Globelics

Absorptive capacity in software industry: Comparative analysis of two Mexican regions, Baja California and Guadalajara

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Abstract

Understanding on the role that region plays in the innovation processes has increased in the last years; in the same way, the necessity to develop the firm absorptive capacity has been shown in an important way. If a firm doesn't develop its absorptive capacity cannot take advantage from the knowledge that is generated in a region and be innovative. But, is necessary understand that if a region promotes the development and exchange of knowledge, as well as use of innovators practices, the firms will increase their absorptive capacity and therefore their possibility to innovate. In this paper we show the importance that region has in the creation and development of absorptive capacity in Mexican software firms. To carry out the analysis, we suggest the concept of Sectoral Regional System of Innovation (SSRI), which allows us to stand out the importance of a region for the absorptive capacity development. In this paper two cases are analyzed: Baja California and the Metropolitan Area of Guadalajara (MAG). In each of them the determinant of the absorptive capacity are analyzed as well as the role of each SSRI in their creation and development.

Key words: SRSI, Absorptive Capacity, Software Firms.

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Introduction

Mexican software industry finds itself in a relatively early stage of development, where the process of innovation implies interaction among software firms and other agents. The study of software has been approached from different perspectives and level of detail. For instance, with a closer focus on national and sectoral systems of innovation, Baskaran and Muchie (2006) analysed the national system of innovation and the sub-system of Information Technologies – software amongst these – in China, India, South Africa, Thailand and Brazil. Evidence showed that the sub-system has problems to resolve, such as: (i) the disarticulation and lack of links between government, industry and Research and Development (R&D) institutions, as well as public and private organizations, multinational organizations, and so forth, and (ii) the lack of local suppliers that allow a greater integration of the local value chains.

Scholars such as Malerba (2002), Giuliani (2002), and Moulaert and Sekia (2003) have revaluated the role that a local, regional or sectoral environment carries out for the development of the institutions and firm's competitiveness and innovation capabilities. This literature has considered that a local/regional environment -a group of institutions, local agents, and their interrelations- can achieve processes of collective efficiency, defined as those competitive advantages derived from external economies and combined action of those agents. At the same time, this literature has taken into account the concepts of national system of innovation (Freeman, 1988; Lundvall, 1988 and 1992; and Nelson, 1988 and 1993), technological system (Carlsson, 1995 and 1997), cluster (Porter, 1990), regional systems of innovation (Cooke, 1998), the competence theory of the regions (Lawson, 1999), and learning regions (Asheim, 1996 and 2000).

Drawing on those bodies of literature, and in order to understand the process of innovation in the Mexican software industry, which has evolved in specific regions, we suggest a Sectoral-Regional System of Innovation (SRSI) approach. This highlights sector specificities and emphasizes the region as the space where the software industry develops. SRSI could be defined as a group of firms and other agents related with a certain sector and

established in a specific region; both firms and agents carry out interactions to achieve an appropriate firm's performance and promote the innovation in the sector.

Nowadays, the Mexican software industry has been studied at micro level (González, 2006), at cluster level (Hualde and Gomis, 2006), at national level (AMITI, 2001; Mochi, 2006), and from the policy perspective (Sallstrom y Damuth, 2003). But we believe it is essential to understand the nature and relevance of the region and the forms of interaction among the agents that are involved in the innovation process in this sector.

The aim of this paper is dual: on the one hand, we discuss the SRSI concept and argue that this is a better approach to understand the case of the software industry in specific regions, on the other, we analyze how in each SRSI the software firms evolve and can increase their absorptive capacity starting suitable processes of internalization of information and knowledge that exist in the environment, but also that generated in the interaction process. We suggest that each SRSI has different nature and level of interaction among the agents, and their specific configuration has an effect on the firm's absorptive capacity.

Our main argument is that in order to stimulate innovation and competitiveness in the customized segment of the software industry in Mexican regions, it is crucial the interaction among software firms and other local agents. The firm's absorptive capacity depends on its different interactions with other agents (academics links, user-producer interaction) and learning activities. In a dynamic environment like the software industry, the firms need to identify and absorb information and knowledge that is useful to their requirements and apply them in the best way for new commercial ends. Likewise, in order to remain in the market, to be competitive and to reach new market niches, the software firms need to update their absorptive capacities.

In that sense, this paper contributes to the understanding of SRSI and absorptive capacity' determinants in micro and small-sized software firms that produce customized software in two Mexican regions: Baja California and Guadalajara. We will illustrate it by a mix

methodology: a) statistical analysis based on a survey applied to software firms in the two regions, and b) exploratory multiple-case study, we will include some interviews that support the statistical analysis.

I. Conceptual framework

1.1 Systems approaches

Innovation systems can be defined in a variety of ways: at national, technological, regional or sectoral level. All of them involve the creation, diffusion, and use of knowledge. Systems consist of components, relationships among these, and their characteristics or attributes.

The concept of system and their relation with the region has been developed starting the input/output analysis of Leontief (1941), whom focusing on the flows of goods and services among sectors in the economy at a particular point in time. Some years after, Freeman (1988) introduced the national innovation systems approach, which was further developed by Lundvall (1988 and 1992), and Nelson (1988 and 1993). This framework includes different actors and organizations, primarily in science and technology, as well as the role of technology policy, and not only industries and firms. The analysis is carried out at the national level: R&D activities and the role played by universities, research institutes, government agencies, and government policies are viewed as components of a single national system, and the linkages among these are viewed at the aggregate level; the competition among actors within industries was introduced through Porter's 'diamond' (Porter, 1990).

Drawing on these contributions, Malerba (2002), Breschi and Malerba (1997) and Malerba and Orsenigo (1990) introduced the concept of sectoral systems of innovation based on 'industry' or 'sector', which is based on the idea that different sectors operate under different technological regimes characterized by particular combinations of opportunity and appropriability conditions, degrees of cumulativeness of technological knowledge, and characteristics of the relevant knowledge base. These regimes may change over time,

making the analysis inherently dynamic, focusing on the competitive relationships among firms by explicitly considering the role of the selection environment.

