To Cluster or Not to Cluster: A Simulation Study of Managerial Practices for Innovating in SMEs

Martin H. Kunc

Assistant Professor of Strategic Management

Universidad Adolfo Ibáñez

Avenue Las Torres- Peñalolen, Santiago - Chile

Email: martin.kunc@uai.cl

Abstract: During the last two decades a strong line of research has emerged in management research and policymakers' agenda: the relationship between firms and clusters. One of the several reasons explaining the increased interest in clusters is the positive association between networks within geographical boundaries and knowledge diffusion. However, there is a strong assumption in this reasoning: clustered firms have enough capabilities to transform local interaction, which has to be also rich in information, into valuable knowledge to improve its performance. What will happen if firms in the cluster lack of skills to absorb information? What will happen if clustered firms do not have rich interactions? This paper aims to show the benefits and trade-offs existing for a Small and Medium Enterprises when at the moment of start an internationalization process managers need to decide either to emphasize the interfim interactions generated inside a cluster or to follow a standalone process without clustering.

Keywords: Clusters, SMEs, Knowledge, Innovation

1. Introduction

Today, the competitive environment for most firms, irrespective of size, industry and in most countries, is very difficult. Two factors account for this situation. First, over the past two decades, production has become more knowledge intensive. Second, competition has both globalized and become more innovation-based.

As innovation-based competition diffused through the process of trade liberalization, it accelerated the pace of technological change, increasing the need for firms in developing countries to engage in a continuous process of innovation irrespective of the sector in which they are located (Mytelka, 2000). However, past habits and practices are not everywhere conducive to such innovative behavior. There is thus a pressing need for new thinking with regard to how sluggish firms can be turned into dynamic competitors and what practices and support structures need to be put into place to realize this objective.

The efficiencies derived from "learning to allocate" are becoming less important than the flexibility that can be gained from "learning to learn" (Mytelka, 2000). Increasingly, the position of firms and regions in a globalized economy will reflect their capacity to learn. In contrast to the quasi-autonomous process of learning by doing, learning-to-learn is a conscious process in the absence of which firms neither improve productivity nor develop the capacity to innovate in products or processes as competitive conditions change (Mytelka, 2000). The linkages firms establish with research centers, clients, suppliers and even competitors at home and abroad can be critical in this respect. The accelerated pace of technological change, moreover, requires a far large volume and set of resources than many firms have in-house or can easily access, especially knowledge-based resources (Mytelka, 2000). SMEs have some ways to have access to those resources: to cluster with other SMEs in the same geographical areas or with similar interests to share experiences; or to internationalize their business by belonging to a global value chain.

Within the district or cluster literature (Porter, 1998, 2000) is generally accepted that "cluster embeddedness" allows a firm to take advantage of a number of cluster related externalities, which have a positive impact in its competitiveness. Such externalities include, for instance, the firm's access to a specialized labor force or to specialized technological and administrative services, or even to several marketing complementarities (Porter, 2000). This, in turn, tends to

increase industrial district firms' ability to manage information flows and speed up knowledge and innovation spillovers.

On the other hand the global value chain literature (e.g., Giulani, Pietrobelli and Rabelotti, 2005) suggests that the role played by the value chain leader, particularly buyers, in transferring knowledge is crucial for firms because it facilitates the access to information about the needs of multinational customers and a mode to gain access to international markets. However, it is less clear how the leaders of the chain foster and support the acquisition of knowledge to innovate in process, which implies more efficiency in the production system; products, which consists of moving into more sophisticated product lines in terms of increased unit values; or functions in the chain abandoning low-value added functions to focus on higher value added activities

While clustering or global value networking policy options are not exclusive options, the relative emphasis given by the managerial policies and the endowments of the Small and Medium Enterprises (SMEs) can strongly affect the outcome of the SME internationalization process. This paper tests a serie of propositions about the role of clusters or global value chains in the innovating capabilities of SME and their success in internationalization processes. To test these propositions, a System Dynamics (Sterman, 2000) model is developed which runs a serie of scenarios using different managerial policies and levels of initial endowments of the firm and the cluster. In that sense, I aim to identify managerial practices that improve the performance of the SMEs either through clustering or seeking actively a position in global value chains independently of the local network.

2. Literature Review

2.1 The importance of absorptive capacity

Innovating firms have a central characteristic. The knowledge applied by firms in innovations is not general purpose and easily transmitted and reproduced, but appropriate for specific applications and appropriated by specific firms. Firms are essentially constrained in their innovating activity by their existing range of knowledge and skills to closely related zones (Pavitt, 1984). Innovation is, therefore, largely a cumulative process specific to firms. Therefore, the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities. This capability is defined as the capacity

to learn or absorb from their environment and it is largely a function of the firm's level of prior related knowledge (Cohen and Levinthal, 1990). The stock of knowledge is usually embodied in skilled human resources that are able to understand new production technologies, basic science innovations and solve complex problems. These knowledge workers, who share a common language and technical background, may be able to form communities of practice where they can seek advice from other peers of local or international communities and boost processes of knowledge exchange and generation.

