birth and management of industrial clusters has been studied quite extensively in the past. Governments are strongly attracted to this phenomenon for a variety of reasons, most of which must seem obvious to all: there is potential for economic growth and employment as well as for attracting valuable investments, technological assets and critical economic resources to certain geographic areas, typically those seen as less economically developed or ''strategic.''

The relevant literature has identified a number of roles that local, national and regional governments typically play *vis-à-vis* industrial clusters (Meyer-Stamer, 1999; Rabellotti, 1999). These roles can be classified in a few categories:

—*Initiator*: Macro-economic or regional policy decisions often pave the way for industrial clusters to emerge or they—often less deliberately—create critical conditions that force these clusters to evolve in completely new ways. Perhaps the most spectacular recent example of the former is the Finnish government's liberalization and deregulation of the telecommunications industry during the 1980s. This radical process contributed to the development of a world-class industrial cluster in southern Finland over the next decade, nurturing the growth of global telecommunications equipment leaders such as Nokia.

—*Promoter*: Governments can promote an industrial cluster's products, services and image in a variety of ways, including export promotion infrastructure, networking abroad and trading negotiations with other governments. National governments of countries such as France, Taiwan and Singapore provide good examples of long-term promotion efforts on a global scale in support of industrial clusters, i.e. in the food, semiconductor and computer hardware sectors, respectively.

—*Coordinator*: State governments can be active in carrying out project tasks such as benchmarking, technology transfer, best-practice exchanges and expert assistance on behalf of clusters. In the Brazilian state of Santa Catarina, for example, the local government has been described as playing an active coordinating role throughout the 1990s to support the state's textile and tile manufacturing clusters (Meyer-Stamer, 1999).

—*Manager*: State, national or regional governments sometimes provide massive resources to start and/or support industrial clusters in particularly intensive ways that either include or fall just short of taking ownership stakes in some of the main firms and related economic and capital infrastructure. This is often the case with ''industrial cities,'' ''industrial poles'' and the like, which are typically started with a significant injection of public funds and supported thereafter with heavily subsidized resources, tax incentives and favorable macroeconomic policies. In addition, in these situations, governmental institutions and representatives often play a rather active role, not only influencing the strategic orientations and business activities of the firms within the cluster but also taking an openly managerial role, i.e. running the economic, capital and financial infrastructure surrounding the cluster's firms—or even some of the firms themselves.

APPENDIX B

RESEARCH STUDIES LOOKING AT INDUSTRIAL CLUSTERS, DEGREE OF KNOWLEDGE INTEGRATION, AND SCOPE OF COMPETITION[a]

	London Financial	Piemonte Automobile	Emilia Romagna Tiles	Mexican Shoe Manufacturing	Santa Catarina Textiles	Finland ICT	Silicon Valley IT
I—Institutional fabric							
Social community							
Relatively homogenous system of values and views System of values and views encourages initiative and technical change System of institutions that spread system of values within the cluster	Amin and Thrift (1992)	Belussi (1992)	Barbagli, Brusco, Pisati, Santono, and Serravalli (1998), Capecchi (1990)	Rabellotti (1995), Arias (1992)	Meyer-Stamer (1999)	Arni (1999)	Saxenian (1994), Porter (1998)
Economic agents							
Relative number of individuals with specialized skills and knowledge Relative number of firms within geographic proximity Relative number of economically linked firms Relative number of international and multinational firms	Gordon and McCann (2000)	European Commission (1999)	Piore and Sabel (1984), Brusco (1982), Brusco (1999), Sternberg (1996), Lazerson (1990)	Rabellotti (1999), Schmitz (2000), Humphrey and Schmitz (1998)	Ramos Campos *et al.* (1999)	FinnFacts (2001)	Saxenian (1994), Rosenberg (2002), Becker (2000), Bresnahan, Gambardella, and Saxenian (2001)
Relative size of international and multinational firms				Rabellotti (1995)			
Relative number of "meso-level" institutions	NA		Brusco and Righi (1989)				
Diversity of "meso-level" institutions	NA		Murray (1991)				
Quality of "meso-level" institutions	NA		Brusco (1999), Pyke *et al.* (1990)		Muller-Glodde (1991)		
II—Geographic closeness							
Net internal economies of scale advantages	NA	European Commission (1999)	Berardi and Romagnoli (1984) Lazerson (1990)	Rabellotti (1995)	Meyer-Stamer (1999)	Koski, Rouvinen, and Ylä-Anttila (2001)	Porter (1998)
Net specialized labor advantages	Cheshire and Gordon (1995)						