Carlsson (1995 and 1997) focuses on the notion of technological systems. This concept involves market and non-market interaction in three types of network: buyer–supplier (input/output) relationships, problem-solving networks, and informal networks. While there may be considerable overlap between these networks, it is the problem-solving network which really defines both the nature and the boundaries of the system: where do various actors in the system turn for help in solving technical problems? Buyer–supplier linkages are important, the more so the more technical information is transmitted along with the transactions and less so, the more commodity-like the transactions are. Sometimes the most important technical information comes from sources (e.g. universities and research institutes) separate from buyers and sellers. Sometimes the informal, mostly personal, networks established through professional conferences, meetings, publications, etc. are important channels of information gathering and sharing.

1.2 The concept of Sectoral-Regional System of Innovation (SSRI)

Based on the pioneering work of Alfred Marshall (1890), François Perroux (1982), and others, the two last decades of researches on industrial districts and clusters, industrial poles and other agglomeration of productive enterprise have unveiled some of the most important dimensions of the localization of industry (see Breschi and Lissoni, 2001; Martin, 1999; and Meardon, 2001).

Different theoretical currents have converged in the analysis of the relationships between regions and innovation. These currents include the regional systems of innovation approach (Cooke, 1998), the competence theory of the regions (Lawson, 1999) based on the work of Prahalad and Hamel (1990) and Foss *et al* (1996); the clusters approach such as Porter's work (1998, 2001), the learning regions perspective (Asheim, 2000), and the economics of knowledge spillovers with the work of Feldman (1999), and others.

Regional systems of innovation (RSI) are sets of institutions and organizations (innovating firms, universities, research funding agencies, government laboratories and other public bodies), flows of knowledge, personnel, research, and embodied technology that occur within a region (Cooke *et al*, 1998; de la Mothe and Paquet, 1998; Howells, 1998).

The competencies of regions approach was developed by Lawson (1999), and exemplified empirically by Niosi and Bas (2001). In competencies theories, learning is central, and core competencies explain why some regions keep their competitiveness over other regions for decades, if not centuries, in specific industries and technologies. According to Porter (1998, 2000, 2001), clusters are geographically proximate groups of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities. Clusters participants often do not always compete directly among themselves but serve different segments of a large market, or exploit different applications of a given technology. However, they use common suppliers and knowledge sources. This analysis converges with the precedent one in that the frontiers and competitive advantages of the clusters are often unclear, even for many of its economic agents.

Industrial districts have been revisited as learning regions (Asheim, 1996 and 2000). In learning regions, interaction of different kinds, including cooperation and other local user-producer transactions, create synergies that multiply the innovative potential of the diverse organizations of the cluster. Public institutions may be the promoters of such collaboration, but cooperation can otherwise be fostered by the simple interaction of private organizations – such as local users and producers – or by the interaction of private and public entities –i.e. industry/university collaboration-.

In the last ten years economic some studies have tried to demonstrate that knowledge spillovers occur within regions (Feldman, 2000). Spillovers (or externalities) are benefits (or losses) that some organizations spread out to others without using the market mechanism. Knowledge spillovers are usually benefits that some organizations freely receive from the research efforts of other firms. Innovative activity tends to be greater in

regions where knowledge-generating inputs are the greatest, probably because knowledge spillovers are the largest in such regions. Some studies converge on several major issues. First and foremost, they located the region in the centre of learning and innovative processes it is the unit of analysis (but not the sole one) for the understanding of innovation. Second, all of them consider that technological innovation is not the result of the isolated activity of firms or other organizations, but the outcome of interactions among different organizations (users and producers, suppliers and assemblers, university and industry, etc.). Third, all of them believe that industrial innovation is the main driver of economic growth, and that institutions are key determinants of innovation, through their interactive creation of new productive knowledge and related human capital. Fourth, RSI like NSI are open systems, exchanging information and other resources with other, external systems. However, these contributions seldom recognized some major dimensions of RSI or innovative clusters, such as a) industry specificities of regional systems, b) temporal and evolutionary dimensions: the determinants of birth, growth, restructuring and decline of these local agglomerations, and c) absorptive capacity of regions as a variable.

Drawing on these contributions, we build the concept of SRSI, which could be defined as a group of firms and other agents related with a certain sector and established in a specific region; both firms and agents carry out interactions to achieve an appropriate firm's performance and promote the innovation in the sector. We suppose that in each region the SRSI is different and the factors that influence in the absorptive capacity are different so. The SRSI approach shows us that firms do not compete neither learn in an isolated way. In the last years some scholars such as Malerba (2002), Giuliani (2002), Moulaert and Sekia (2003), have revaluated the role that a local, regional or sectoral environment carries out for the development of institutions and firm´s competitiveness and innovation capabilities. So, that literature has considered that a local environment -a group of institutions, local agents, and their interrelations- can achieve processes of collective efficiency, defined as those competitive advantages derived of external economies and combined action of those agents. In this way, the presence of a favorable environment rebounds positively on the local agents, since it diminishes the uncertainty, compensates the weaknesses of the individual

agents, allows learning processes and contributes to the diffusion of knowledge in a sector or productive activity.

Our main argument is that in order to stimulate innovation and competitiveness, in the cases of Baja California and Guadalajara, it is crucial the interaction among software firms and other local agents. However, we should take into account that firm's absorptive capacity depends on its different interactions with other agents (academics links, user-producer interaction) and other learning activities. In a dynamic environment like the software industry firms need to identify and absorb information and knowledge that is useful to their requirements and apply them in the best way to design and develop new commercial ends.

A SRSI has a number of different types of agents: firms, organizations, policy bodies, venture capitalists, etc. However, to evaluate the performance of a system, we have to evaluate each of these agents connected in the entire system, and not as single entities. All parts must be of a certain size and quality in order for the system to function well. Therefore, we focus on the performance of the total system.

1.3 Absorptive Capacity

At the firm level, Cohen and Levithal (1990), Van den Bosch, *et al* (1999, 2002), Lane, *et al* (2002), Lenox and King (2003), Lund Vinding (2004) and others, suggest firms need to internalize information and knowledge that exist in the environment. In base on these scholars, firm's absorptive capacity is defined as the ability to evaluate, assimilate, and apply information and knowledge to commercial ends. They suggest that absorptive capacity depends on mechanisms such as prior related knowledge, learning activities, and interaction among firms and other agents.