Proposition 1: SMEs that have developed their absorptive capacity by hiring knowledge workers or its owners are graduated from related university programs can upgrade their production function faster through innovations than firms without absorptive capacity.

2.2 The importance of participating in global vertical networks – Standalone internationalization

SMEs can participate either in vertical or horizontal networks, which can be local or global. A vertical network is characterized by the integration of the firm to a value chain. The association of firms, sometimes competitors, to develop an external market or new products characterizes a horizontal network.

Participating in a value chain can be useful to upgrade the production function of a firm according to changes that a firm has in its role in the value chain. The role played by a leader of a value chain, particularly buyers, in transferring knowledge is crucial for firms integrating a value chain because it facilitates the access to information about the needs of different customers as well as new production requirements. However, the learning process for a SME in a value chain is not similar in all value chains. Different leaders will foster and support in different ways the acquisition of knowledge to innovate in processes, products or functions to facilitate the upgrading from low-value added functions to higher value added activities (Giuliani, Pietrobelli and Rabelloti, 2005). Most of the effect generated by the leader in the value chain is generated thought coordination mechanisms. Coordination may occur through market or non-market relations.

The learning process should be higher if the SME belongs to a global value chain (because of the experience gained from competing and supplying international markets) than to a local value

chain. And it improves even more if the coordination occurs through long-term agreements rather than spot sales.

Proposition 2a: SMEs that have high absorptive capacity can upgrade faster their innovative capabilities by being part of a global value chain than not belonging to a global value chain. Thus, their level of internationalization can be high and profitable if they prioritize the development of international markets.

Proposition 2b: SMEs that belong to a global value chain but have low absorptive capacity are employed as low cost suppliers and their relationships with the chain leader is coordinated through market-based transactions reducing the development of innovative capabilities. Thus, their level of internationalization can be high but not very profitable.

2.3 The effect of participating in local networks or clusters – Internationalization through clustering

Porter (1998) defines a cluster as a geographically proximate group of interconnected companies and associated institutions in particular fields linked by commonalities and complementarities. Clustering may be considered a major facilitating factor for a number of subsequent developments: division and specialization of labor, emergence of a wide network of suppliers, the appearance of agents who sell to distant national and international markets, the emergence of specialized producer services, the establishment of a pool of specialized and skilled workers, and the formation of business associations. Carbonara (2004) presents a typification of clusters in terms of both learning mechanisms and knowledge management functions.

- *Cluster type 1*

  This cluster results from two main processes: (i) the decentralization of production in a local area characterized by a specific manufacturing vocation, which is carried out by a large firm internal or external to the area, or (ii) the agglomeration of an entrepreneurial system within a local area.

  In the first case, small sized firms involved in labor-intensive production phases decentralized by a large firm characterize the cluster. The interfirm relationships are basically aimed at acquiring products, whereas their content is generally characterized by a low level of complexity, so involving the transfer of a low amount of operative knowledge. Such knowledge regards the terms of the market transaction and supports

the production coordination mechanisms between firms. In the second case, the cluster results from an agglomeration of isolated small firms, and interfirm relationships are rare or absent. This type of cluster is mainly characterized by incremental innovative processes activated by mechanisms of 'learning by doing' as well as 'learning by localizing' where simple processes of learning occurs because the firms belong or are located within the cluster.

Proposition 3a: SMEs with low absorptive capacity that are part of a cluster type 1 produce fairly simple and homogeneous products (low firm sophistication), most of transactions are market based and local interfirm relationships are rare or absent. Therefore, these SMEs cannot upgrade their production function to become international suppliers.

- *Cluster type 2*

This type of cluster is formed by a large number of small and medium firms, highly specialized in a few phases of the production process, located in a specific area due to geographical advantages. In this type of clusters, firms develop complementary competences and are related by a dense network of relationships, where they co-operate and compete with each other. The high specialization of the firm competences in relation to particular production processes lead to vertical and horizontal learning. The learning mechanism has been called 'learning by specializing'.

The learning processes are strongly affected by the spatial issue. Geographical proximity as well as direct relationships among people in firms creates an environment wherein information, codes, languages and strategy are shared, activating mechanisms of collective learning. The collective learning is generated by: high labor mobility within the cluster, the emulation processes, the presence of complementary information and specialized services.

The knowledge generated is based on a common feature that is the identification of the firm with its specific environment. As a result, knowledge generated from these learning processes is strictly contextualized, and strongly linked to environmental and cultural factors characterizing the local area.

Proposition 3b: SMEs without knowledge workers, which are part of a cluster type 2, develop their absorptive capacity from rich local interfirm interactions in the cluster and

upgrade their production function, albeit slowly. Thus, their level of internationalization is relatively low.

