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Regional clusters and technological spillover: a Brazilian case study

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Abstract

Clusters are geographic concentrations of interconnected companies and institutions in a particular field and encompass an array of linked industries and other entities important to competition. The present study aims to analyze the phenomena of *technological spillover* concerning to the specific Brazilian high technological cluster in São Carlos, a medium city located in the center of the state of São Paulo - Brazil. Lately this region has been composed by around 100 high technology enterprises, all of them involved in strategic areas: computer; robotics; automation; fine chemicals; electronics; genetics; and new materials. The methodological approach is based on a simple case study.

Key words : clusters; externalities; technological spillover.



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Introduction

The debate concerning the regional clusters of companies and local productive arrangements has gained special prominence in the literature due to the growing importance of this phenomenon relating to the experiences of socioeconomic development of several countries along the last decades. Besides, the largest interest regarding this theme is due to the intensification of the inter-regional competition and its implications, in particular for the situation of the emergent economies (Enright, 1998).

Clusters are geographic concentrations of interconnected companies and institutions in a particular field and encompass an array of linked industries and other entities important to competition. From this concept, it should be inquired what kind of collective efficiencies is sought by the companies of a certain cluster. In some cases, such efficiencies can be directly related to the incidental external economies (externalities already existing in the area, independently of any economic agents' actions), such as offer of specialized labor, access to the source of raw material or even for being close to the great buyers of the local products, as is the case of small and medium size vendors of parts and components to larger companies. In other cases, the economic agents deliberately look for means of cooperation and joint actions, in order to reinforce their competitive capacity, sharing costs and risks and establishing services of collective character. The concept of collective efficiency, in that sense, combines the spontaneous effects (or unplanned) to those that are sought (or planned), and it is defined as the competitive



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advantage derived of the local external economies and of the joint action. These advantages concern mainly the possibility of diffusion of tacit knowledge due to the space proximity among the agents. Marshall's classic approach highlights the easiness of the process of circulation of information within a specific cluster of companies by means of their own channels of communication or specialized sources could cause a technology and knowledge overflow. In the literature, this phenomenon is known as a *technological spillover*. The present study aims to analyze the phenomena of *technological spillover* concerning to the specific Brazilian high technological cluster in São Carlos, a medium city located in the center of the state of São Paulo - Brazil. Lately this region has been composed by around 100 high technology enterprises, all of them involved in strategic areas: computer; robotics; automation; fine chemicals; electronics; genetics; and new materials. The methodological approach is based on a simple case study. According to Yin (1998), this case study method has as main characteristic the fact of being generalized to theoretical propositions, and not to populations and universes. The generalization to the theoretical proposition is exactly the subject intended by the work, which makes of the case study the ideal instrument to attain the objective.

Externalities (external economies)

In fact, this discussion improves the classical analyses on the industrial districts of England in the late 19th. century, revealed mainly by Alfred Marshall's works (1920), emphasizing the importance of the positive externalities as incentive factors to the geographical concentration of a



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group of producers. These analyses point out the externality concept as benefits gains for the productive units, which are formed due to the expansion of an industry or of an industrial section. Benefits are gained by an industry, when the area in which it has good infrastructure and highway nets, labor qualified in readiness, offer of raw materials and close location to the consuming markets. The existence of those resources decisively influences the reduction in production costs and provides industrial expansion in general. For example: The existence of a tannery in a given area stimulates the construction of footwear and leather goods factories in its surroundings.

According to Brito (2003), the externalities can be classified into 4 different categories:

Technical Externalities: from the technical point of view, the interdependence among the agents results in modifications in the characteristics of the respective production functions.

Pecuniary Externalities: changes in the relative prices of the factors and modifications of the cost structures of the companies.

Technological Externalities: the effects of the spillovers that result in changes in the adoption of a specific innovation and the rhythm of its diffusion in a certain market.

Demand Externalities: situations in which the demand of goods offered by each unit is affected by modifications in the demand of other units or in which an individual consumer's demand is influenced by the joint demand of the same product.