Prior related knowledge has important implications for the development of absorptive capacity over time, because "accumulating absorptive capacity in one period will permit its more efficient accumulation in the next…and to exploit any critical external knowledge that

may become available" (Cohen and Levinthal, 1990:136). One of the most comprehensive and well-know contributions about this refers to the accumulation of internal capabilities. But, these scholars argue that internal capabilities and external collaborations are viewed as complementary. And an increased knowledge base will create more opportunities to exploit new technical developments by increasing the ability to internalize and exploit external knowledge (Lun Vinding, 2004:156).

Drawing on Cohen and Levinthal (1990), Van den Bosch et al (1999:551) suggest that the absorptive capacity depends on prior related knowledge, but they argue that absorptive capacity also depends on organizational structures and combinative capabilities, which are associated with a suitable system for processing knowledge (as Lane and Lubatkin, 1998, suggested). They suggest that different organizational forms directly impact on the absorptive capacity because each firm has different functional areas, and each functional design has specific efficiency, scope and flexibility. In this sense, each firm has different means to transfer knowledge inter and intra functional areas, consequently communication structure could be different.

Jones and Crave (2001) analyzed how small-size firms increase their absorptive capacity, particularly through "the way managers mobilize their resources to identify, obtain and utilize [them into] new knowledge." The introduction of new organizational practices, such as 'multi-task scheme into the firms, has helped to a significant improvement of the absorptive capacity. This is particularly important in micro and small-size firms without a Research and Development (R&D) unit. Cohen and Levinthal (1990) also argue that it is necessary to examine structures of communication between 'the organizations and its environment as well as among subunits'.

Drawing on these authors we suggest that the internal and external relationships imply to create new information and knowledge flows. Additionally we argue that external interactions must be considered as a crucial mechanism to increase firm's absorptive capacity in a dynamic technological environment (i. e. Information Technology Industry)

where micro and small-sized firms predominate. Our case study show us that some Mexican software firms are able to internalize specific information and tacit knowledge, but there are other firms that are unable to internalize them, that is to say, some of them have constraints to evaluate, assimilate and apply the information and knowledge to create new products, processes and services.

1.4 Operationalizing the concepts of SRSI and absorptive capacity

Following Cohen and Levinthal (1990), learning and innovation are the two faces of R&D at the firm level. In-house R&D efforts produce internally-generated knowledge, but they also bring external knowledge to the firms, as they update their stock of information in order to create novelty.

SRSI operates under similar conditions. R&D activities within the local area generate both human capital and new knowledge, but also foster the incorporation of externally-generated knowledge into the region. This section tends to disaggregate this learning process into what we consider its main components are: human capital, organizations and institutions, and investments.

Human capital. The basic component of learning and innovation is human capital, which is made of skills and knowledge embodied in the labor force; in operational terms it is usually defined as the aggregate number of years of formal education within a population. Education is a particular kind of investment. It is an investment in learning activities, which may be undertaken by individuals or by the state, due to the fact that education has important positive externalities that spread in the region and the nation. All learning processes are first and foremost individual human learning. Without human capital there may be no absorptive capacity at the level of the firm, the region and the nation. Thus, training and higher education institutions, as well as the capacity to attract human capital from other areas, are key elements of the absorptive capacity in the region.

Organizations and institutions. Learning is more complex than simply a process of human capital investment and individual education. Knowledge is most often created, stocked, and diffused within organizations; this process occurs within institutional rules of the game and incentives. Thus regions, as well as firms, may favor (or limit) collective learning processes. SRSI are made of institutions (rules of the game, including public policy, regulations, incentives) and organizations (innovating firms, universities, government laboratories, venture capital) with their routines. Institutions may favor innovation by giving incentives to these organizations to conduct R&D or they may put obstacles to these activities. Organizations may or may not contain the proper routines for such collective innovative synergy to take place. Or the region may not contain the necessary organizations that make interactions viable and growing, such as venture capital firms and research universities in the appropriated areas.

Investments. Local R&D expenditures are key elements of the SRSI. They do not only increase learning capabilities but they also increase transformation and exploitation of useful knowledge by local firms. However, in order to increase the absorptive capacity of firms these R&D activities should be in line with the institutions and organizations that represent the core competencies of the region. Not all R&D activities thus increase the absorptive capacity of the fims, but only those that are complementary with the other pieces of the SRSI.

We argue in favor of SRSI because: a) Regional Systems of Innovation are industry specific, b) innovation systems vary from one industry to the other, c) human capital, institutions and organizations create, diffuse and stock industry-specific knowledge, and d) knowledge externalities are industry-specific as well (Breschi, 2000; Swan *et al*, 1998; Niosi and Bas, 2001). The proper mix of organizations, human capital and institutions is industry-specific.

To approach the concept of absorptive capacity we suggest five analytical categories: a) learning activities; b) academic and entrepreneurial linkages; c) organizational structure; d)

leader's experience, leader's formation, and firm's experiences, and e) quality and worker's competences.

SRSI are made up of components and relationships

Components are the operating parts of a system. They can be of a variety of types: actors or organizations such as individuals, business firms, banks, universities, research institutes, and public policy agencies (or parts or groups of each).

Relationships are the links between the components. The properties and behavior of each component influence the properties and behavior of the set as a whole. At the same time, each component depends upon the properties and behavior of at least one other component in the set. Because of this interdependence, the components cannot be divided into independent subsets; the system is more than the sum of its parts. Also, if a component is removed from a system or if its characteristics change, the other artifacts in the system will alter characteristics accordingly, and the relationships among them may also change, provided that the system is robust. A non-robust system would simply collapse if an essential component were removed. Thus, a function (say venture capital finance), which is carried out by a particular set of actors in specific forms, may be carried out by another set of actors and under different arrangements in a similar system at a different time or in a different place.

Relationships involve market as well as non-market links. Feedback (interaction) is what makes systems dynamic; without such feedback, the system is static. Put differently, the greater the interaction among the components of a system, the more dynamic it is. But even a highly dynamic system may not be able to survive, unless it evolves in the right direction. One result of interaction (feedback) among actors is that capabilities change and increase over time, and therefore, the system configuration also changes.

