Cluster Absorptive Capacity: Why do Some Clusters Forge Ahead and Others Lag Behind?

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CLUSTER ABSORPTIVE CAPACITY
WHY DO SOME CLUSTERS FORGE AHEAD AND OTHERS LAG BEHIND?

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Abstract

This article provides a firm-centred interpretation of why some industrial clusters forge ahead and others lag behind. It argues that the dynamic growth of a cluster depends on its absorptive capacity and therefore on the capacity of firms to absorb external knowledge and diffuse it into the intra-cluster knowledge system. This article speculates on the relationship existing between the heterogeneity of firms’ knowledge bases with both intra- and extra-cluster knowledge systems. It concludes by illustrating that a conceptual link exists between firm-level knowledge bases, the cluster absorptive capacity and its potential for growth.

KEYWORDS ★ absorptive capacity ★ firm knowledge base ★ industrial clusters

One of the most interesting challenges for economists and social scientists in general is to understand why some countries forge ahead and others fall behind (e.g. Abramovitz, 1986; Romer, 1992; Verspagen, 1993; Fagerberg et al., 1994). With a great level of detail, some of them look at understanding regional disparities (Martin and Sunley, 1998; Caniels and Verspagen, 2001; Cooke, 2001) and the phenomena that lead to the emergence and growth of dynamic, successful industrial clusters, while others fail miserably (among others, Pyke and Sengenberger, 1992; Steiner, 1998). This paper argues that the dynamic growth of a cluster depends on its absorptive capacity (Cohen and Levinthal, 1990), conceived as the capacity of clusters to absorb, diffuse and creatively exploit knowledge that is acquired from extra-cluster sources. In its definition, cluster absorptive capacity entails two interrelated aspects: (a) the formation of linkages with extra-cluster sources of knowledge (i.e. the extra-cluster knowledge system); and (b) the structural characteristics of the intra-cluster knowledge system (Bell and Albu, 1999). Whereas most cluster studies have focused on the diffusion and innovation process at the intra-cluster level, more limited consideration has been given to understanding the process of absorption of extra-cluster knowledge and, more specifically, the interplay between intra- and extra-cluster knowledge systems. This paper tries to fill the gap. Its original contribution stands on the fact that it sets the firm at the centre of analysis (Maskell, 2001). In more detail, it develops a conceptual framework explaining the formation of both intra- and extra-cluster knowledge systems based on the heterogeneity of the firms’ knowledge bases. The interplay between intra- and extra-cluster knowledge systems, moreover, is explored referring to the conceptualization of firms that behave as technological gatekeepers (Allen, 1977). This is considered to play a critical role in channelling extra-cluster knowledge into the local, intra-cluster knowledge system and, thus, in narrowing down the gap with the technological frontier. This paper therefore intends to conceptually explore the following research questions: How does the heterogeneity of firms’ knowledge bases affect the structure of the intra-cluster knowledge system? And, more importantly, How does it affect the absorption of extra-cluster knowledge?

The paper is organized as follows: The first section reviews the literature on clusters in both advanced and developing countries. This is done with the aim of defining the conceptual boundaries...
of the cluster definition. This concept was in fact widely studied during the 1980s and 1990s, which poses a question of consistency between terminologies and concepts used in the literature. The section concludes with a definition of ‘cluster’ as it is used in this paper, based on mere geographical and sectoral criteria. The next section critically reviews some of the most influential contributions dealing with issues of industrial clustering, learning and innovation at the intra-cluster level, and develops an original conceptual framework which links firm-level knowledge bases to the nature of the intra-cluster knowledge system. It continues by reviewing the literature on extra-cluster linkages and provides a definition of technological gatekeeping in the cluster. It moreover conceptually explores the link between the knowledge base of firms and their propensity to establish external linkages and to behave as technological gatekeepers. The third section defines the concept of cluster absorptive capacity, considering firm-level knowledge bases, intra- and extra-cluster knowledge systems. It then, through a review of existing empirical studies, explores the relationship between cluster absorptive capacity and cluster dynamism. The concluding section provides a guide for further research and briefly discusses some policy implications.

From industrial districts to clusters: a ‘workable’ definition

Cluster studies in the advanced and developing worlds

On the stream of the seminal contribution by Alfred Marshall (1920), several studies have been undertaken over the past 30 years, which have well documented the strength and weaknesses of what for the time being I will call ‘economic localities’ in the world. Marshall first introduced the concept of industrial district as a concentration of ‘large numbers of small businesses of a similar kind in the same locality’ (Marshall, 1920: 277). According to Marshall, the localization of specialized activities produced external economies which were generated by the presence of three factors: local availability of inputs; presence of a skilled labour force and knowledge spillovers. Long after this contribution, an Italian scholar, Giacomo Becattini (1979), stressed the similarities between the metallurgical and textile-producing areas of Great Britain described by Marshall and certain areas of Italy. He referred to the Marshallian industrial district as a localized social and productive ‘thickening’, held together by a ‘complex and tangled web of external economies and diseconomies, of joint and associated costs, of historical and cultural vestiges, which envelops both inter-firm and interpersonal relationships’ (Becattini, 1989: 132). The interest in industrial districts raised by Becattini at the end of the 1970s and during the 1980s was also shared by various Italian economists, who became increasingly interested in the economics of regions and localities (e.g. Bagnasco, 1977). The industrial district was then proposed as an alternative model to the large Fordist firm, and theorists attributed the success of this model to several interconnected meso-level factors. Among these: the high degree of vertical division of labour (Becattini, 1990), the coexistence of competitive and cooperative behaviours of firms (Dei Ottati, 1991), the flexible use of skilled manpower (Brusco, 1982), the diffuse innovative capacity (Bellandi, 1989), and the role played by local institutions and associations (Brusco, 1982; 1990).

The Marshallian industrial district represents the historical conceptual antecedent of most cluster studies. Much after its conceptualization, a series of theoretical and empirical contributions were produced, which studied different types of economic localities in the advanced and the developing worlds. Among the former, one stream of studies was spurred by Piore and Sabel’s (1984) Industrial Divide, which identified flexibility and specialization as fundamental alternatives to mass production. The flexible specialization model – being based on flexible automation, differentiated products and small batch production – relied on dense networks of firms and subcontractors, which combined competition with cooperation. Due to the conceptual similarities with the work undertaken at that time by Italian scholars of industrial districts, Piore and Sabel contributed to generating an international echo on this specific subject of studies (Piore, 1990).