From this concept, it should be inquired what kind of collective efficiencies is sought by the companies of a certain cluster. In some cases, such efficiencies can be directly related to the incidental external economies (externalities already existing in the area, independently of any



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economic agents' actions), such as offer of specialized labor, access to the source of raw material or even for being close to the great buyers of the local products, as is the case of small and medium size vendors of parts and components to larger companies. In other cases, the economic agents deliberately look for means of cooperation and joint actions, in order to reinforce their competitive capacity, sharing costs and risks and establishing services of collective character. The concept of collective efficiency, in that sense, combines the spontaneous effects (or unplanned) to those that are sought (or planned), and it is defined as the competitive advantage derived of the local external economies and of the joint action.

In this sense, it is essential to focus not only on the effects of external economies, but also on the interactions between companies and the cooperation forms among them. However, as mentioned by Altenburg and Meyer-Stamer (1999), "given the complexity of interaction patterns in clusters, [...] it is impossible to formulate a precise definition of cluster or to establish a clear separation between pure agglomeration and complex clusters, with strong externalities". In spite of that difficulty, the same authors formulate an operational definition of clusters based on measurable variables: "A cluster is a gathering of considerable size of firms in a geographic area defined with clear specialization profile and in which the trade and the specialization inter-firms are substantial".

In synthesis, in a lot of situations, geographical proximity of producers belonging to the same productive chain can facilitate the generation and dissemination of important knowledge processes and for the occurrence of the collective efficiencies (Schimtz, 1989) and not just the



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economic actors' individual efficiencies. The economic actors' proximity can also generate positive impacts in the process of sustained development of a specific region. Especially, the presence of universities, technical schools and research centers/institutes provides larger access to the differentiated knowledge of scientific and technological base. In this way, a lot of derived advantages can be observed in such agglomerations and inter-organizational interactions for the small and medium-size companies. These advantages concern mainly the possibility of diffusion of tacit knowledge due to the space proximity among the agents. Logically, these possibilities depend on the social context and the specificities of institutions in a given place. Such a tacit knowledge allows, as well observed by Alfred Marshall (1842-1924) almost one century before, that *"the secrets of the companies stop being secrets and end up hovering in the air, so that even children can learn without being aware of it"*. Marshall's classic sentence highlights the easiness of the process of circulation of information within a specific cluster of companies by means of their own channels of communication or specialized sources could cause a technology and knowledge overflow. In the literature, this phenomenon is known as a *technological spillover*.

Constituent elements of a cluster

On the other hand, a series of constituent elements can be found within a cluster that reflect the economic agents' own potential competitive bus: social rules, traditions and habits that are singular to the local system (the "informal" institutions). The existence of an elaborated net of



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institutions facilitates knowledge diffusion and innovation, contributing to the increment of the competitive capacity of the producer agglomerations.

Besides the presence of related local external economies, the market size, concentration of specialized labor, technological spillovers and other factors that favor local specialization, some characteristics are present in the clusters. The most important can be summarized as follows. The local companies usually interact sharing systems of production, trade and distribution. They also cooperate in marketing, promotion of exports, supply of essential inputs, P & D activities and others (Suzigan, 2001).

However, it is necessary to specify that types of joint actions or cooperation initiatives the local agents develop and their frequency. Among them, the following can be pointed out:

1. Joint purchases of inputs.
2. Joint participation in fairs and exhibitions (national and international).
3. Shared strategies of commercialization, such as brand, advertising, distribution channels, forces of sales, among others.
4. Sharing of facilities, as manufacturing units and laboratories for essays and certification.
5. Accomplishment of services groups, such as market research, provision of information.
6. Participation in "export consortia"
7. Establishment of technical schools and research centers for forming and qualifying the workforce.



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Actually, it could be said that the balance between competition and cooperation is being sought. The local companies can benefit from the support of local institutions, many times commanded by local leaderships that usually coordinate private and public actions. Thus, the companies try to cooperate in areas in which they would have difficulties in acting separately, the so-called pre-competitive "areas". The producers share the costs and risks of those decisions and they benefit collectively from the access to those goods and services, that a lot of times can exercise a decisive role in the managerial competition process.