Attributes are the properties of the components and the relationships between them; they characterize the system. "Because the components of a technological system interact, their characteristics derive from the system" (Hughes, 1987). In other words, the features, which are crucial for understanding the system, are related to the function or purpose served by the system, as well as the dimensions in which it is analyzed. The function of an innovation system is to generate, diffuse, and utilize technology. Thus, the main features of the system are the capabilities (together representing economic competence) of the actors to generate, diffuse, and utilize technologies (physical artifacts as well as technical know-how) that have economic value.

2. Mexican Software industry: industrial structure.

In Mexico, the software industry is in process of development and growth. The Information Technology and Communication Industry (ITC) represents 1.4% of the GDP,[3] reaching the place 19 worldwide, while that percentage represents in average 4.3% in the countries of the Europe Union and 5.5% in U.S.A. (SE, 2005[4]). This gap is high in the software industry, which contributes with 0.1% in the GDP (SE, 2005), it is 6 times lower than the world average and 9 times lower than the U.S.A. In Latin-American, Mexico ranks second in all sectors of ITC, after Brazil (Mochi, 2006).

During the period of 1992 to 2003 the Manufactured Software industry participated with 7.7% annual average in the total production of Information Technology Industry (IT), while the IT Services industry participated with 22%, Hardware industry with 40.7%, and others with the rest.

Next table shows different segments of the Mexican software industry. Package software represents 29.4% of total software; customized software just represents 8.0%, and own production and consumption 62.6% (segment C). If government agencies and large firms hire independent software firms, the demand of customized software reached about 70.6%

[3] Gross Domestic Product.
[4] Council Economy: www.Software.net.mx, official site of the Mexican software industry.

of total industry. This will be possible if software firms have technological capabilities to offer solutions to specific problems from the government agencies and manufacture firms, and if these agents decide to leave out producing it themselves and hire it to independent software firms.

Table 1. Participation by software segment, and sectors of demand, 2005

Type of segment	Production/ Development (mdd)	Participation rate	Sectors of demand (in order of importance)
(A) Package software	817	29.4%	Services, Government, Financial, Retail Services, and Manufacture.
(B) Customized Software	221	8.0%	Services (financial, insurance, education, transportation, health, culture), Government, Industry (manufacture y mining, etc.), and Retail Services.
(C) Own production and consumption	1,738	62.6%	Government and Manufacture.
Total	**2,776**	**100%**	**-**

Source: Own elaboration, based on Mochi (2006).

The demand of products and services is concentrated in the retail services, financial, electronic and automotive industries, the major users are medium and large enterprises leaving out the small and medium-size firms.

Despite the fact that there is a policy of promoting the software industry (PROSOFT[5]) the export activity is low. In 2005, exports of customized software were 164 million of dollars, which represents 74% of that segment, but if we consider both segments, A plus B, it represents just 16%.

[5] Program for the Development of Software Industry (PROSOFT). This Program has two strategies. The first one is consolidate the domestic market by creating skilled human resources, improve ITC infrastructure, as well as stimulate the demand for software from government procurement. The second one is to increase exports capacity.

There are not real data about software industry. Scholars and policy makers speculate that there are between 1000 and 1500 firms. AMITI (2001) and González (2006) realized studies in different years and they found that 87% are micro and small-sized firms with less than 30 employees in average, in other words, the industrial structure is atomistic. Many of them offer at the same time consulting services (IT services), selling packaged software or developing software.

3. Research Methodology

The research strategy is based on a mix methodology, including quantitative and qualitative approaches. On the one hand, we use data obtained through a survey applied during 2007 to 83 software firms in two regions: Baja California (30 firms), which is located in the north of Mexico; and the Metropolitan Area of Guadalajara (MAG) (53 firms)[6], which is located in the occident of this country. We use the technique of multivaried analysis, which allows us to obtain the factors that determine the firm´s absorptive capacity in both regions, as well as to measure their importance. Each case is analyzed under the perspective of Sectoral-Regional System of Innovation. On the other hand, we use exploratory multiple-case study to understand better the problem. Considering this qualitative methodology, the cases studied were micro and small-sized software firms that develop and design customized-software. The unit of analysis refers to the set of companies that develop software. We interviewed project leaders and software developers in two software firms. The fieldwork was carried out between April-2005 and March-2007.

3.1 Identifying the actors in each SRSI.

To map the SRSI information on local agents was also gathered through semi-structured interviews. There are four types of agents: (a) universities and technical education schools; (b) public research centers; (c) local government agencies; (d) industrial associations and other private organizations.

[6] Surveys are part of the investigaction project "SMEs: nets of knowledge, innovative activities and local development" financed by National Council of Science and Technology-Mexico (CONACYT, C02-45550).

The so-called 'snowball method' was used to know more about each SRSI. This method implies that each actor is asked to point to further participants. The method assumes that the firms or other actors are aware of at least some other actors who master the specific technology area.

The first step was to identify actors in software industry in each region and consult industrial associations too. Later on, interviews with these actors and associations pointed to further actors (researchers, organizations), which in turn were contacted (snow-ball).

3.2 Factor analysis

We performed factor analysis to extract factors from the scale of each construct (name of each factor). Bartlett´s Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy were employed first to test the appropriateness of the data for factor analysis. Eigen-values larger than 1 for Baja California and 1.2 for the MAG were used to have a comparative number of factors (5). Factor loadings exceeding 0.5 were principles to choose factor.

Baja California		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.709
Bartlett's Test of Sphericity	Approx. Chi-Square	484.249
	Df	171
	Sig.	.000

MAG		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.612
Bartlett's Test of Sphericity	Approx. Chi-Square	458.244
	Df	171
	Sig.	.000

Table 2. Total variance explained Baja California

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.831	46.479	46.479	8.831	46.479	46.479	8.132	42.799	42.799
2	2.015	10.605	57.085	2.015	10.605	57.085	2.285	12.025	54.824
3	1.742	9.166	66.251	1.742	9.166	66.251	1.848	9.724	64.548
4	1.566	8.241	74.492	1.566	8.241	74.492	1.601	8.427	72.975
5	1.304	6.861	81.352	1.304	6.861	81.352	1.592	8.378	81.352
6	.915	4.818	86.170						
7	.547	2.879	89.049						
8	.423	2.225	91.274						
9	.413	2.174	93.448						
10	.285	1.497	94.945						
11	.239	1.260	96.205						
12	.186	.977	97.182						
13	.152	.798	97.981						
14	.111	.586	98.566						
15	.095	.502	99.068						
16	.084	.443	99.511						
17	.045	.234	99.745						
18	.030	.158	99.903						
19	.018	.097	100.000						