- *Cluster type 3*

  The cluster is characterized by the presence of one or more hub actors, such as leader firms or 'meta-managers'. These actors coordinate inter-organizational processes within the cluster.

  In this cluster, the leading actors strongly influence the knowledge generation process. Leader firms have sufficient critical mass to perform R&D investments so that they are able to introduce both radical and incremental innovations. They also have scientific and technical competences that contribute to understand and adapt the innovations produced elsewhere and embedded in new technologies and new products.

  Meta-management structures play an important role for the cluster innovative performance. These structures provide the small and medium firms with innovation services, co-ordinate the production activities performed by the cluster's firms, activating and managing co-operative inter-firm relationships both inside and outside the cluster, and deal with the external environment (research centers, universities, clients, suppliers, etc.).

  Meta-management structures represent a cognitive interface between cluster and the external environment. These actors are placed in two fundamental knowledge flows: one inside the cluster and the other external to the cluster.

Proposition 3c: SMEs with absorptive capacity can upgrade their production function without hiring knowledge workers and become international because of the highly rich local interfirm interactions (clustering.

3. Visualizing the build-up of innovating capabilities and its effect on internationalization and profitability

The following section tests the propositions and helps to envisage a conceptual framework for best managerial policies to build up innovative capabilities and the effects on internationalization and profitability. The propositions are tested using a system dynamics model (Sterman, 2000). System Dynamics' models represent theoretical concepts using stocks and flows, and the relationships between the concepts using causal links. There are five stocks and four dynamic

processes in the model, which can be appreciated in figure 2. There are three reinforcing processes: “innovativeness and sophistication” which captures the core process of upgrading – higher sophistication – in the market using SME’s innovative capabilities, “upgrading process in global networks” which captures the effect of internationalization in the capability to invest in knowledge workers and accelerate the process of sophistication, and “upgrading from international market experience” which shows the effect of learning from international markets in innovation capability. There are two balancing processes: “upgrading process through clustering” which depicts the process of upgrading generated through interfirm relationships in a cluster and the decline of the leve of interaction as the SME expands internationally, and “losing cluster connections” which portraits the process of losing interfirm relationships as the efforts to satisfy international markets increases.

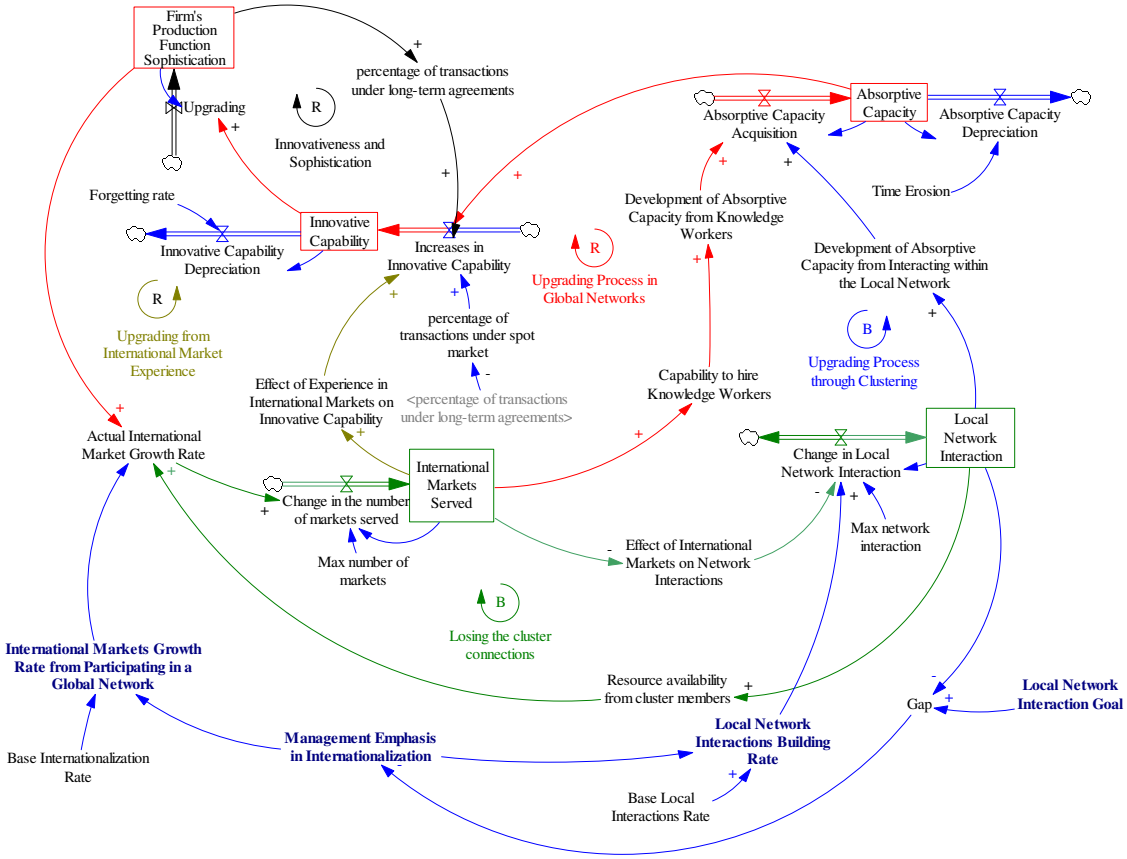

Figure 2. The complete picture of the simulation model

First, I will review the dynamic processes driving the innovation and upgrading of the SME. Figure 3 shows the core process of upgrading occurring in the SME. First, “Absorptive Capacity” indicates the capacity of the firm to learn from its transactions with the market. There