In an inclusive way, the concept of groupings (cluster) or local productive arrangements can be understood as the sectorial and geographical concentration of companies necessary to identify a series of inherent characteristics to the clusters, inter-dependent of their performance niche, of the product type or service provided. Among the several characteristics, the most important is the gain of collective efficiency, understood as the competitive advantage derived from the local external economies and from the joint action (Enright, 1994; Humphrey and Schmitz, 1995; Porter, 1998; Altemburg and Meyer-Stamer, 1999).

It is important to stress that clusters are only formed when both sectorial and geographical aspects are concentrated. Otherwise, they are just production organizations in disperse sections and geography, therefore not forming a cluster. In the latter case, the scope for work division and scale economy is small. In contrast, in the case of a cluster, there is a wide scope for division of tasks among companies, as well as for specialization and for innovation, essential elements for



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competition besides local markets. In this case, also, there is a significant space for the joint action of companies belonging to a cluster, which fails to happen in dispersed systems.

What is observed in practice, however, it is that there is great difficulty in characterizing a cluster, since the productive systems can not always be clearly separated into dispersed or agglomerate (clustered) categories. The limits between these categories are not always clear, and, in some cases, there can be a mix of the two ways. It is important to highlight that this difficulty does not at all alter the essential fact that the gathering brings gains in collective efficiency that separate producers can rarely attain.

On the other hand, these gains in efficiency do not necessarily result from the existence of a cluster. A group of companies producing similar products in a same area constitutes a cluster; even so, these sectorial and geography concentrations bring few benefits. The collective efficiency should be understood as the result of internal processes of the relationships inter-firms. The clusters are not necessarily formed just by an industry type; however, they generally concentrate only an industrial sector, receiving, for this reason, critics related to its vulnerability in the regional economy, tends in view the challenge for the need of permanent modernization faced to the constant technological innovations, non characteristic phenomenon of diversified areas.

On the other hand, the clusters can respond to crises and opportunities in a more dynamic way, once its specialties can be reorganized in new processes.



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In the vision of the Regional Economy School that it looks for entails between the economic geography and the industrial performance there is a strong tendency in the contemporary capitalism towards dense located clusters. "Those clusters are constituted as intensive regional economies in transaction that, in turn, are connected by interdependent structures that are spread throughout the whole globe" (Scott, 1998). Still under this focus, extra-market coordination and public policies are essential in the construction of located competitive advantages. Here also it is worth pointing out that this type of public policies is, road-of-rule, more wanted for the promotion of a local productive cluster: Fiscal incentives; investments in urban infrastructure and construction of public equipment (highways, airports, concession of lands, paving, connection to the energy grid, telephone lines, etc...).

On the other hand, the technological-based clusters constituted another kind of studies regarding the agglomerates of companies. Under the focus of the Innovation Economy, the geographical proximity of a group of companies with universities, R & D centers, technical schools and other specialized agents constitute a strategic factor in knowledge generation and diffusion processes, greatly contributing to the business of the cluster. This phenomenon can also cause knowledge spillovers.



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Methodological approach

The methodological approach is based on a simple case study. According to Yin (1998), this case study method has as main characteristic the fact of being generalized to theoretical propositions, and not to populations and universes. The generalization to the theoretical proposition is exactly the subject intended by the work, which makes of the case study the ideal instrument to attain the objective.