Net inter-firm knowledge sharing and networking advantages	Amin and Thrift (1992)		Piore and Sabel (1984)				Swann and Prevezer (1996)
Net inter-firm technology transfer advantages	Feloy et al. (1997)		Sabel (1982)			Arni (1999)	
Net shared market intelligence advantages			Sabel (1982)				
Net product-, technology- and managerial-innovation advantages			Romagnoli and Lungarella (1989)				
III—Economic linkages							
Common customers (both firms and individuals)	Cheshire and Gordon (1995), Gordon and McCann (2000)	European Commission (1999)	Lazerson (1990)	Humphrey and Schmitz (1998), Rabellotti (1995)	Meyer-Stamer (1999)	Sanchéz et al. (2000)	Arthur (1994)
Common suppliers and service providers							
Common infrastructure such as transport, communications and utilities							Cooper and Folta (2000)
Common pool of human talent, such as skilled professionals, or specialized labor							Becker (2000)
Common educational, training and coaching facilities for workers							Swann and Prevezer (1996)
Common educational, training and coaching approaches for workers	Amin and Thrift (1992)						
Common university, research center and technology invstitute specializations							Becker (2000)
Common risk capital markets				Humphrey and Schmitz (1998)			
IV–"Common Glue"							
Leadership							
Explicit leaders of the cluster	Buck et al. (1997)				Meyer-Stamer (1999)	Sanchéz et al. (2000)	Rosenberg (2002)

	London Financial	Piemonte Automobile	Emilia Romagna Tiles	Mexican Shoe Manufacturing	Santa Catarina Textiles	Finland ICT	Silicon Valley IT
Explicit leaders are accepted by all of the cluster's economic agents							Leonard and Swap (2000)
Building blocks							
Strong sociocultural ties across boundaries	Leyshon and Thrift (1994)	European Commission (1999)	Rabellotti (1995)	Rabellotti (1995)		Sanchéz *et al.* (2000)	Sternberg (1996)
Common code of behavior amongst the cluster's economic agents				Dominguez-Villalobos and Grossman (1992)			
Degree of trust between the cluster's economic agents			Humphrey and Schmitz (1998)				
Attitude for mutual collaboration amongst the cluster's economic agents	BRITE (2001), Taylor *et al.* (2003)		Rabellotti (1995)	Humphrey and Schmitz (1998)			
Common language	Feloy *et al.* (1997)						Zhang (2001)
Common industrial culture				Morris and Lowder (1992)			
Common industrial atmosphere							
Common approaches to developing human capital							Cooper and Folta (2000)
Common business understanding and mindset				Rabellotti (1995)			Porter (1998)
Common competitive performance approaches and measurements							
Communication mechanisms							
Regular communication events	Feloy *et al.* (1997)						
Regular communication interactions	Amin and Thrift (1992)				Meyer-Stamer (1999)	Sanchéz *et al.* (2000), Ali-Yrkkö, Paija, Reilly, and Ylä-Anttila (2000)	

Regular communication approaches		Rabellotti (1995)	Rabellotti (1995)				
Coordination mechanisms							
Benchmarking taskforces across the cluster's firms				Boston Consulting Group Study (1998)	Meyer-Stamer (1999)	Sanchéz et al. (2000), Paija (2001)	Saxenian (1994)
Executive education of cluster firm's employees							
Mutual cooperation initiatives across cluster's firms	Feloy et al. (1997)		Brusco (1999)	Humphrey and Schmitz (1998)			Christensen (1997)
Technology transfers across the cluster's firms			Pedersen et al. (1994)				
Joint R&D initiatives across the cluster's firms	NA						
Joint manufacturing initiatives across the cluster's firms	NA		Schmitz (1995)				
Joint product design initiatives across the cluster's firms							
Joint sales and marketing initiatives across the cluster's firms	NA						
Professional rotations							
Degree of own-sector employment within cluster's home region	Feloy et al. (1997)		Rabellotti (1995)	Rabellotti (1995)		Paija (2001)	Becker (2000)
Degree of inter-firm mobility within cluster							
Degree of spin-offs/start-ups by cluster's employees							
Scope of competition of industrial clusters							
External factors							
Main customers	Feloy et al. (1997)		Schmitz (1995)	Woodruff (1998), Rabellotti (1995)			
Main product and services markets			Brusco (1999)				
Key demographic trends						Sanchéz et al. (2000)	Becker (2000)

APPENDIX B—*continued*

	London Financial	Piemonte Automobile	Emilia Romagna Tiles	Mexican Shoe Manufacturing	Santa Catarina Textiles	Finland ICT	Silicon Valley IT
Main legal and regulatory frameworks							
Internal factors							
Key resources (i.e. human capital, financial capital)	Simmie and Sennett (1999)		Rabellotti (1995)	Rabellotti (1995), Humphrey and Schmitz (1998)			Puri and Hellmann (2000) Saxenian (1994)
Key processes (i.e. innovation, product development, supply chain management)							
Key competencies and capabilities (i.e. key technologies, speed of innovation)							Porter (1998)
Social factors							
Learning (i.e. about customers, products, technologies, managerial approaches)	Keeble *et al.* (1999)		Rabellotti (1995)	Rabellotti (1995)			Porter (1998), Leonard and Swap (2000)
Knowledge creation						Sanchéz *et al.* (2000)	
Knowledge sharing							
Cultural behavior and norms							

[a] For Veneto Plastics, Manaus Telecom, Manaus Consumer Electronics, Manaus Light Automotive and Stuttgart Autoparts, we carried out expert interviews and field visits, using the templates and constructs outlined in Tables 1 and 2.