are two basic types of transactions: *spot market transactions* are simply one-off sale of a product without any further interaction between the firm and its buyer, and *long-term agreement transactions* are transactions made by the firm with its buyer where there is certain transference of knowledge and support from the buyer to the firm to develop better products over time. Absorptive capacity is driven by two process: one is hiring knowledge workers – variable "Development of absorptive capacity through knowledge workers" – and the second process is through interfirm interactions in a cluster – variable "Development of absorptive capacity from interacting within the local network". Second, "Innovative Capability" captures the capability of the firm to improve its products or processes through the lessons gained from market transactions. The capability increases each time that the SME makes a transaction, but long-term agreement transactions in multiple international markets provide higher benefits to the SME than market-based transactions in few international markets. Third, an increase in the SME's innovative capability drives an upgrade in SME's production function sophistication (stock "Firm's Production Function Sophistication"). If a SME is able to innovate as it learns from its market transactions, the production function will become better and more sophisticated as time goes. A highly sophisticated production function allows the firm to have access to global networks, obtain long-term transactions, and accelerates the process of acquisition of experience in international markets, which increases its innovative capability and the sophistication of its production function even more.

The process of innovation and upgrading is started by the emphasis of the management in internationalization of the firm but the final results strongly depends on the absorptive capacity that the SME has initially, the emphasis in investing in knowledge workers to accelerate the process of absorptive capacity development, or the richnes of the interfirm interactions in its cluster.

