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# Clusters of innovative firms: absorptive capacity in larger networks?

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## **Abstract**

Firms are often compared in terms of their resources or capabilities (resource based view of the firm (Barney, 1991, 1997) dynamic capabilities (Eisenhardt & Martin, 2000) and their performance on knowledge transfer (Argote & Ingram, 2000), absorptive capacity and relative absorptive capacity. Innovative firms are often located with other firms in clusters, with relationships and networks that have developed over time or in response to particular drivers and conditions.

This paper investigates assumptions related to innovative firms and their environments and brings together research relevant to individual firms, notions of absorptive capacity and findings about clusters of firms. Firm relationships in cluster configurations are discussed and a research agenda proposed.

## **Introduction**

The economic history of the last ten years has shown that nations that succeed in promoting innovation have dramatically outperformed those that don't in achieving superior wealth creation, productivity increase and living standard improvement (West, 2001). Countries and nation states are concerned to improve the productivity of their firms and specifically to maintain and where possible, increase their innovative activity.

While innovative firms are found in many parts of the business landscape, innovative firms are often located in clusters (Baptista & Swann, 1998; Porter, 1998; West, 2001) where effective networks are important influences, particularly in the context of information technology firms (Hagedoorn & Schakenraad, 1992). Previous research on networks highlights the importance of dense horizontal linkages and reciprocal relationships in the achievement of competitive success in regional networks (Nohria & Eccles, 1992).

This paper broadly discusses innovative firms and is structured as follows. First, we review what is known about innovation and link this to the absorptive capacity of firms. Second, we examine research about innovative firms within clusters, focusing particularly on information technology firms. Third, we look at problems and possibilities in tracking and measuring the developmental paths of cluster development, with implications for future research.

### **Innovative firms and absorptive capacity**

Innovation is variously defined as the generation of 'new products, new processes, new services' and new organisational structures. Innovation is differentiated from invention and involves application or commercialisation of the created product, process or production, on a scale larger than one item. Organizational innovation takes many forms, from incremental improvements that are competence enhancing to radical or disruptive innovations which require new technologies, knowledge or skills, and tend to be competence destroying.

The innovative process has dimensions that are internal and external to the firm. Baptista (1998) describes the internal dimension as consisting of those sources of knowledge that a firm finds advantageous to internalize, and the external dimension comprising the sources which the firm does not attempt to internalize on the grounds of high cost, high level of specialization, or because of other constraints. The external sources are obtained by a variety of formal and informal strategic arrangements with other organisations which have these knowledge bases. The assumption here is that knowledge is not information alone, but requires certain competencies from the organisation to be able to maximize benefits.

Within each firm, critical work functions in the innovation process include idea generation, entrepreneuring or championing, project leading, gatekeeping, sponsoring or coaching. "While 70 to 80% of technical effort is routine problem solving, about 20 to 30% is unique and critical" (Roberts & Fusfeld, 1997: 277). These critical functions in the innovation process have been mapped for personal characteristics and organisational activities. Highly innovative firms and units behave as focused communities while less innovative units behave more like traditional bureaucratic departments (Judge, Fryxell & Dooley, 1997). A firm's ability to recognise the potential of an innovation is "a function of how it collects and processes information, depends on nature of the innovation, the organisation structure, systems, people, local environment and managerial dominant logic" (Afuah, 1998: 92).

Previous work on organisational structure and innovation uses the notion of 'absorptive capacity' to analyse the ability of firms to assimilate knowledge and to transfer information across divisions of the

firm. “An organisation’s absorptive capacity can be described as the ability to understand new external knowledge, assimilate it, and apply it to commercial ends” (Cohen & Levinthal, 1990: 128). The absorptive capacity of a firm does not reside in single individuals but depends on links across a mosaic of individual capabilities (Cohen & Levinthal, 1990). In addition, absorptive capacity has less to do with the capacity of individuals than with the organizational structure, and large complex organizations depend on tried and tested innovative routines (Nelson & Winter, 1992). More recently dynamic capabilities in non-dynamic environments are also described as routines (Eisenhart & Martin, 2001).