On the wave of the flexible specialization theory, regional studies too gained momentum in the 1980s.
The resurgence of regional economies (Sabel, 1989) generated a proliferation of empirical and theoretical contributions by economic geographers, sociologists, scholars of innovation studies, and social scientists in general. Among the most important contributors to this literature, there was the French group of economic geographers, GREMI (Aydalot and Keeble, 1988), which explicitly stressed the dynamic nature of industrial agglomerations and their capability to generate change. They used the term ‘innovative milieu’ to define such a concept. By definition, the milieu ‘groups together in a coherent whole a production system, a culture and actors. The coherence between various actors lies in the common approach to situations, problems and opportunities’ (Crévoisier et al., 1989: 11) Similarly, Maillat (1990) defined the milieu as comprising material and non-material elements:

The material elements are organised around a territorial production system (nature of companies and their local integration, coherence of all the activities etc.), the local labour market and the way it works (nature of jobs, types of chains of mobility etc.) and the territorial scientific system (training system, research institutes, production and accumulation of regions’ knowledge). These various elements function in symbiosis and give the milieu its specific characteristics. The latter are reinforced by the non-material elements, particularly by the technical culture. . . . The technical culture is communicated, acquired and renewed by exchanges and contacts which require a certain proximity. (Maillat, 1990: 345–6)

Competitiveness studies also became interested in geography in the 1990s. In The Competitive Advantage of Nations (1990), Michael Porter introduced the importance of clusters for competitiveness. As he said, ‘the city or region becomes a unique environment for competing in the industry’ (Porter, 1990: 156). In his work he defined clusters as ‘geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standards agencies and trade associations) in particular fields that compete but also cooperate’ (Porter, 1998: 197–8). Thus, a clear condition for the existence of a cluster was the presence of linkages between companies and institutions. In particular, these linkages were considered important for productivity growth:

Close linkages with buyers, suppliers, and other institutions contribute importantly not only to efficiency but to the rate of improvement and innovation. . . . In this broader and more dynamic view of competition, location affects competitive advantage through its influence on productivity and especially on productivity growth. (Porter, 1998: 209)

While linkages were considered fundamental, loosened consideration was instead given here to inter-firm geographic proximity, since ‘the geographic scope of a cluster can range from a single city or state to a country or even a network of neighboring countries’ (Porter, 1998: 199). Furthermore, unlike other approaches, social and cultural aspects were less emphasized in Porter’s definition of cluster, even though he mentioned that the existence of ‘repeated, personal relationships and community ties fostering trust facilitate the information flow within clusters’ (Porter, 1998: 216–17).

At the end of the 1980s, clustering of economic activities also became an issue of interest for developing countries. In particular, drawing on successful experiences of more advanced countries, clustering was seen as a strategy to overcome growth constraints of small informal firms (Aftab and Rahim, 1989; Schmitz, 1989; Humphrey and Schmitz, 1996; Van Dijk and Rabellotti, 1997). Pioneering cluster studies in developing countries emphasized the importance of ‘collective efficiency’ for growth and competitiveness. According to Schmitz (1999), in fact: ‘clustering opens up efficiency gains which individual enterprises can rarely attain. These gains are captured in the concept of collective efficiency, defined as the competitive advantage derived from local external economies and joint action’ (Schmitz, 1999: 141).

The collective efficiency approach was based on the idea that static efficiency gains were not sufficient to allow firms in developing countries to compete on a ‘high road’ of development (Pyke et al., 1990). This was instead possible when firms in clusters fostered joint action and therefore horizontal and vertical cooperation between local producers and local institutional bodies (Schmitz, 1995). Thus, this approach emphasized the importance of intra-cluster cooperative productive linkages, which constituted a fundamental part of the collective efficiency framework. This approach adopted a rather simple conceptualization of cluster (Schmitz, 1995; Humphrey and Schmitz, 1996),
which in fact was defined as: ‘A sectoral and geographical concentration of enterprises. Whether specialization and cooperation develop is considered a matter for empirical research and not subsumed in the definition’ (Humphrey and Schmitz, 1996: 1863). This definition reflects the fact that the context of developing countries is such that the typical features of advanced countries’ economic localities (e.g. presence of social linkages, of institutions etc.) are not easy to find empirically.

Finally, during the 1990s, Latin American scholars (e.g. Cassiolato and Lastres, 1999; Cassiolato et al., 2003) proposed analysing the processes of learning and capability accumulation of what they defined as local productive systems by using a systems of innovation approach (Lundvall, 1992; Nelson, 1993). By local productive systems they meant:

Any productive agglomeration involving economic, political and social agents localized in the same area, performing related economic activities and presenting consistent articulation, interaction, co-operation and learning processes. It includes not only firms (producers of final goods and services, suppliers of inputs and equipment, service providers etc.) and their different forms of representation and association, but also other public and private institutions and organisations specialised in educating and training human resources, R&D, engineering, promotion, financing etc. (Cassiolato et al., 2003: 23)

Different approaches seem therefore to have developed their own workable definition of the economic locality. In the following section, I will compare such definitions and provide an explanation for the definition of ‘cluster’ which is adopted in this paper.

A workable definition of ‘cluster’

The overview of schools of thought and definitions presented in the previous section covers only partially the enormous empirical and theoretical literature which has been produced on the issue in recent years. One result of this enormous production is that there has been a tendency towards hybridization of the original concept of Marshallian industrial district, so that different definitions have been proposed to address very similar economic phenomena, while, in other cases, very similar definitions have been adopted to describe different concepts. Beside this, the lack of common agreement on the definition of what I have so far called ‘economic locality’ has generated a terminological melting-pot which blurs the boundaries of the phenomenon studied. As an example, Table 1 shows how concepts vary according to whether, beyond geographic concentration, the definition also includes the same sectoral specialization of firms (the rows) combined with: (a) no other a priori characteristics; (b) the presence of inter-firm social linkages; (c) the presence of inter-firm learning and innovation linkages (the columns).

Clarification of the various definitions of ‘economic localities’ is necessary for several sets of reasons: first, because, as suggested by Markusen (2003), in regional studies, fuzzy concepts have proliferated which lack conceptual clarity and are therefore difficult to operationalize – a condition which makes it difficult to test any cause–effect relation between the presence of given characteristics (at the micro or the meso level) and their outcomes. Second, definitions matter because viewing the Marshallian Italian industrial district as a dominant paradigmatic model – whose virtues are so unique that they cannot even be compared to other similar forms of localized industrial agglomerations – seems an excessively myopic perspective (Rabellotti, 1995). Third, clusters tend to change over time, both in absolute terms, consistent with the evolution of their member firms and workers, and in relative terms, compared with other clusters. On the basis of this, attributing a crystallized set of attributes to these ever-changing agglomerative productive phenomena is of limited value. It is more useful, instead, to focus on what is less likely to change over the long term: the geographic space and the productive specialization.