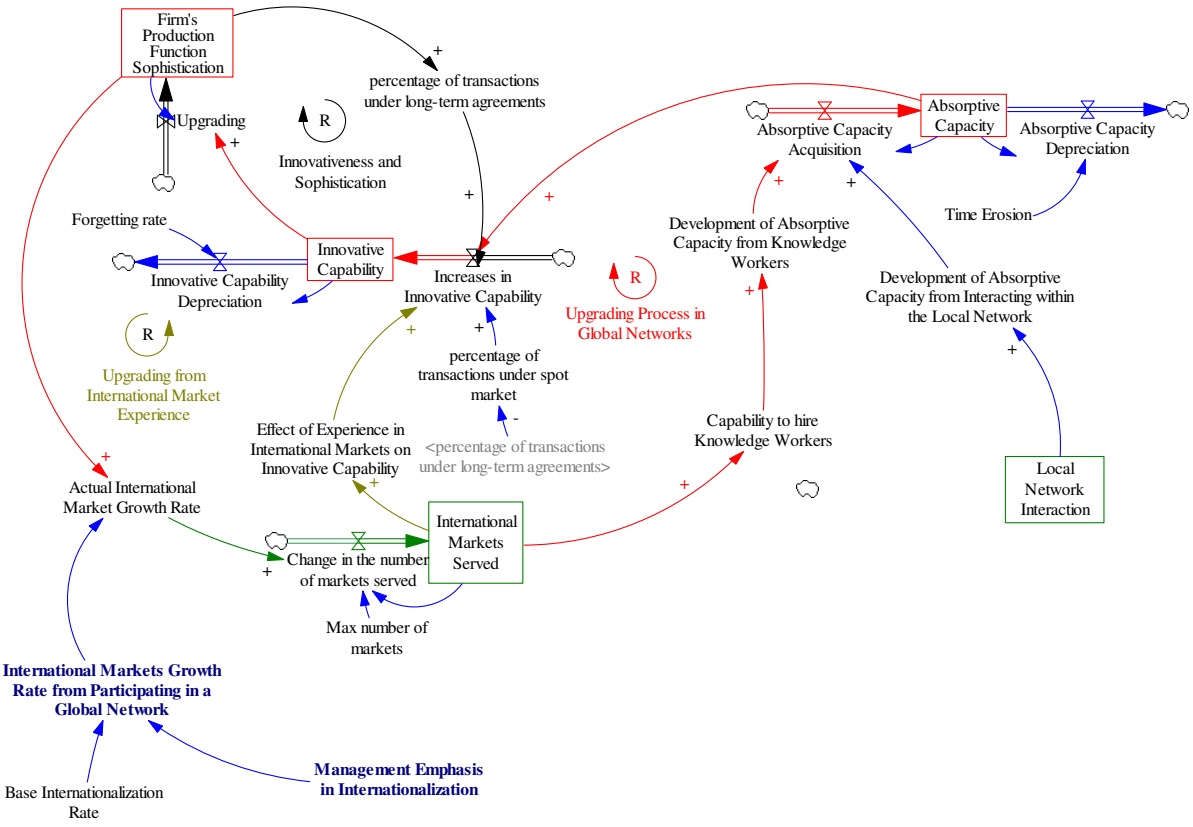

Figure 3. The core processes driving the upgrading of a SME

Second, I review the main balancing processes occurring at the level of local interfirm interactions in the cluster, see figure 4. As the number of international markets served (stock "International Markets Served") increases, this implies a trade-off in the attention paid by the SME to its local cluster. In the model is considered the existence of a negative relationship between the internationalization of SME and its level of interaction (stock "Local Network Interaction") with its peers in the cluster – loop "Losing the cluster connections". Among many factors for the occurrence of this process, the lack of enough time to deal with local peers is one of the reasons for a reduction in the level of interaction with the local network and its effect on the development of the absorptive capacity of the firm determined by interactions with their local peers. Unless there is a clear goal of maintaining the relationships with the peers in the cluster (variable "Local Network Interaction Goal"), successful internationalization will tend to reduce the level of interaction in the network. Other factors that may account for this reduction are the risks perceived by SME's managers of losing important international markets by exchanging information with local competitors

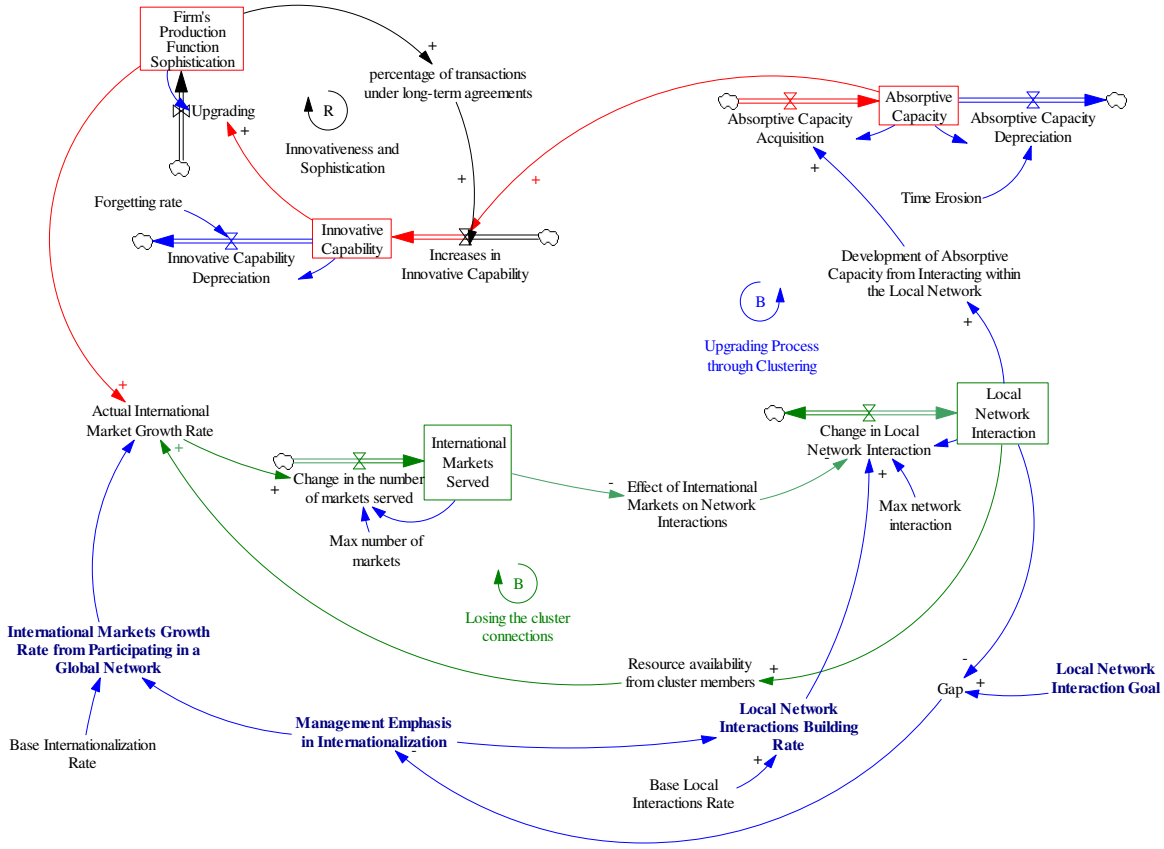

Figure 4. The balancing processes reducing the interactions between local firms in a cluster

The model tests the propositions assigning different values to a set of variables, which captures either initial endowments or rate of change of dynamic processes, as table 1 shows. The values mentioned in the table indicate the change of the value used with respecto to the base case. Simulations start with a SME that serves only one market with low levels of local network interaction, absorptive capacity and production function sophistication as well as low intention of becoming international, which I defined as the base case. The base case was calibrated using sensitivity and qualitative analysis to reach an expected poor performance of an isolated firm with low initial endowments and no intention to become international. The base case represents the situation of many SMEs that are simply survivors in their industry.