Absorptive capacity also enables the firm to predict more accurately the nature and commercial potential of technological progress (Cohen & Levinthal, 1990). It makes the organisation more proactive, with a high sensitivity to emerging technological opportunities, seeking out new opportunities to exploit and develop its technological capability. This notion describes the ability of organisations to recognise the significance of new opportunities (Cohen & Levinthal 1990) and is linked to a firm’s ability to apply the learned external knowledge commercially, such that it must be able to link to product markets in a meaningful way. Application requires coordination processes within the firm and collaboration processes with external agents.

The notion of absorptive capacity has been investigated in international joint ventures (Lane, Salk and Styles, 2001), where assimilating external knowledge or connecting new knowledge to existing knowledge is understood as a sensemaking process, requiring both flexibility and adaptability to facilitate this process. Absorptive capacity includes “applying external knowledge, the ability to diffuse knowledge within the organisation, integrate it with organisation’s activities and generate new knowledge from it” (Lane, Salk and Styles, 2001: 1157). They argue that the more tacit the knowledge the more difficult it is to transfer and to assimilate it because of the social nature of the knowledge and its causal ambiguity. “What matters most for long-term success of transitional companies in international joint ventures is their ability to effectively diffuse new knowledge to their people” (Lane, Salk and Styles, 2001: 1157).

The ability of firms to ingest knowledge and to translate it to commercial ends is a notion that has implications for market focus, not only at the firm level but also at a larger than firm level, or cluster level. Over time the absorptive capacity of the firm co-evolves with its knowledge environment with different organizational forms and combinative capabilities (Van den Bosch, Volberda, & De Boer, 1999).

Innovation in firms is also influenced by the broader institutional framework in which the firm is embedded (West, 2001). This includes public infrastructure or any facility or institution provided through public funds which facilitates the exchange between production and consumption. Physical infrastructure includes ports, railways and motorways, as well as legal, administrative and educational systems.

### **Innovative firms and local environments: clusters**

Porter contends that “clusters affect competition, first by increasing the productivity of constituent firms or industries, by increasing their capacity for innovation and thus for productivity growth and by stimulating new business formation that supports innovation and expands the cluster” (1998:13). Hence Porter states that a cluster may be defined as a system of interconnected firms and institutions whose value as a whole is greater than the sum of the parts.

Clusters are variously defined as “geographic concentrations of interconnected companies and institutions an array of linked industries and other entities, suppliers of specialised inputs, providers of specialised infrastructure.” Clusters often extend downstream to channels and customers and laterally to manufacturers of complementary products and to companies in industries related by skills, technologies or common inputs. They may include governmental and other institutions that provide specialised training

education and technical support.” Common examples are the Californian wine cluster, Italian leather fashion. Clusters are chains of related industries with multiple linkages and synergies.

Clusters boundaries are defined by linkages and complementarities across industries, and by institutions that are most important to competition within cultural frameworks. For example the variation in the pharmaceutical cluster and chemicals cluster in Germany and Switzerland; and medical devices in Massachusetts. Clusters promote competition and cooperation and without vigorous competition, clusters will fail (Porter, 1998). Cooperation also occurs through vertical relationships in related industries. Clusters are also seen as new spatial organizational forms between markets and hierarchies and an alternate way of organising the value chain.

The phenomenon of clusters of firms engaged in productive outputs is not a recent phenomenon. Indeed Alfred Marshall wrote about industrial districts in 1920. More recently the focus of clusters as sites of innovation (OECD Boosting Innovating, Innovative clusters; Rouvinen & Yla-Anttila, 1999) have been widely researched across the western world.

Clusters of firms engaged in productive activity are found in many countries and in many industry sectors. Studies of cluster development in different countries have identified common elements of clusters as well as differences in clusters related to information technology and biotechnology (Prevezer, 1998). West (2001) argues that United States data has shown that about one-half of economy-wide productivity advance is actually located in the computer and information technology industries, and this paper focuses on IT clusters. Information technology firms are often located in geographical configurations referred to as clusters. These are areas where research, innovation, entrepreneurship, networks, money and opportunity come together with existing customers and suppliers, achieve sufficient critical mass and sustain growth over years or decades with minimal intervention. The success of the phenomenon of Silicon Valley has lead to other nations attempting to create their own productive configurations. Most clusters include one or more leading universities, other research institutions, private venture capital, a large skilled workforce, investment attraction programs and aggressive international marketing.