Table 3. Total variance explained MAG

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.956	26.082	26.082	4.956	26.082	26.082	4.508	23.725	23.725
2	2.249	11.834	37.916	2.249	11.834	37.916	2.179	11.467	35.192
3	1.900	10.001	47.917	1.900	10.001	47.917	2.016	10.612	45.804
4	1.601	8.428	56.345	1.601	8.428	56.345	1.668	8.780	54.584
5	1.324	6.968	63.314	1.324	6.968	63.314	1.659	8.729	63.314
6	1.241	6.531	69.845						
7	1.021	5.372	75.217						
8	.831	4.373	79.590						
9	.780	4.105	83.695						
10	.645	3.394	87.089						
11	.528	2.778	89.867						
12	.484	2.547	92.414						
13	.358	1.884	94.298						
14	.322	1.696	95.994						
15	.249	1.309	97.304						
16	.200	1.054	98.358						
17	.133	.702	99.060						
18	.102	.535	99.595						
19	.077	.405	100.000						

3.3 The SRSI cases

We studied two regions, the Metropolitan Area of Guadalajara (MAG) in central Mexico, and Baja California (four cities in this region: Ensenada, Mexicali, Rosarito and Tijuana)

close to the border between Mexico and the United States. From the existing literature, it became evident these two regions had different characteristics relevant for this research: the integration of firms in a cluster, their interactions with universities and other local organizations, the complexity of process and product technologies, among other features. The following sections describe the main findings.

Figure 1.
Two SRSI, Guadalajara and Baja California

4. Principal Findings

Conditions that allowed the emergence of the software sector in Baja California and MAG, and factors that sustain their competitive and innovation capacity along the time, are related to the existence of interactions and alliances among software firms, and among software firms and local institutions. It is considered that in the regions, as socially built spaces, the

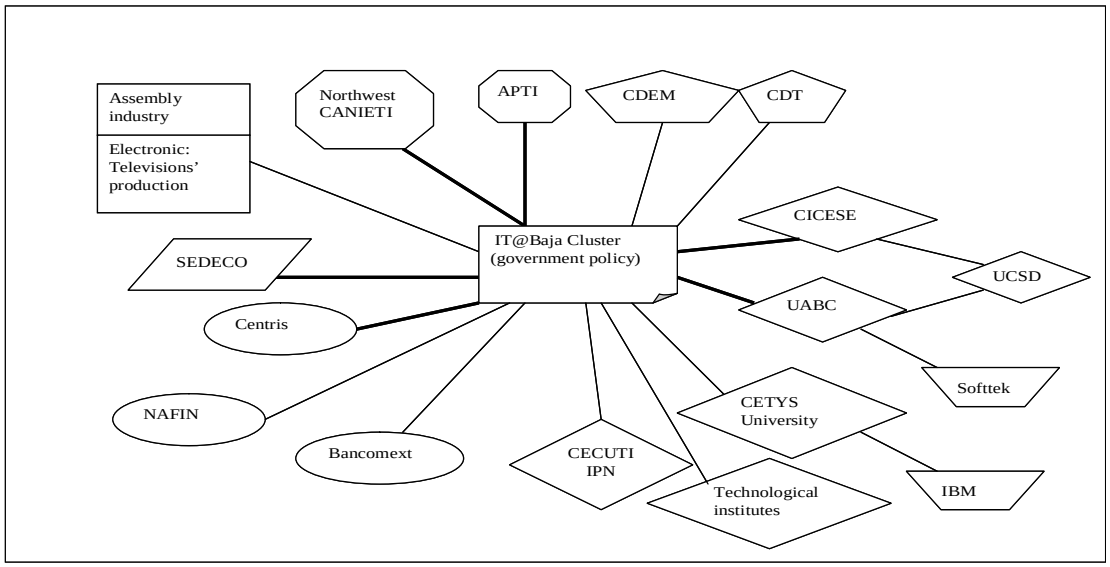
competitive advantages are incubated and developed by means of the use of a series of intangible resources that, when they are specific, give advantages to these in comparison with other territories (Hualde and Gomis, 2004).

It is necessary to understand that high technology industry development, like software industry, necessarily supposes the development of integration forms among firms, as well as technology generators and users. Sophistication, complexity and the growing diversity of knowledge areas that include an information technology are opposed with firm necessities for specializing and being able to dominate competitive technologies. It is very difficult for a firm support in an isolated way the increase of their costs and their specialized human resources demand, therefore it is necessary a new integration dynamics and a new relationship among firms, as well as among firms and the support institutions.

4.1 Main links of the SRSIs

Figures 2 and 3 and tables 4 and 5 describe the main characteristics of each SRSI, they show organizations and institutions that conforms each SRSI. By means of the participants and their relationships we can analyze the operation of the system like a whole and understand the role that each agent plays in the development of the SRSI. In the same way, the operation of each SRSI allows to understand the different dynamics that are generated in each region. When analyzing the complete system we can see the role that plays this in the the creation and development of the software firms' absorptive capacity.

Figure 2. Main links of the Baja California's SRSI



Source: Own elaboration.