For these reasons, I will use the concept of cluster to refer to a geographical agglomeration of firms operating in the same industry – as defined in Cell A of Table 1. This definition is very simple. With few exceptions, it is considerably simpler than most of those discussed above at the beginning of the first section. However, it does not imply that within a cluster there is nothing more than geographic proximity and productive specialization, but that what is there – in terms of, for example,
social and learning linkages – is not there by definition, as previously remarked by Schmitz (1995).

Intra- and extra-cluster knowledge systems and the knowledge base of firms

The intra-cluster knowledge system

Literature review on concepts related to the intra-cluster knowledge system. The intra-cluster knowledge system is defined here as the flows of knowledge linking firms in the cluster. This section reviews some of the main influential contributions relating industrial clusters to processes of knowledge diffusion and generation at the intra-cluster level.

In this respect, it seems fair to start this section by suggesting that flows of knowledge in clusters are often associated with the concept of knowledge spillovers, which are conceived as leaks of knowledge which diffuse into the economic system and are ‘in the air’, available as a public good (Arrow, 1962). One of the claimed characteristics of knowledge spillovers is that they tend to be highly localized (Jaffe, 1989; Jaffe et al., 1993) and several contributions have shown that a relationship exists between spatial clustering, knowledge spillovers, learning and innovative output (Audretsch and Feldman, 1996; Baptista, 2000).

In particular, what makes geographically bounded spaces highly conducive to knowledge spillovers is the fact that they allow tacit knowledge, which is sticky (von Hippel, 1994) and highly localized in principle (Nelson and Winter, 1982; Pavitt, 1987), to be transferred easily. Tacit knowledge is embodied in people and difficult to express through codified language, therefore it needs face-to-face contact and direct interaction to be transmitted. Thus, informal conversations between technicians or workers, labour mobility, imitative behaviours, are all means of transmitting such tacit knowledge.

Clusters are seen as an ideal locus for this type of knowledge diffusion process. This is considered to be due not only to the reduced geographical distance between people and firms, but also to the fact that they share the same or complementary interests in their work, that is by operating within the same

Table 1 Different definitions of ‘economic localities’

<table>
<thead>
<tr>
<th>Geographical agglomeration plus sectoral specialization</th>
<th>No other a priori characteristics</th>
<th>Social linkages</th>
<th>Learning and innovation linkages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster Swann &amp; Prevezer, 1998</td>
<td>Industrial locality Scott, 1998</td>
<td>Local innovation system Cassiolato et al., 2003</td>
<td></td>
</tr>
<tr>
<td>Cluster Humphrey &amp; Schmitz, 1996</td>
<td>Innovative cluster Simmie &amp; Sennet, 1999</td>
<td>Local productive system Cassiolato et al., 2003</td>
<td></td>
</tr>
<tr>
<td>Specialized area Capello, 1999</td>
<td>Industrial cluster Morosini, 1994</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geographical agglomeration only</td>
<td>D Regional cluster Enright, 1996</td>
<td>E Milieu Capello, 1999</td>
<td></td>
</tr>
<tr>
<td>Productive arrangement Cassiolato et al., 2003</td>
<td>System area Garofoli, 1991</td>
<td>F Technological district Antonelli, 2000</td>
<td></td>
</tr>
</tbody>
</table>
industry. Furthermore, whenever the cluster is characterized by a vertical division of labour, it is likely that user–producer linkages are established, which promote processes of informal interaction and incremental learning (Lundvall, 1988). The same is considered to occur in horizontal relations between potentially rival firms: unintentional leaks of knowledge are believed to happen between nearby firms (Bellandi, 1989). Finally, industrial clusters, being a spatially localized set of economic activities, are also envisaged as a locus where social relations are entangled with productive ones. Social embeddedness (Granovetter, 1985) is said to generate an environment of trustworthy relations which enhance knowledge exchange and at the same time promote a process of social monitoring among colocalyzed producers and technicians (e.g. Becattini, 1990).

According to what has been suggested above, clusters are often considered loci where knowledge is easily diffused, and, particularly, where tacit knowledge – which is inherently a private good (Nelson and Winter, 1982) – becomes a public, freely available good. This serendipity creates an environment which not only supports technical diffusion processes, but also favours incremental innovation through joint problem solving of colocalyzed producers.

The arguments outlined above were seminally described by A. Marshall (1920), who, in his Principles of Economics, wrote:

. . . so great are the advantages which people following the same skilled trade get from near neighbourhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them, unconsciously. (Marshall, 1920: 225)

In Industry and Trade (1919), Marshall defined this as ‘industrial atmosphere’, which was conceived as a sort of technological externality from which firms took advantage, in a rather unstructured way, for being located within the district. In particular, the industrial atmosphere concept has been associated with the idea that knowledge was ‘in the air’ and hence freely available locally as a public good.

While Marshall described Lancashire’s cotton and Sheffield’s cutlery industrial districts of the 19th Century, more recent contributions have stressed similar phenomena in other industrial districts of that same period: for example, Allen (1983) described the collective invention process of blast furnaces in the Cleveland industrial district in England. He showed that the free exchange of information about new techniques and plant designs among firms of the cluster generated a spiral of incremental innovation which was directed to improve the efficiency of blasts by progressively increasing their height and temperature. As Allen put it, the process of collective invention occurred because, first:

. . . the large overall increases in height and temperature were the culmination of a series of small increments. Second, firms made public the operating results of their new furnaces. Third, firms that build taller or higher temperature furnaces used the information generated by existing furnaces. (Allen, 1983: 4–5)

A similar account was reported by Nuvolari (2004), who provided a collective invention interpretation of the steam pumping engine’s technical change processes in Cornwall during the British Industrial Revolution.

These accounts have shown that the joint effort of different entrepreneurs in districts managed to foster a wave of incremental improvement on a given technological process. In more recent times, the relationship between clustering and learning has also been emphasized by many scholars. In most of these accounts, learning and incremental innovation are considered highly interwoven activities. And meso-level forces are often advocated to explain the process of knowledge generation in clusters.