Proposition tested	Variable in the Model	Concept	Value	Run
Proposition 1	Absorptive Capacity	High Low	0,5 0,1	Stand alone Base Case
Proposition 2a	Absorptive Capacity Internationalization Market Growth Rate Capability to hire knowledge workers	High High High	0,5 1 1	Stand alone Stand alone Stand alone
Proposition 2b	Absorptive Capacity Internationalization Market Growth Rate Capability to hire knowledge workers	Low High Low	0,1 1 0,5	Low cost stand alone Low cost stand alone Low cost stand alone
Proposition 3a	Absorptive Capacity Local Network Interaction Development of Absorptive Capacity from Interacting within the Local Network	Low Low Low	0,1 0,2 0,5	Type 1 cluster Type 1 cluster Type 1 cluster
Proposition 3b	Absorptive Capacity Local Network Interaction Development of Absorptive Capacity from Interacting within the Local Network	Low Low High	0,1 0,2 1	Type 2 cluster Type 2 cluster Type 2 cluster
Proposition 3c	Absorptive Capacity Local Network Interaction Development of Absorptive Capacity from Interacting within the Local Network	High High High	0,5 0,5 1	Type 3 cluster Type 3 cluster Type 3 cluster

Table 1. Variables changed in the scenarios and name of the corresponding simulation run

The most important initial endowment of a SME is its absorptive capacity, which allows the firm to transform market experience into innovative capacity and later on in firm sophistication. Basically, we have two scenarios with respect to the level of absorptive capacity. The first scenario consists of firms with high absorptive capacity wanting to internationalize independently from their cluster or firms wanting to internationalize within their cluster. The second scenario consists of firms with low absorptive capacity which try to compensate their poor endowments through local interfirm interactions inside their clusters. These firms are considered to be in different type of clusters. Some clusters can be poor in terms of intensity of the interactions, variable “Local network interaction”, but rich in terms of the quality of the interactions, variable “Development of absorptive capabity from interacting within the local network”. The simulations explained in table 1 capture these different scenarios in changes in the key variables. The following section shows the effects in SME performance of these scenarios.

3.1 Results from the Simulation

Table 2 displays the final performance of the SME according to the scenarios suggested in table 1. The performance is calculated multiplying the percentage of transactions under long term agreements, an indicator of the value added transactions, by the number of international markets covered, an indicator of expansion in the global markets and opportunities for further learning. The results are very surprising. Any managerial policy that considers internationalization a priority increases the performance with respect to the base case (an isolated local SME) at least four times. Even more interestingly is the result obtained by integrating a type-3 cluster, which has obtained a three times higher performance than a stand-alone internationalization process. What are the reasons for such disparity in performance?

Scenario	**Performance**
type 3 cluster	54
type 2 cluster	4
type 1 cluster	4
low cost stand alone	5
base case	**1**
stand alone	17

Table 2. Simulated performance after 20 quarters

As we can observe in figure 5, the percentage of transactions under long-term agreement is fairly similar between “standalone” and “type 3 cluster” scenarios and far better than other scenarios. Therefore, the percentage of transactions under long-term agreements is not the source of the difference between these two managerial policies.

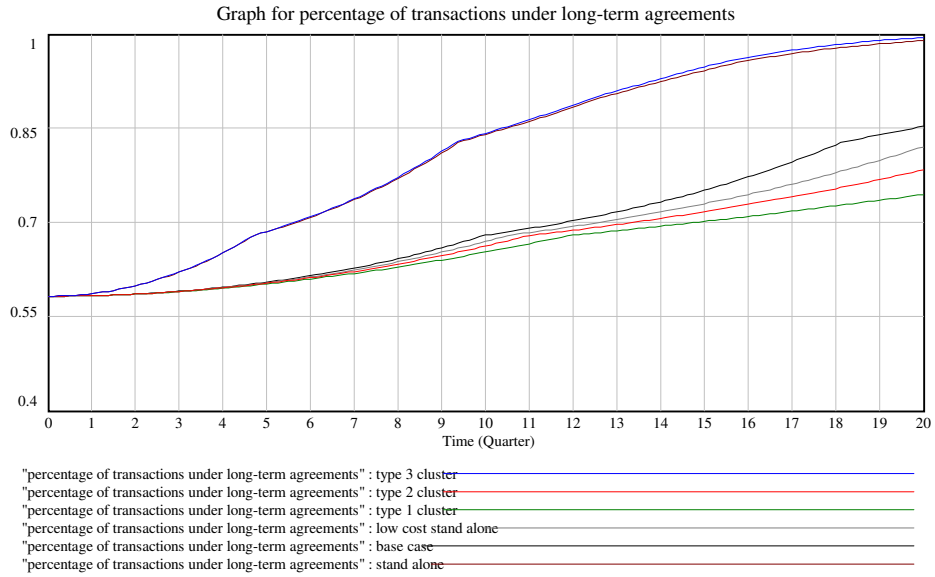

Figure 5. Simulated percentage of transactions under long-term agreements after 20 quarters