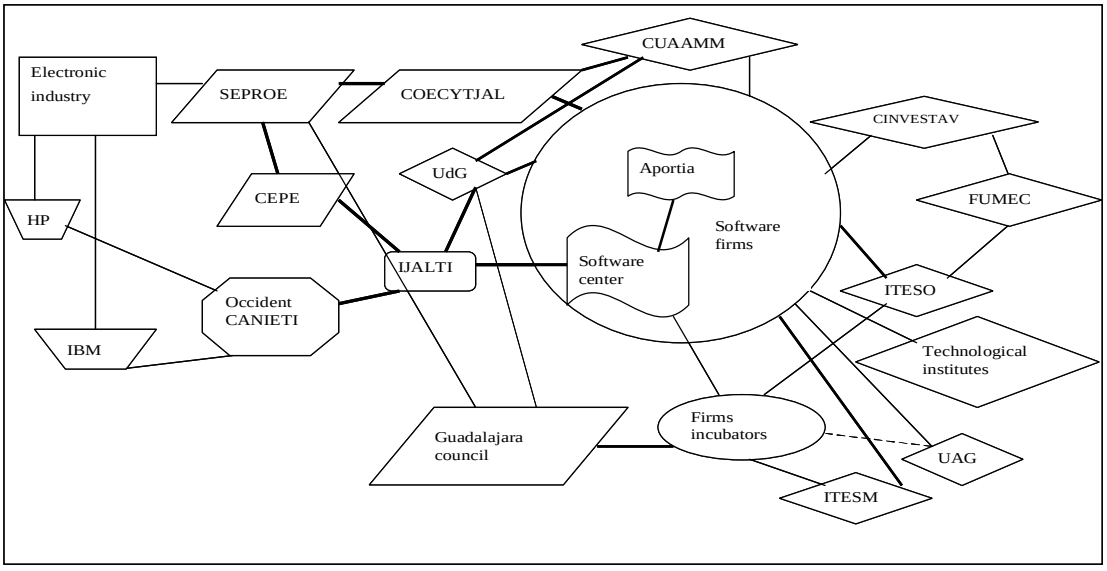
Table 4. Characteristics of Baja California's SRSI

Institutions and agents	Principal functions
IT@Baja cluster	Information Technologies Cluster of Baja California (IT@baja) arises in 2004, it is a civil association that has as objective directing the development strategy of information technologies sector in Baja California.
APTI	The Information Technologies Suppliers Association (APTI) tries to motivate the continuous growth of the associates that allows them the benefit of their services in a formal way, regulating and protecting their activities in economic, fiscal and legal terms, to guarantee to the community a good quality in the borrowed services, fomenting through this way the development of the computer culture.
CDEM, CDT	The Council of Economic Development of Mexicali (CDEM) and the Council of Economic Development of Tijuana (CDT) are civil associations that have as objective to increase the economic development of these municipalities, supporting in the most dynamic areas.
CETYS University	Private educational institution that forms human resources related with information technologies, besides offering training in the area.
UCSD	The University of California in San Diego (UCSD) has participated in several combined projects with Mexican institutions to investigate about the clusters in Mexico and San diego.
Softtek	It is one of the most important Mexican firms in the software industry. In Baja California it participated with the installation of the Global Center of Development (CGD). This is a development center that gives service to the market of United States and it links students and professionals to fulfill the work demand in North American. This is a project where federal, state and university funds converge, the UABC participates with infrastructure and students and the company with the contracts of clients.
IBM	Transnational company that created the Center of Technological Excellency in Opened Standards together with CETYS university. This center teaches specialized technologies such as Linux and Java to a select group of students. Later on, an incubation strategy will be developed (as second phase) and development of companies that links the human capital with the regional and international market.

Institutions and agents	Principal functions
CECUTI IPN	Center of Education Continuous -Unit Tijuana- that depends of the National Polytechnic Institute. In the software area it participates offering training to companies of the region.
BANCOMEXT	The Mexican Bank of External Trade (BANCOMEXT) has participated financing projects in the development of the software industry in Baja California.
NAFIN	National Financial (NAFIN), the same as BANCOMEXT, participates as financing organism in the beginnings of the industry of the software of the region.
SEDECO	Secretariat of Economic Development of the State (SEDECO), it has taken charge to promote the software industry through a state plan of clusters promotion.
CANIETI Baja California	The representation of the National Chamber of the Electronic Industry, of Telecommunications and Technologies of the Information (CANIETI) in Baja California. It was during the first two years of the process of formation of the cluster of the institution that impelled and it wrapped up to the companies of software in a direct way and the nearest institution to the same one.
Centris	Centris is a program of the Council of Economic Development of Tijuana, favored partly by the Interamerican Bank of Development. It is a private institution without ends of lucre whose purpose are the creation, development and acceleration of small and medium innovation companies in Baja California in a development mark and transborder integration.
CICESE	The Center of Scientific Investigation and of Superior Education of Ensenada (CICESE) is a public center of education and search. This institution has an area of Sciences of the Calculation in engineering of processes and simulation that it has played a very important paper in the development of the sector in Baja California, not only as creator of human resources, but as promoter of the industry from its beginnings.
Universidad Autónoma de Baja California (UABC)	From the beginning they are trying to adapt their study plans to the potential demand of the software industry in the region by means of the creation of a master in IT.

Source: Own elaboration.

Figure 3. Main links of the MAG's SRSI



Source: Own elaboration.