In the 1980s and 1990s, several Italian scholars highlighted the importance of the industrial atmosphere for the innovation potential of Italian industrial districts (Becattini, 1990). This was because industrial districts were seen as loci of unique competences, which have been accumulated over time (Bellandi, 1989; Belussi and Gottardi, 2000): ‘Agglomeration favours the transmission of information even among rival firms through inter-firm mobility of skilled personnel; exchange of ideas within local institutions; locally rooted demonstration effects – I see my competitor manage to solve certain sub-furniture problems: so showing me a way of solving my own problems, which are similar to his’ (Bellandi, 1989: 163 [my translation]).
The industrial district was therefore viewed as a cognitive laboratory (Becattini and Rullani, 1993) or a creative milieu almost by definition. This view of knowledge diffusion and generation is also found in the French literature of GREMI. As suggested by Perrin (1991), the local milieu is viewed as a generator of innovative behaviour:

... the fact that physical externalities and the know-how of the localized actors are internalized within the same territory involves a potential reinforcement process. Moreover, since externalities are collective goods, they can be appreciated not only by the actors who have contributed to their promotion but also by larger groups so that other local agents may be incited to join the networks. (Perrin, 1991: 42)

The innovative environment of the milieu is tied to the presence of processes of collective learning and of reduction of the elements of dynamic uncertainty. Camagni (1991: 3) defined the innovative milieu (i.e. milieu innovateur) as the ‘set, or the complex network of mainly informal social relationships on a limited geographical area ... which enhance the local innovative capability through synergetic and collective learning processes’. Capello (1999) further defined collective learning as a social process, in which:

... the mechanisms for the spatial transfer of knowledge are social because new knowledge is transferred to other agents, whatever the will of the original inventor, thanks to common technological, organizational and institutional routines and behaviours which facilitate the sharing of information and know-how. In other words, the outcome of the innovative process becomes a public good. (Capello, 1999: 365)

In the competitiveness literature, too, Porter (1990: 156) conformed to this thinking, when he stated that: ‘The information flow, visibility, and mutual reinforcement within such a locale give meaning to Alfred Marshall’s insightful observation that in some places an industry is “in the air”’. While he emphasized, on the one hand, that ‘a concentration of rivals, customers, and suppliers will promote efficiencies and specialisation’ (1990: 156), Porter also remarked that ‘more important, however, is the influence of geographic concentration on improvement and innovation’ (1990: 157), since ‘proximity increases the speed of information flow within the national industry and the rate at which innovations diffuse’ (1990: 157). In the same spirit, Saxenian (1994) described the formation of a ‘technical community’ in Silicon Valley, formed by technician entrepreneurs with high collective identity, as a critical element to generate an environment of informal socialization which boosted innovation:

Every year there was some place, the Wagon Wheel, Chez Ivonne, Rickey’s, the Roundhouse, where members of this esoteric fraternity, the young men and women of the semiconductor industry, would head after work to have a drink and gossip and brag and trade war stories about phase jitters, phantom circuits, bubble memories, pulse trains, bounceless contacts, burst modes, leapfrog tests, p-n junctions, sleeping sickness modes, slow-death episodes, RAMs, NAKs, MOSes, PCMs, PROMs, PROM blowers, PROM blasters, and teramagnitudes, meaning multiples of a million millions. (Tom Wolfe, quoted in Saxenian, 1994: 32–3)

Preliminary contributions in the developing country literature also aligned with the views reported above. In fact, spillovers and information ‘in the air’ were often mentioned as main explicative factors of knowledge transfer and ultimately as an incentive to innovation. In the case of the surgical instrument cluster in Sialkot (Pakistan), Nadvi (1999) suggested that:

... upgrading requires a capacity to learn ... both at the level of the individual firm and in the relations between firms. In the cluster context, knowledge spillovers can facilitate such learning (Audretsch and Feldman, 1996). Moreover, cluster-wide bodies and real service centres can accelerate the dissemination of know-how among local producers (Brusco, 1982). (Nadvi, 1999; 1606; emphasis added)

Similarly Meyer-Stamer (1998), with reference to the tile cluster in Santa Catarina (Brazil), suggested that:

... it seems that in the ceramic tile cluster there is at least some information in the air. There is substantial informal information exchange going on between professionals from tile producers; unlike in other branches, it is perfectly normal for them to visit competitors’ factories. (Meyer-Stamer, 1998; 1505; emphasis added)
More explicitly, McCormick (1999) stated that ‘given that one of the major characteristics of developing countries is their weak technological base, technological spillovers within a cluster are crucial to its upgrading and ultimately to industrial development’ (1999: 1533).

More recent works carried out by developing countries' scholars, however, have started to highlight that knowledge diffusion in clusters may not circulate as smoothly as in contexts where firms perform frontier in-house R&D, employ highly skilled human resources, which operate under constant stimuli to innovate and improve their own technical background – i.e. the advanced world. More convincingly, they are characterized by a higher variability, with differing capacities for generating change and innovation (Bell and Albu, 1999; Caniels and Romijn, 2003; Schmitz, 2004; Giuliani et al., 2005b). This aspect is explored in the sections which follow.

Firm knowledge bases and the intra-cluster knowledge system Recent contributions have expressed their conceptual discontent with the almost externality-driven interpretation of cluster capacity to learn and innovate as discussed in the second section above (e.g. Breschi and Lissoni, 2001). Some of them have noted the need to bring firm-level learning into the analysis of clusters’ innovation (Maskell, 2001). Bell and Albu (1999: 1722), for example, mentioned that:

. . . most of the studies . . . gave no attention to the nature of the knowledge-resources and other capabilities underlying the technical change observed in clusters. None raised questions about how such change-generating capabilities were acquired and accumulated. This neglect of the resource base for technological dynamism seems to arise partly because research on clusters has emphasised the importance of inter-firm links within spatially concentrated groupings. Intra-firm issues have attracted much less attention, inevitably involving only limited efforts to identify and understand the specific resources underlying technological change. This trend has been reinforced by perceptions of passive technology diffusion, rather than creative technical change, as the dominant intracluster process contribution to technological dynamism.

In the same vein Martin and Sunley (2003: 17) argued that: ‘In too many accounts local “territorial learning” is privileged, yet what this process actually is remains ambiguous and its interactions with firm-based learning are left completely unexamined (Hudson, 1999)’. This section tries to fill this conceptual gap and explores the following research question: How do firm knowledge bases influence the intra-cluster knowledge system?

A relevant concept here is the ‘knowledge base of the firm’. On the basis of Nelson and Winter (1982) and Dosi (1988), the knowledge base of a firm is defined as a ‘set of information inputs, knowledge and capabilities that inventors draw on when looking for innovative solutions’ (Dosi, 1988: 1126). Knowledge is seen as residing in firms’ skilled employees, who embody tacit capabilities, and at the same time it is not merely the sum of each individual’s knowledge since it resides in the organizational memory of firms. As Nelson and Winter (1982) put it:

. . . [t]he possession of technical ‘knowledge’ is an attribute of the firm as a whole, as an organized entity, and it is not reducible to what any single individual knows, or even to any simple aggregation of the various competences and capabilities of all the various individuals, equipments, and installations of the firm. (Nelson and Winter, 1982: 63).