The success of the phenomenon of Silicon Valley has lead to other nations attempting to create their own productive configurations. Recent examples include “Silicon Glen”, between Edinburgh and Glasgow in Scotland, “Silicon Bog in Ireland”, Singapore, “Silicon Wadi” in Tel Aviv, Israel, and Bangalore in India and “Silicon Island” or Taiwan. Washington DC, and Austin Texas (PWC, 2000).

In comparing and contrasting the cases of Silicon Valley and Route 128, Baptista found that innovation and its communication are key factors in the development of clusters. Cluster success, at least in the case of highly complex and ever changing technologies, seems to reside in the ability of firms to establish networks of relations that allow them to keep up with the latest developments” (Baptista, 1998: 41). One of the defining factors in clusters of productive firms is the presence of small entrepreneurial firms, either through spillovers from existing firms or through the attraction of new firms to meet emerging requirements.

There is variation in cluster formation between countries. Baptista (1998:42) refers to a previous comprehensive study of Germany (Cooke & Morgan, 1994), where there is a “well defined hierarchy of institutions supporting innovation, large scale government and private institutions to multiple technology transfer, providing business to SME’s and supporting supplier-customer relationships that lend themselves to new innovations through simultaneous engineering”.

From an overview of innovative clusters in the European and the US context, Baptista contends that 3 properties are common to all successful innovative clusters. These are “(1) formal and informal networking, allowing for effective transfer of technology and other organizational capabilities; (2) close

user-producer collaboration allowing for production flexibility and joint development; (3) mobility and flexibility in the local labour market allowing for redundancy and easy adaptation to changes in products and services” (Baptista, 1998: 43).

Each of the influences of clusters depends to some extent on personal relationships, face-to face communication and interactions among networks of individuals and institutions (Porter, 1998). The close presence of other innovators sharing similar experiences makes regional networking important, with changing forms of networks from emerging stages to the early growth of the firm (Hite & Hesterley, 2001).

The notion of absorptive capacity within a cluster, requires more than transmission of knowledge or information, as “information may be easily transmitted across great distances, translating information into knowledge is a complex cognitive process. It requires a shared language, and a set of common frames of reference. In the initial stages, this language may not even exist, and there is a need to create common codes of communication. Innovation becomes an interactive process that involves questioning and interpretation, which is facilitated by face-to face-contact (Feldman 1994). The transfer of tacit knowledge is the key to successful development.

Absorptive capacity is acquired and accumulated through interactive mechanisms, externally by ‘boundary spanning’ and internally by learning from experience (Kim, 1999). Kim contends that boundary spanning shows how existing absorptive capability enables firms to exploit external information, including substantive technical knowledge, and awareness of where useful complementary expertise is available outside the organisation.

### **Clusters from a dynamic perspective**

The dynamics of clustering or the notion that clusters have a life cycle where a cluster may be strong in some parts of the industry but not in others. Similarly the strength of a cluster is multi-faceted: and can be an *entry attractor* or *growth promoter* (Swan & Prevezer, 1998).

“A geographical cluster is a collection of related companies located in a small geographical area, perhaps centred around a strong part of the science base. Firms group together to take advantage of strong demand in the location, a large supply of scientific manpower, and the network of complementary strength in neighbouring firms” (Swan & Prevezer, 1998: 3).

(Swann and Prevezer, 1998) contrast entry attraction and growth promotion. They found that a cluster that is already strong is less likely to attract further entrants to that sub-sector. Cross-sectoral effects are found on the entry of new firms. For example, clusters with strong computer hardware components and systems sectors are more successful at attracting entry into software, peripherals and services.

A comparison of IT clusters in Silicon Valley and Route 128 found that these clusters have two distinct economies (Kenny & von Burg, 1999). Economy 1 is comprised largely of existing firms, corporate research laboratories and universities. Economy 2 is formed of institutions that are specialised in new firm formation.

The critical agents were in each region were Stanford University and ARD in Boston, seed institutions, universities, and corporate research laboratories such as Xerox PARC and IBM in San Jose. Kenny and von Burg found that there were more needs, more opportunities and more success in Silicon Valley. In both regions, Economy 2 lowered the boundaries of existing firms, repeated spin-offs, and created a pattern of path for future (Kenny & von Burg, 1999:69-76). A “critical point is whether the technologies and innovations being developed can be extruded from these Economy 1 firms to be actualized through

the institutions of Economy 2” (Kenny & von Burg, 1999: 99). Others debate the use of different economies (Saxenian, 2001), suggesting that these types of economies make false distinctions.