Table 5. Characteristics of MAG's SRSI

Institutions and agents	Principal functions
CANIETI Occidente	The National Chamber of the Electronic Industry, of Telecommunications and Information Technologies (CANIETI) promotes the development of this sector in a global environment with services of high quality. Their main purpose is to achieve the competitive development of the industry in the region.
IJALTI (Institute Jalisciense of IT) Civil association led by the industry and the Secretariat of Economic Promotion (SEPROE) and supported by the COECYTJAL and the State Council of Economic Promotion (CEPE)	The workspaces of the IJALTI are focused to develop the capacities and competitions of the established local industry, to support the incubation of companies of technological base in the mark of the concept of technological accelerators, to promote the training and certification of human resources jaliscienses together with educational institutions, to foment the technology transfer for the best use IT in the strategic sectors of Jalisco and to promote the access to infrastructure, so much of hardware as of software, to the companies small and middle-sized firms of the State.
Software Center	The Software Center is one of the infrastructure projects for IT, it is the more strong of the country. It is formed thanks to the efforts of the Federal and State governments, as well as of the academy and of the private initiative. It is created on September 28, 2006. It harbors to 33 software firms, which offer 400 employments approximately. It was built and is administered by the IJALTI whose directive advice is compound by the State government, the State Council of Science and Technology of Jalisco, the University of Guadalajara, the CANIETI (National Chamber of the Industry Electronic Telecommunications and IT), and the Institute Jalisciense for the Quality.
Aportia	Aportia is an integrative firm that combined the capacities of 12 firms dedicated to different branches related with the technologies of information. It has capacity of human resources of around 241 developers and testers. It has certifications in CMMI, level 2 and it has been an important promoter of the software industry in Guadalajara.
CINVESTAV Guadalajara	The of the Center of Investigation and Advanced Studies of the I.P.N (Cinvestav), Unit Guadalajara, carries out investigation activities and technological development in electric, electronic engineering and calculation, as well as in the academic environment as in local, national and international productive sectors. It is had master programs and doctorate in sciences. It is an important promoter of the embedded software in the region.
ITESO UAG	The Technological Institute of Superior Studies of West (ITESO) and the Autonomous University of Guadalajara (UAG) have formed human resources that have created software firms in the region. In the same way they contribute with the continuous training in diverse areas related with IT.
COECYTJAL	The State Council of Science and Technology of Jalisco (COECYTJAL) has been fundamental for the promotion and development of the industry of the regional software. It creates a program for the development of the industry. The objective of the program is to increase the software industry and to extend the market of Technologies of Information, Microelectrónica, Multimedia and Aerospace. The support is guided to projects that foment the creation, development, consolidation, viability, productivity, competitiveness and sustentabilidad of the firms of these sectors.
CUAAMM	The University Center of Art, Animation and Multimedia (CUAAMM) is a company that arose with direct support of the COECYTJAL (with the equivalent of venture capital), and it is guided directly to international markets through networks that are had abroad.
Incubators of firms	This model begins with the incubators of the universities. The biggest and important universities in the region have incubators to support companies that are very focused to the technology: Technological institute of Superior Studies of Monterrey, ITESO, University of Guadalajara (UdG) and Autonomous University of Guadalajara (UAG). The City council of Guadalajara also has an incubator in downtown, and it has a building enabled with offices, which offers to a very low price to the venturesome ones to help them, in the same way, the government offers them to participate in the software projects. They give them the appropriate place and in turn way to work.
FUMEC	The United Foundation Mexico-United States for the Science (FUMEC) is taking charge of the study to also determine the state of the embedded software of Jalisco and the capacities

Institutions and agents	Principal functions
	with those that are counted, also it is working by means of the pattern of the road maps: self-driven, biotechnology, consumption goods. Guadalajara is taking as an outburst point the embedded software by the concentration of firms that exist there is in the region.

Source: Own elaboration.

4.2 Absorptive capacity's factors in each SRSI

Factors that impact in absorptive capacity's development in Mexican software industry are related with learning activities - internal or external -, academic linkages, organizational structure, workers' competences and firm's experience, and quality. In the case of Baja California's SRSI, the factors that impact absorptive capacity are the following: learning activities are marked as the most important factor in absorptive capacity, continued by the academic linkages, the organizational structure and the leader's formation occupies the third place in order of importance, in fourth place leader's experiences and firm's experience, in a last factor appears quality and worker's competences. In MAG's SRSI case academic linkages and external learning activities are the most important factor for the absorptive capacity, another important factor in this case is the organizational structure and internal learning activities, entrepreneurial linkages and leader's formation appear here as an important factor, worker's capacities and firm's experience is another important factor, the last factor is the quality and leader's experience. Table 6 shows us those factors in the two Mexican regions.

Table 6. Absorptive capacity's factors in each SRSI

Baja California				
Learning activities	**Academic linkage**	**Organizational structure and leader's formation**	**Leader's experience, and firm's experience**	**Quality and worker's competences**
Learning by means of: - Sales, marketing and client services' area - Investigation and development organization -Consultant companies - Competitors - Virtual nets -Specialized publications	- Links with local universities - Links with local technological institutions - Links with centers of professional training and technical attendance	-Internal organization of the firm - Leader's studies level	-Leader's experience -Firm's experience	-Quality certification - Competition level (ability, formation) of the personnel (of the whole company)

Baja California				
- Congresses and fairs - Use of licenses and programs - Links with clients - Links with Chambers and associations				
Metropolitan Area of Guadalajara				
Academic linkage and external learning activities	**Organizational structure and internal learning activities**	**Entrepreneurial linkage and leader's formation**	**Worker's competences, and firm's experiences**	**Quality and leader's experience**
- Links with local universities - Links with local technological institutions - Links with centers of professional training and technical attendance Learning by means of: -Consultant companies - Competitors - Virtual nets -Specialized publications - Congresses and fairs - Use of licenses and programs	-Internal organization of the firm Learning by means of: - Sales, marketing and client services' area -Investigation and development organization	- Links with clients -Links with Chambers and associations - Leader's studies level	- Competition level (ability, formation) of the personnel (of the whole company) -Firm's experience	-Quality certification -Leader's experience

Source: Own elaboration.

The differences in factors that impact in the creation and development of absorptive capacity can be explained by the differentiated characteristics of each SRSI.

In the case of Baja California's SRSI, learning activities is the major factor that impacts on absorptive capacity, the rol that Northwest CANIETI has played highlights that. CANIETI has been able to unite under oneself objective to competitors firms under the ideology for to be more competitive and for work like a whole. The relationship with external agents has been important also in the sense that the linkages and knowledge that are generated through the interaction between user-producer, competitors and other agents, allow to the firms knowing more about each agent's necessities and this way offer more personalized services with more level of complexity.

With regard to academic linkages is clear the rol that has carried out the CICESE and the UABC in the formation of human resources, but these institutions have also been important promoters in the creation and development of companies of the sector, in certain way it is for that reason that the academic linkages occupies the second place in order of importance like factor. The third factor is related with entrepreneurial linkages, in the sense that many engineers or academics are even partners or proprietors of software firms in the region and, given its formation are able to organize in a better form its company. The importance of the fourth factor can be explained by the learning that have come acquiring managers and workers of the sector through the assembly industry. The last factor has to do with worker´s capacities and quality in the firm. The software firms are forced to implant models and methodologies characteristic of quality software, generally culminated with the obtaining of certifications emitted by international organisms. These certifications are exhibited as sample of the excellence of their productive processes and they understand as a necessary, although not enough mechanism, for the reception of new clients or the maintenance of those already existent.

For the case of SSRI of the MAG, the first component to increase the firm's absorptive capacity is related with academic linkages and learning activities. The academic linkages with local universities are very bound in certain way, with the sector development policy in the region, which gives a lot of importance to incubators model. In the same way, the role that has given the government to the University of Guadalajara inside the Institute Jalisciense of Technologies of information (IJALTI) can help us to understand the reason of the importance of the universities in this region. The most important learning activities are conferences and congresses, specialized publications, learning for interaction with competitors and consultant companies and in certain way, although in a grade not very important, the learning by interacting with virtual networks.