Even though standalone SMEs have more absorptive capacity than type-3 cluster SMEs, they reach less number of international markets than type-3 cluster SMEs as figure 6 shows. Therefore, the reinforcing process between international experience and firm sophistication is stronger in SMEs belonging to type-3 clusters. What can have made a difference in the reinforcing process?

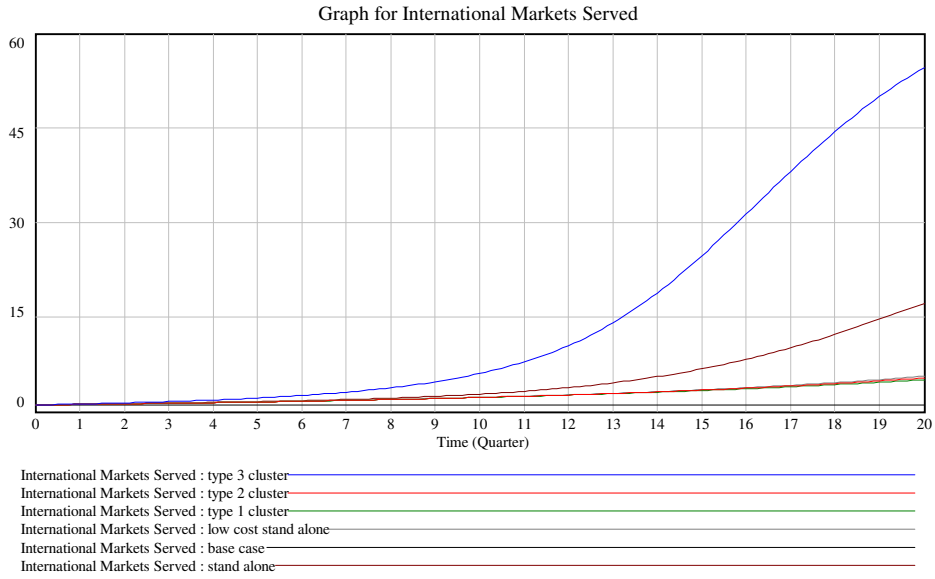

Figure 6. International markets supplied after 20 quarters

In this respect, we need to look for the answer in the balancing process. SMEs with high absorptive capacity in global networks achieved higher levels of innovative capability by hiring knowledge workers, albeit not too much, than SMEs with high absorptive capacity but focusing their process of generating and capturing knowledge on interfirm interactions inside a very rich cluster, the type-3 cluster. While a standalone firm in global networks is exposed to international experiences and has higher absorptive capacity, a standalone firm loses the richness of local interfirm interactions especially with respect to sources of resources necessary to sustain its growth. In the long term the balancing process "Losing the cluster connections" will affect both firms as they grow and focus their effort in international partners, but the initial endowment of a rich cluster will be sufficient to allow the SME to reach a critical mass in terms of international experience. Figure 7 shows the effect of resource availability in the capability to grow in international markets.

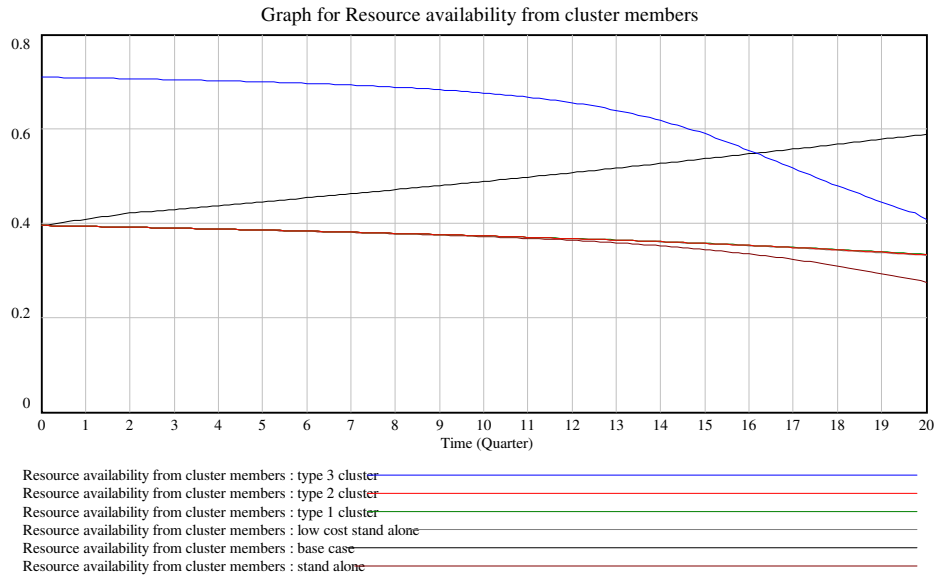

Figure 7. Evolution of the availability of resources from cluster members in a period of 20 quarters