This knowledge base is considered the result of a process of cumulative learning, which is inherently imperfect, complex and path-dependent (Dosi, 1997): imperfect, because of the uncertain nature of technical change and of agents’ bounded rationality; complex, because – as suggested by Kline and Rosenberg (1986) and Freeman (1994) – learning and innovation are not linear processes but rather the result of ‘persistent feedback loops between innovation, diffusion and endogenous generation of further opportunities of advancement’ (Dosi, 1997: 1536); and path-dependent because ‘past technological achievements influence future achievements via the specificity of knowledge that they entail, the development of specific infrastructures, the emergence of various sorts of increasing returns and non-convexities in the notional set of technological options’ (Dosi, 1991: 183). The features of the learning and technical change process deliver persistent heterogeneity among firms in the economic system and, understandably, within the cluster’s boundaries.

The presence of firms with different knowledge
bases within the cluster makes it reasonable to claim that firms are able to establish knowledge linkages at intra-cluster levels, according to the absolute and relative strength of their knowledge bases. Absolute, because I expect that firms with stronger knowledge bases will be more likely to establish knowledge linkages than firms with weaker knowledge bases. On the one hand, this is due to the fact that the former know more and therefore have more to transfer. On the other hand, it is associated with the fact that firms with particularly strong knowledge bases are likely to be perceived by other cluster firms as ‘technological leaders’ or ‘early adopters’ of technologies in the local area, leading to them being sought out as sources of advice and knowledge more often than firms with weaker knowledge bases. By the same token, firms with very limited or weak knowledge bases are less exposed by being asked technical knowledge by other cluster firms.

The transfer of knowledge should also be dependent on the relative cognitive distance between any two firms in the cluster (Lane and Lubatkin, 1998). Several contributions have in fact emphasized that the propensity of firms to establish knowledge linkages with other firms is associated with the degree of similarity/dissimilarity in their knowledge bases (Rogers, 1983). In particular, firms with too distant knowledge bases might be incapable of fruitfully transferring each other’s knowledge. Consequently, it seems reasonable to assume that firms will show different ‘cognitive positions’ (Giuliani and Bell, 2005), depending on: (a) the amount of knowledge they have accumulated over time and can therefore release to others; and (b) their capacity to decode and absorb knowledge that is potentially transferable from other firms. If these rules apply, and given the heterogeneity of firms’ knowledge bases, I expect that knowledge does not diffuse in clusters evenly as if it were ‘in the air’ (Marshall, 1920), or mutually between firms. On the one hand, I agree that there is a tendency towards mutual knowledge exchange (Coleman, 1990), as ‘reciprocity appears to be one of the fundamental rules governing information trading’ (Schrader, 1991: 154). Nevertheless, this is most likely to occur when there is a high degree of similarity between the level of firms’ knowledge bases so that they share similar experiences and new, recently acquired pieces of technical knowledge. In this case, firms would behave as ‘mutual exchangers’ of knowledge. The inter-firm transfer of knowledge (within the cluster), however, need not involve only a set of balanced, mutual exchanges between firms with similar knowledge bases. It seems likely that differences between the knowledge bases of firms will lead them to play differing, sometimes asymmetric roles within the cluster knowledge system. Heterogeneous knowledge bases are likely to lead to a degree of imbalance in the knowledge interactions of the firms. Firms with strong knowledge bases, for example, are less likely to seek out useful knowledge from firms with weaker knowledge bases – as suggested by Schrader (1991: 166): ‘even if the inquirer is eager to reciprocate, his or her cooperativeness remains without economic value if no relevant information exists that could be returned’. Some firms may therefore transfer more knowledge than they receive from other local firms, so acting as net ‘sources’ within the cluster knowledge system.

As said, moreover, the propensity to acquire knowledge from other cluster firms is also shaped by the perceived relative cognitive distance from the source of knowledge. Firms have more incentives to ask for technical advice when they know that they will be able to decode and apply the received knowledge (Carter, 1989). Consequently, while the similar levels of their knowledge bases may lead some firms into balanced exchange, other firms with lower but still significant capacities are likely to absorb more knowledge than they release, so acting as net ‘absorbers’ within the cluster knowledge system.

Finally, however, the knowledge base of some firms may be so low that it neither offers anything of value to other firms nor provides a capacity to acquire and exploit knowledge that others may have. Such firms are likely to be ‘isolated’ within the cluster knowledge system.

Hence, the intra-cluster knowledge system is likely to be characterized by different structural characteristics according to the absolute and relative knowledge bases of firms. Densely connected knowledge systems should be associated with the presence of firms with strong knowledge bases. Conversely, the predominance of firms with weak knowledge bases is associable to highly disconnected and fragmented knowledge systems at the intra-cluster level.
Extra-cluster knowledge linkages and technological gatekeeping

Literature review on concepts related to the extra-cluster knowledge system At the end of the 1980s, special attention was given to the nexus between local–global communities and worlds of production (Alger, 1988). The process of globalization (Cooke and Kirkpatrick, 1997) and the new international division of labour (Frobel et al., 1980; Dicken, 1992) emphasized the importance of local production systems being interconnected with distant markets, both in terms of demand and supply. Increased interdependence on global resources, though, did not mean undermining local resources and capabilities (Dicken, 1994). In fact, to sustain international competition, local and global knowledge systems should be aligned (Kim and von Tunzelmann, 1998).

While neo-Marshallian studies have long emphasized the endogenous potential of knowledge generation in districts, other contributions have started to view districts as neo-Marshallian nodes in global networks (Amin and Thrift, 1992). This perspective suggested the importance of extra-cluster networking and the acquisition of extra-cluster knowledge to avoid phenomena of entropic death and negative lock-in (Grabher, 1993) and to allow local competencies to be nurtured by knowledge transferred from non-local resources. As stressed by Camagni (1991:4):

The attraction of external energies and know-how is exactly the objective we assign to innovation networks: through formalized and selective linkages with the external world (or, very often, with external and specialized ‘milieux’) local firms may attract the complementary assets they need to proceed in the economic and technical race. Internal, mainly informal and tacit linkages may not be sufficient to achieve the main goal, especially in times of rapid economic and technological change.