The second factor is related to the organizational structure and the internal learning. A third factor is related to the interaction with clients and chambers and associations, besides the leader's academic formation. It is clear that the Software Center, the integrative APORTIA,

CANIETI, and the government have been important promoters of the industry and in turn, generating means of absorptive capacity in the software industry in this the region. In the same way the leader's academic level impacts in this aspect.

The fourth factor is related to the formation of workers and with the firm's experience. In this factor is important the learning that managers and workers have obtained from other industries of the region such as electronic and manufacture. In this sense, it is necessary to highlight that some firms hire workers that have programming experience obtained in that industries. The creation of training institutions in the region occupies an important role in the formation of workers. Finally, the factors related with the quality and the leader's experiences are those that impact in the firm's absorptive capacity.

4.3 Evidence from case studies

The cases studies are placed in Guadalajara (Dawcons and Innox), both are micro-sized firms. Dawcons began operations in 2001, uses web technology and is focalized on customized software. The users of this firm are located on ITC industry, manufacture industry, government agencies and services firms. At the time of the interviews, this firm had employed 9 software professionals, 6 of whom were engineers, 1 graphic designer, and 2 developers. Innox began operations in 2002, uses PHP language programming and web technology, and it is focalized on customized software. The users of this firm are located on ITC industry, manufacture industry, government agencies and services firms. At the time of the interviews this firm had employed 9 software professionals, 6 of whom were engineers, and 3 developers.

The evidence has show us that firm's projects are particularly about remade software, as well as maintenance of systems that have been installed in the user firm. In our study, the software firms remade software that already exists in the market, but sometimes they design and develop new software. In order to do that, the firms can identify and absorb general and specific information. Next table show us the determinants of the firm's absorptive capacities.

Table 7. Determinants of the firm's absorptive capacity.

Determinant	Firm	
	Dawcons	**Innox**
Learning activities	-Congresses and fairs	-Virtual networks -Congresses and fairs
Academic and entrepreneurial linkages	-Links with clients -Links with Chambers and associations	-Links with clients -Links with Chambers and associations
Organizational structure	-Internal organization of the firm	-Internal organization of the firm
Leader's experience, leader's formation, and firm's experiences, and	-Leader's experience	-Leader's experience
Quality and worker's competences	-Quality certification	-Quality certification

Source: Own elaboration based on interviews.

One of the major *learning activities* among the firms is congresses and fairs, which are the principal means to 'obtain information about the tendency of the market'. Other activity of learning is the virtual networks, which is a means to obtain information and knowledge. Virtual networks are a common means among the firms that use open-software platform. Into the virtual networks developers and 'aware' users can share information and knowledge that is generated in an informal way.

The interaction between software firms and user is the major issue of the *entrepreneurial linkages*. Through the interaction the software firms can identify useful information and knowledge in order to design and develop software programs. Sometimes, the producer can find by codified means the information about the productive and organizational process to develop software program (applications) that the users need. But, the users are also important to obtain the information because of 'they have specific information about their requirements and necessities that the producer can not find easily by codified means'.

In this sense, the user-producer interaction is important because of there is a tacit knowledge that the producer need in order to update or develop software programs. 'A good design of the project is calibrated by the user', and the software program will be efficient if the user-producer interaction is deep.

Into the *academic linkages*, the universities have taken a pro-active role in the interaction process, they have involved in the creation of human resources with specific knowledge. The links with Chambers and associations are other means to increase absorptive capacity. At this respect, APORTIA (integrative firm) has taken a proactive role in order to increase the exportations of software services to United States.

Innox have increased their absorptive capacity of specific information and knowledge. In this case, we found that the producer has prior related and specific knowledge. This firm has systematic processes to transfer and processing knowledge, which permits to register the solutions at technical problems that engineers find in the software projects. For this firm, one of the best mechanisms to internalize specific information and knowledge at individual level is the 'multi-task' scheme in different stages of the project, which represents a type of *organizational structure*.

We found that sometimes the firms are able to identify specific information and knowledge because the leader's projects have a great experience, and in order to design and develop new software programs the firm depends on the ability to internalize specific information and knowledge, and the *leader's experience* is crucial to do that. If well the firms have increase their absorptive capacity, Dawcons have abilities to absorb general information and knowledge, it is to say, information and knowledge about software programs and software tools that have been standardized and that become 'common sense' in the industry, but it has not showed the ability to absorb specific information and knowledge to design and develop new products, process or services.

The last determinant is the *quality* of the software process. Both firms were involved into a certification process to obtain CCMi level 3. This certification allows to the firms to manage the projects in a best way, at this level they have procedurals to coordinate team-works, improve human resources and technical process to measure all firm's activities.

Conclusion

The study show us that the firm's absorptive capacity is determined by different factors related with the dynamics of the sector in each region, with the emergence and development conditions, and with the existence of certain institutions and practices in each region.

The concept of Sectoral-Regional System of Innovation allows us a better understanding for dynamics that are generated in software industry in a specific region, it help us to visualize in a better way the impact from the region characteristics to the software industry development.

The firms we analyzed have increased their absorptive capacity of specific information and knowledge. These firms has systematic processes to transfer and processing knowledge, which permits to register the solutions at technical problems that the engineers find a long the projects. One of the best mechanisms to internalize specific information and knowledge is through user-producer interaction into different stages of the project, which is common among the micro-sized firms.

The user-producer interaction is dynamic but the things changes very quick and Mexican software firms are unable to modify their behavior as the software industry requires. The process to increase the absorptive capacity is crucial to reach that.

The creation of new knowledge expressed into new software programs, processes, and services, has levels of complexity and dynamism. We consider that new knowledge depend on the kind of information and knowledge that software firms can identify in order to design and develop software programs, and at the same time it depends on the mechanism to internalize them.

Finally, the market niches that represent a better opportunity are located in sectors that demand manufacture software and not only administrative software (in which most of

Mexican firms have been focused). The evidence has showed us that the firms have increased their absorptive capacity in order to design and develop new software programs, these programs support the production of goods in other industries such as automotive.

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