Major features of the dynamics perspective of clusters range from positive feedback and cluster strength to growth and entry. Fixed effects which make one cluster more attractive than another include climate infrastructure and cultural capital. The strength of the science base played an important role in attracting entry and promoting growth in a cluster (Swann, 1998).

### **Analyses of cluster development: methodological issues**

Research into existing configurations of firms that have already formed a cluster and have demonstrated some success is well advanced. A range of factors associated with successful clusters have been identified (Porter, 2000; Wolfe, 2001). Porter argues that the early formation of a cluster requires the presence of a strong pool of critical factors, a set of specialised skills, a strong research base, and good infrastructure leading to research institutions and leading or dynamic firms with strong linkages to the global economy.

Wolfe identifies 8 factors, which contribute to cluster development. These are: “the presence of local champions with greater vision than single firm success; the existence of strong S&T knowledge infrastructure and includes research universities, government laboratories and cooperative research centres; sources of motivated learners and technology, knowledge and skills; the presence of at least one exporting firm with some global reach; involvement by local networking facilitators who promote the growth of relationships within the cluster; involved, knowledgeable local sources of innovation financing; sustained aligned development strategies by local institutions and governments; supportive business climate, and policy conditions favourable for innovators” (Wolfe, 2002: 27.)

While these factors describe successful clusters and their components and linkages, governments setting out to encourage cluster development have difficulty in learning from these attributes. Typically governments look for phases of development that result in clusters, while much of the research looks at fully formed clusters. We have some precision in defining clusters, we need processes to measure and map the entry and growth of firms and changes over time, and ways of understanding changes over time.

The use of ‘history friendly’ economic models (Feldman, 2001; Malerba, Nelson, Orsenigo & Winter, 1999) goes some distance in this direction. Feldman’s analysis of the formation of a regional industrial cluster and the development of an entrepreneurial culture applies the model to US Capitol area, tracing the role of entrepreneurs in cluster development in biotechnology and IT industries.

We know that the linkages between the firm and its value chain and networks of relationships are crucial to the success of clusters, and research has shown that more open and decentralised industrial system advantaged entrepreneurs in emerging sectors. Social capital also plays important roles in innovation at the firm and cluster level (Feldman, 2001, Wolfe, forthcoming). Feldman’s (2001) study found evidence of entrepreneurial activity as well as supportive social capital, venture capital and entrepreneurial support services.

### **Implications for managers**

As previously noted, factors which contribute to a firm’s innovation processes include its processes for collecting and processing information, the organisation structure, systems, people, local environment and managerial dominant logic (Afuah, 1998). Firms which have developed routines for maximising their internal absorptive capacity may have distinct advantages in this networked cluster than those who do not. Managers may have particular roles in encouraging internal knowledge development and knowledge acquisition from external networks, the assimilation of this knowledge within the firm as well as

consequent exploitation in terms of application internally or through innovative products or processes. Collaborative relationships with research organisations, suppliers and distributors and market intelligence regarding their customers and competitors is essential in such dynamic environments. They may also be advocates with industry associations and local governments for specific institutional requirements to assist the development their industry.

### **Implications for research**

Further work is needed in a number of areas. First, explicit links need to be made between the innovative process within firms to notions of absorptive capacity. While absorptive capacity is linked to knowledge transfer, its relationship with the innovative process is implied rather than explicit. Second, research on innovative firms in clusters has been implemented from a number of different perspectives and exists in a number of disciplines. This research needs to be analysed in relation to notions of absorptive capacity and distinguished from notions of social capital. Third, a focus on the methodological issues of investigating phenomena of clusters as they develop rather than when they are well developed, clearly identified and functioning is required. The 'history-friendly' economic model may provide some direction and the use of case study comparisons and network analysis may take us further in this direction.

Above all, future research requires clarity and specificity in language and frameworks as well as in conversations regarding the nature of the capacity and the dynamics of innovative firms and clusters.

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