The importance of extra-cluster networking has been increasingly highlighted by the cluster literature in both advanced and developing country contexts (Becattini and Rullani, 1993; Bell and Albu, 1999; Humphrey and Schmitz, 2002; Bathelt et al., 2004) and several contributions have now explored the processes by which the integration of extra-cluster and intra-cluster knowledge occurs (see e.g. Schmitz, 2004; Giuliani et al., 2005b). Meanwhile, other studies have documented the presence of firms that are relevant for the external openness of a cluster. They have shown that the inflow of knowledge into a cluster can be both driven by actors from outside which are attracted into the cluster by the availability of natural or knowledge resources as well as by local actors who try to tap into outside knowledge (Cantwell and Iammarino, 2003). Among the former, key actors of the local–global nexus are those multinational corporations (Belderbos et al., 2001; Castellani and Zanfei, 2002) that establish production plants in a local cluster or operate as global buyers, exerting a quasi-hierarchical form of governance on clustered firms (Gereffi and Korzeniewicz, 1994; Giuliani et al. 2005a; Halder and Nadvi, 2002; Humphrey and Schmitz, 2002; Kishimoto, 2003). Among the latter – i.e. the local actors who try to tap into outside knowledge – the literature emphasizes the role of the leading firms (e.g. Lazerson and Lorenzoni, 1999), which are typically large, technologically advanced firms (Albino et al., 1999) and are regarded as engines of cluster development.

Great interest has recently been expressed in the technological gatekeeping process of such firms (Bell and Albu, 1999; Giuliani and Bell, 2005). The concept of technological gatekeeping was originally developed in the arena of intra-organizational studies (Allen, 1977) to indicate those ‘key people who differed from their colleagues in the degree to which they exposed themselves to sources of technical information outside their organization [...] and they tend to be the same people to whom others come for information’ (Allen, 1977: 145). Similarly, in a more recent contribution, MacDonald and Williams (1994: 123) defined technological gatekeeper as ‘an individual who funnels information into an organisation from the outside world’. In this context, technological gatekeepers were professionals who, due to their higher propensity to search for new knowledge from outside the firm, became acknowledgeable reference points for other people inside the firm to go to for advice. For this reason, these professionals showed a natural propensity to transfer extra-firm acquired knowledge to other colleagues.
... the gatekeeper is selective in the information he acquires and proactive in acquiring it. ... Although the gatekeeper may well have his own use for the information he acquires, he is also keenly interested in passing it on to others in the organisation for their use. (MacDonald and Williams, 1994: 125)

In the context of this paper, technological gatekeepers are conceived as firms which channel extra-cluster knowledge into the local, intra-cluster knowledge system (Giuliani, 2002). Indeed, this definition can be attributed to Gambardella (1993), who, in a conceptual paper, pointed out that for small regional systems in Italy to have access to (extra-cluster) abstract knowledge they needed to create the conditions for the existence of intermediate agents (which he named technological gatekeepers) which connected extra-cluster abstract knowledge and concrete knowledge accumulated by local firms. Gambardella argued that these types of agents needed to be private firms, which operated according to the rules and incentive systems of the market. Similarly to the intra-organizational literature, technological gatekeepers are not manifestly so and they are not easy to detect among other firms in the cluster. This is because, first, their role is not institutionalized, which means that they have not been formally attributed this role at the local level; and, second, their function is likely to be the result of highly informal interactions with both intra- and extra-cluster actors – a condition which renders their visibility limited to the external observer. In spite of their latent nature, technological gatekeepers are vital nodes of interconnection between intra- and extra-cluster knowledge systems and, therefore, they may positively impact on the cluster absorptive capacity. Identifying them, understanding their characteristics vis a vis those of the other cluster firms, should therefore be a priority in research. Gambardella (1993) suggested technological gatekeepers are characterized by high technical competencies and by being able to translate the acquired external knowledge into know-how that can be used by those other firms in the cluster which have concrete idiosyncratic knowledge. The following section will elaborate on this further.

Firm knowledge bases and extra-cluster knowledge absorption This section intends to explore the conceptual link between the knowledge base of firms and the capacity of a cluster to link up with extra-cluster knowledge. In particular, How do firm knowledge bases influence the extra-cluster acquisition of knowledge and the processes of technological gatekeeping?

Given the heterogeneity of firm knowledge bases, it is possible to argue that some firms would be less distant than others from the technological frontier. Consistent with Cohen and Levinthal (1990), who argue that the capacity of a firm to connect with external sources of knowledge depends on the firm’s prior related knowledge, those firms with less cognitive distance from the technological frontier would be more likely to absorb extra-cluster knowledge and creatively exploit it than firms whose knowledge base is weak. The absorption of extra-cluster knowledge by firms is an important learning phase for the cluster. For this reason, it is desirable that the absorbed extra-cluster knowledge is diffused at intra-cluster level and manages also to reach those firms that have no or very limited external linkages. Hence, as said, the interface between the external linkages and the intra-cluster knowledge system is considered here a critical dimension in the cluster knowledge absorption process. Technological gatekeepers, defined in the foregoing section, play the dual role of acquiring new knowledge from extra-cluster sources, and of transferring knowledge to intra-cluster firms.

In the previous section my proposition was that firms with stronger knowledge bases should be more likely to transfer knowledge to other cluster firms, behaving as ‘sources’ of knowledge. In this section, I have discussed the fact that firms with stronger knowledge bases should also be more likely to interconnect with extra-cluster sources of knowledge. Hence, the conceptual consequence of these two above mentioned propositions is that technological gatekeepers will be among the firms with stronger knowledge bases in the cluster. Recent empirical studies have supported this view (e.g. Giuliani, 2005; Giuliani and Bell, 2005) but further research is still needed in this direction.3
Cluster absorptive capacity: towards a conceptual framework

The concept of cluster absorptive capacity

As said, the absorptive capacity of a cluster depends on the capacity of firms to establish intra- and extra-cluster knowledge linkages. In the second section above I have discussed how the heterogeneous distribution of firms’ knowledge bases is related to both the intra- and the extra-cluster knowledge systems. I propose here a conceptual framework of ‘cluster absorptive capacity’, which includes firm-level knowledge bases, intra- and extra-cluster knowledge systems.

The concept of absorptive capacity did originally refer to the intra-firm ability to ‘recognize the value of new, external information, assimilate it, and apply it to commercial ends’ (Cohen and Levinthal, 1990: 128). In this present work I adapt this concept to clusters of firms. Hence I define cluster absorptive capacity as the capacity of a cluster to absorb, diffuse and creatively exploit extra-cluster knowledge. By analogy with Cohen and Levinthal’s (1990) original concept, cluster absorptive capacity depends on the knowledge bases of its member firms: ‘the development of an organization’s absorptive capacity will build on prior investment in the development of its individuals’ absorptive capacities’ (Cohen and Levinthal, 1990: 131). However, it is not understood as the mere sum of firm-level capabilities: ‘a firm’s absorptive capacity is not however, simply the sum of the absorptive capacities of its employees’ (Cohen and Levinthal, 1990: 131). In fact, in order to understand the level of cluster absorptive capacity it is necessary to look at both intra-cluster knowledge linkages as well as those established by cluster firms with external sources of knowledge: ‘to understand the sources of a firm’s absorptive capacity, we focus on the structure of communication between the external environment and the organization, as well as among the subunits of the organization, and also on the character and distribution of expertise within the organization’ (Cohen and Levinthal, 1990: 132).