An interesting observation from the model is related to the non-limiting effect of absorptive capacity. Once absorptive capacity reaches a plateau, this situacion does not preclude the firm to improve its innovative capability because the firm is exposed to more international markets and more long-term agreements that help the firm to keep improving. However, the lack of resource to grow can become an important constraining effect in the process of international development. In that sense, many SMEs opt for opening production facilities closer to their international markets in order to overcome the limits generated by the lack of local resources.

4. Managerial Policies for Innovating in SMEs: To Cluster or not to cluster

Figure 8 presents the conceptual framework that concentrates around two key dimensiones: absorptive capacity and belonging to a local or global value chain.

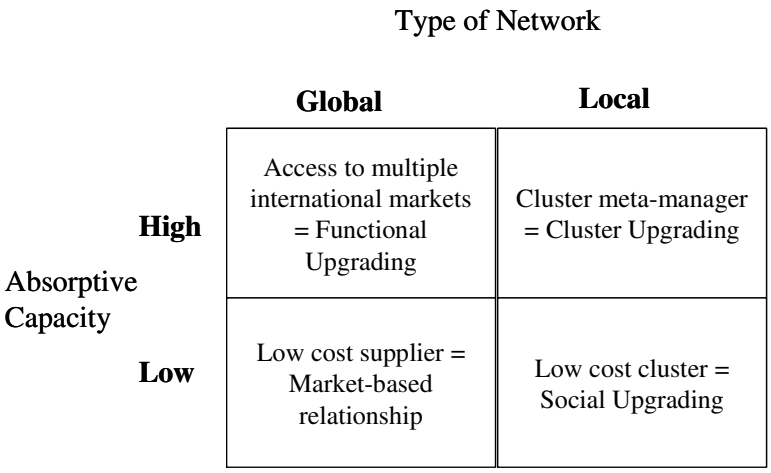

Figure 8. Conceptual Framework for SME's Innovating Practices

While SMEs can participate either in local or global networks, their levels of absorptive capacity determine the effectiveness of their learning processes. When absorptive capacity is high and SMEs can have access to global networks, SMEs may be able to upgrade its functional role in the global value chain by experiencing the access to multiple international markets with different quality and consumer tastes requirements. When absorptive capacity is high and SMEs do not have access to a global network but most of their activity is related to their local area, the best practice for the SME is to act as a 'meta-manager' or technology gatekeeper. In its role as meta-manager, the SME will provide with a source of knowledge from external sources to upgrade the functionality of the cluster. With a more efficient cluster, the SME will be able to upgrade itself to a more important role in its destination markets. In other words, SMEs with high absorption capacity but not belonging to a global value chain should aim to develop type-3 clusters.

When absorptive capacity is low and the SME participates in a global network, its role is assigned to a mere low cost supplier and subject to market-based transactions. In this situation, the SME should translate this experience into a more efficient low cost supplier able to access opportunistic market-based transactions from other companies than only the global chain leader.

When absorptive capacity is also low but the company is embedded in a local network of companies, SME should aim to foster its social skills to upgrade its relationships with other members of the cluster in order to insulate itself from market-based transactions. The creation of social capital with other members of the cluster will help the firm to have access to knowledge from other firms and become more innovative in the long term. SMEs should aim to move from a cluster type 1 to a cluster type 2.

5. Conclusions

The model has been inspired in the process observed in the Chilean wine industry in the last 15 years. In this industry, firms, which have climbed up the ladder of innovation and obtained high value-added products like ultra premiun wines selling for U$S 100 each bottle, have developed absorptive capacities by hiring recognized oenologists, actively participated in vertical networks through establishing alliances with distributors or supermarkets and benefited from the interaction with foreign firms to acquire knowledge, and finally applied this knowledge to upgrade the sophistication of its production function exploiting a positive reinforcing feedback process. However, these processes did not occur all of them at the same time, the fruits of investing in the development of absorptive capacity can only be reaped after a long period of time and in conjunction with investments in building relationships with global supply chains in order to obtain even more valuable transactions.

On the other hand, there are still some firms completely isolated which still use old technology and do not have made partnerships to access international markets. These firms are selling their wine, some of them of very good quality, for only U$S 0.75 per litre to local companies which bottle and label it with their own brands.

For the first group of firms, the future challenges are to achieve economies of scale in knowledge creation processes through public and private partnerships in order to enrich their interfirm interactions and move into a type-3 cluster. For the second group, they need to climb the ladder to improve their sophistication and generate alliances with international partners.

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