As in Cohen and Levinthal (1990) the cluster absorbs external knowledge through ‘receptor’ firms characterized by extraordinarily strong knowledge bases – i.e. the technological gatekeepers. Consistent with the Cohen and Levinthal (1990) model, moreover, the weaker the knowledge base of firms the lower the probability of absorbing extra-cluster knowledge and therefore the more limited the incidence of technological gatekeepers in the cluster.

Cluster absorptive capacity is, however, not just a matter of absorption and diffusion by cluster firms. In fact, the absorption of knowledge from extra-cluster sources is only one face (Cohen and Levinthal, 1989) of the learning and innovative potential of clusters. Indeed, it is the accumulation and generation of knowledge at the firm-level that conditions the capacity of firms to exploit creatively the externally absorbed knowledge, in a path-dependent fashion. Hence, the cluster absorptive capacity influences and is itself influenced by the effort undertaken by firms to accumulate new knowledge: ‘to develop an effective absorptive capacity, whether it be for general knowledge or problem solving or learning skills, it is insufficient merely to expose an individual briefly to the relevant prior knowledge. Intensity effort is critical’ (Cohen and Levinthal, 1990: 131).

On the basis of this, I propose here a taxonomy of levels of cluster absorptive capacity, considering that it might evolve over time (or not), contextually with firm heterogeneous patterns of knowledge accumulation (or lack thereof). The taxonomy (Table 2) ranges from basic to advanced cluster absorptive capacity. I assume here that there are two extreme cases, a non-desirable one, when cluster absorptive capacity is basic, and a desirable one when cluster absorptive capacity is advanced.

Cluster absorptive capacity is in a basic state when firms have very weak knowledge bases, the intra-cluster knowledge system is weakly interconnected and the degree of external openness is very limited. It is advanced when cluster firms both absorb knowledge from extra-cluster sources and contribute to the creation of knowledge by investing in in-house R&D. Clusters with an advanced knowledge system are characterized by an intra-cluster innovative environment, where firms establish dense knowledge linkages. Between basic and advanced levels, I identify an intermediate level of cluster absorptive capacity which includes firms with highly heterogeneous knowledge bases. Following from this, the intra-cluster knowledge system will only partially be disconnected, while a few firms will behave as technological gatekeepers, thus connecting the intra- and the extra-cluster knowledge systems.
Cluster absorptive capacity and cluster growth

The reason why one should care about the determinants of improved cluster absorptive capacity is that they may influence the dynamic growth of the cluster. Even though such a relationship is a very complex one to test (Morosini, 2004), various studies support the view that one or more of the mentioned dimensions of the absorptive capacity of a cluster are related also to its growth trajectory (e.g. Giuliani, 2003; see also Mytelka and Farinelli, 2003). This paper elaborates on this, providing a systematic literature review of empirical case-studies of clusters around the world. For this purpose, a selection of existing empirical studies has been organized on the basis of the following two dimensions: (1) the levels of cluster absorptive capacity, defined as basic, intermediate and advanced; and (2) their dynamism. The dynamism of the clusters refers to their capacity to grow over time. Hence, a static cluster is one where no relevant growth is observed over time, and a dynamic cluster is one where a rapid and sustained growth has been achieved in the recent past. Finally, a leading cluster is one with a consolidated growth trajectory. A summary of case-studies is presented in Table 3.

From the qualitative accounts of these studies, it is possible to observe a relationship between the two dimensions. Static clusters tend to be characterized by basic cluster absorptive capacity. In spite of the fact that the literature is never explicit on the characteristics of the cluster knowledge systems, in a few cases it was possible to observe that clusters that have not grown over time are also characterized by firms with weak knowledge bases and by limited intra- and extra-cluster knowledge linkages. This is the case in the Punjab tubewell industry described by Aftab and Rahim (1989: 503), where informal firms ‘lack of ability to absorb and attract new resources . . . sets the limit to improvement in technology, managerial practice and expansion’.

Among the deficiencies which limit the informal
sector to upgrade and grow, Aftab and Rahim mentioned the lack of linkages with the local institutions and the absence of any productive and technological linkages between modern and informal sector firms. A similar account is that of the garment cluster in Nairobi (Kenya), described by McCormick (1997; 1999) as an ‘embryonic industrial district’ or as a ‘ghetto where marginal businesses congregate’ (McCormick, 1997: 109).

Also in this case, firms have weak knowledge bases: ‘The mini-manufacturers use their networks well, but most are poorly educated, African women whose networks have limited power to uplift a business’ (McCormick, 1997: 125). Besides, they are weakly connected at both intra- and extra-cluster level:

like many clusters in developing countries, the garment markets exhibit weak internal and external linkages. The inter-firm specialisation and division of labour, which are supposed to be key to collective efficiency, are almost totally lacking. Those inter-firm linkages that exist are often informal and at low level . . . (McCormick, 1997: 125)

In spite of the fact that she never referred to knowledge linkages explicitly, it is reasonable to associate the lack of productive linkages also with a weak knowledge system.

Dynamic clusters tend to be characterized by more intermediate cluster absorptive capacity. This means that clusters that have grown dynamically over the recent past are likely to be associated with

### Table 3 Cluster absorptive capacity and dynamism: empirical evidence

<table>
<thead>
<tr>
<th>Cluster absorptive capacity</th>
<th>Static cluster</th>
<th>Dynamic cluster</th>
<th>Leading cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Clothing, Gamarra, Peru</td>
<td>Tubewell, Punjab, Pakistan</td>
<td>Footwear, Agra, India</td>
</tr>
<tr>
<td></td>
<td>Palm sugar, roof tiles, Central Java, Indonesia</td>
<td>Vehicle repair, Kumasi, Ghana</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Garment, Nairobi, Kenya</td>
<td>Leather, Agra, India</td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td>Knitwear, Luhdiana, India</td>
<td>Knitwear, Tiruppur, India</td>
<td>Surgical instruments, Sialkot, Pakistan</td>
</tr>
<tr>
<td></td>
<td>Footwear, Sinos Valley, Brazil</td>
<td>Footwear, Guadalajara, Mexico</td>
<td>Chair manufacturing, Manzano, Italy</td>
</tr>
<tr>
<td></td>
<td>Tile, Santa Catarina, Brazil</td>
<td>Surgical instruments, Sialkot, Pakistan</td>
<td>High-tech, Zhongguancun, China</td>
</tr>
<tr>
<td>Advanced</td>
<td>Surgical instruments, Tüttlingen, Germany</td>
<td>Ski-boots, Montebelluna, Italy</td>
<td>High-tech (microprocessor), Silicon Valley, US</td>
</tr>
<tr>
<td></td>
<td>Watch-making, Jura Arc, Switzerland</td>
<td>Machine tool industry, Baden-Württemberg, Germany</td>
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</tr>
</tbody>
</table>

firms that have upgraded their knowledge base with respect to the technological frontier but do not actively contribute to its enhancement. Moreover, dynamic clusters are likely to show a more open knowledge system, capable of absorbing extra-cluster knowledge, and with the presence of intra-cluster knowledge linkages. However, it is possible that not all firms which form part of a dynamically growing cluster homogeneously increase their knowledge base and form intra- and extra-cluster knowledge linkages. In this respect, intermediate cluster absorptive capacity differs from the advanced one. Advanced cluster absorptive capacity, associated with leading clusters, may represent a state in which firms operate and contribute to the evolution of the technological frontier.

An interesting comparison between a dynamic and a leading cluster is provided by Halder and Nadvi (2002), who compare the surgical instrument cluster in Sialkot (Pakistan) with the Tüttlingen one in Germany. As the authors described, Sialkot seems to be a relatively successful cluster with high export rates into the international market (Nadvi, 1999), whereas Tüttlingen is typically a leading cluster in the surgical instrument industry, with a significantly higher output value, if compared to Sialkot.

In fact, these two clusters target different market segments. Sialkot operates in the production of mature surgical instruments, whose technology relies on surgical mechanics. Moreover, firms in Sialkot do not perform innovative activities and tend to rely on extra-cluster knowledge transfer, mainly deriving from firms in Tüttlingen. As Halder and Nadvi remarked:

Such knowledge flows essentially enhance what Bell and Albu (1999) term knowledge-using capabilities. Acquiring know-how on adopting quality assurance producers in production processes, and incorporating new technologies in manufacture, has helped local producers in Sialkot to produce mature instruments more efficiently and meet quality assurance demands. It has not, however, led to the development of knowledge-changing abilities within the cluster. (Halder and Nadvi, 2002: 24)

Tüttlingen, on the contrary, operates on the technological frontier, producing new products such as minimal invasive instruments, endoscopes and surgical implants. These types of products need complementary capabilities in addition to the metalworking ones, requiring firms in Tüttlingen to carry out intense R&D activity and also to connect with extra-cluster sources of knowledge, as noted by Halder and Nadvi (2002: 31):

Access to such knowledge requires ties to technical skills that lie outside the Tüttlingen cluster. Thus Tüttlingen’s endoscope producers have either acquired or entered into collaborative joint venture agreements with specialised firms in the field of optical lenses from outside the cluster.

This example makes it clear that the Sialkot cluster, characterized by firms whose knowledge bases are comparatively weaker and far from the technological frontier compared to those operating in Tüttlingen, is capable of generating a different innovative environment, typically a knowledge-using rather than knowledge-producing one. Hence this story provides an interesting insight into the differences between two different levels of cluster absorptive capacities – which can be considered intermediate in the case of Sialkot and advanced in the case of Tüttlingen – and their long-term performances.

Among the advanced cases, one can also take Silicon Valley. As was well described by Saxenian (1994), Silicon Valley represents a good example of a cluster where firms, operating on the technological frontier, have strong knowledge bases; the local knowledge system is dense and firms tend to have a high degree of external openness. In this respect, since Silicon Valley is a place where knowledge is primarily created, extra-cluster knowledge linkages are more likely to flow outward than inward: ‘expanding in distant locations, Silicon Valley firms simultaneously enhanced the capabilities of these independent, but linked, regional economies’ (Saxenian, 1994: 159). Silicon Valley is therefore a good example of a high-performing cluster with an advanced cluster absorptive capacity.

These examples are mostly descriptive and largely anecdotal. However, they represent a stimulus to understand what determines variability in the key characteristics of the cluster absorptive capacity and to explore whether and how firm knowledge bases influence the characteristics of both intra- and extra-cluster knowledge systems.
Conclusions

This paper has illustrated the existence of a conceptual link between the firm’s knowledge bases, the cluster absorptive capacity and its potential to grow dynamically. The cluster absorptive capacity framework has been developed to explain the differentials in clusters’ growth around the world. In particular, this paper attributes substantial explanatory power to firm-level knowledge bases as key elements of the capacity of clusters to grow. In fact, clusters characterized by firms with strong knowledge bases are more likely to show dense intra-cluster knowledge systems and to be highly connected with extra-cluster knowledge. In such cases the incidence of technological gatekeepers may be high. Opposite to this, clusters characterized by firms with weak knowledge bases will be characterized mainly by a highly disconnected intra-cluster knowledge system and with poor connection to the external world; technological gatekeepers are unlikely to be found in this kind of cluster. Studies carried out in line with the conceptualization developed here have recently provided an empirical validation of this framework (see e.g. Giuliani, 2003). However, further empirical research is needed in this direction. This is particularly so for the policy implications which this type of framework may have. In fact, if the capacity of a cluster to grow dynamically depends ultimately on firm-level specificities, cluster policies should be oriented towards strengthening firm knowledge bases, rather than towards the cluster as a collective entity.

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Notes

1. The notion of tacit knowledge is normally attributed to the seminal contribution of M. Polany (1967: 3), who noted that people ‘know more than they can tell’. He specifically referred to the fact that not all knowledge can be fully codified and therefore transmitted through distance. Instead, part of the knowledge is embodied by people, acquired through progressive experience and accumulated over time (e.g. learning by doing).

2. ‘But an industry which does not use massive material, and needs skill that cannot be quickly acquired, remains as of yore loth to quit a good market for its labour. Sheffield and Solingen have acquired industrial “atmospheres” of their own; which yield gratis to the manufacturers of cutlery great advantages, that are not easily to be had elsewhere: and the atmosphere cannot be moved’ (Marshall, 1919: 284).

3. Interestingly, Giuliani and Bell (2005) have found that some cluster firms, which have strong knowledge bases similar to those of technological gatekeepers, behave very differently, establishing barely any intra-cluster knowledge linkages with the other firms but being strongly connected externally – a role which the authors refer to as ‘external stars’. Hence, external stars, which are best positioned of all the cluster firms to make positive contributions to the cluster knowledge system, rarely do so. It is still a matter of empirical investigation what drives firms to behave as external stars, and what inhibits technological gatekeeping behaviours.

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