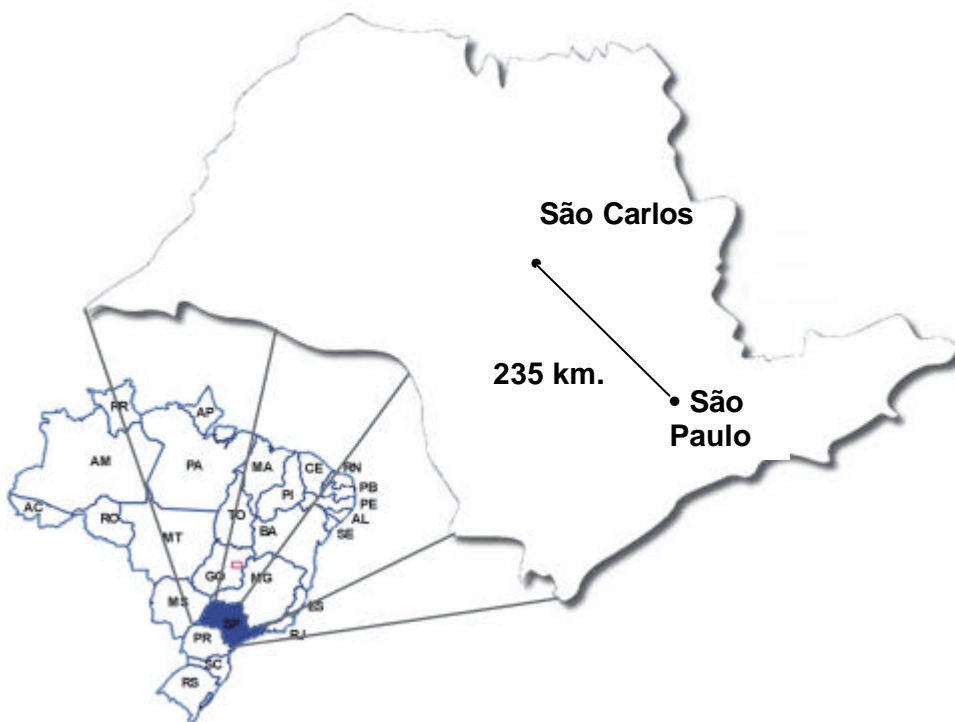
The "cluster" of optical instruments in São Carlos (Brazil)

The city of São Carlos is located approximately 230 km from São Paulo (capital of São Paulo State). It has an estimated population of 218,702 inhabitants (2006 data) and a GDP per capita of U.S. \$ 13,734.00 (IBGE / 2005). Its Human Development Index - HDI (0841) is high, occupying the 17th position in the HDI ranking of municipalities of São Paulo state (UNDP 2000).



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Figure 1: Localization of São Carlos cluster



The productive activities developed in the region of São Carlos up to the 1980s focused on the following productive chains: agro-industrial products, mainly citrus and sugar / ethanol sector and the engineering and metallurgical expertise in capital goods for the regional industry, such as for example, cars and durable consumption goods ("white line"). From the 1990s and in recent



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years, there has also been the presence of some multinational companies such as Volkswagen Motors, Electrolux (formerly Climax, belonging to the local business group “Indústrias Pereira Lopes-IPL” up to the 1990s) (De Lorenzo and Sacomano, 2003).

The city of San Carlos presents a remarkable peculiarity in relation to cities of the same size in the State of SP, because of the presence of two public universities (University of São Paulo – USP – and Federal University of São Carlos – UFSCar), which additionally house a large number of units from different areas of knowledge, several of them in the exact sciences and technology (engineering). There are several research groups with nationally and internationally acknowledged excellence, which caused the emergence of dozens of technology-based companies, through the overflow of knowledge (spillovers), over the past decades. There are 2 units of the Brazilian Agricultural Research Corporation (EMBRAPA), which congregates dozens of researchers in the area.

According Sacomano and De Lorenzo (2003), this technological vocation has been markedly enhanced because the High Technology Foundation Park of San Carlos (ParqTec) was created in 1985, supported in three main areas: 1.) Local competence in science and technology created especially in two major local universities, University of São Paulo (USP) and Federal University of São Carlos (UFSCar); 2.) small technology-based companies; 3.) the entrepreneurial culture and an "industrial atmosphere in the region, that since the 1950s were notable for their significant role in the Sao Paulo industrial production, especially in metal-mechanical industries, metallurgy, electrical equipment and telecommunication equipment.



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During the early 2000, the region had new industrial investments, specially a new plant of the Brazilian Aeronautics Company EMBRAER, located in the city of Gavião Peixoto (about 40 km from São Carlos) and a aircraft maintenance unit of TAM-air line company. It is also important to point out the creation of a course in Aeronautical Engineering in the campus of the School of Engineering of São Carlos / USP, in the early 2000.

In recent years, actions aimed at creating and strengthening technology-based companies showed up, too, through various initiatives sponsored by the local, state and national governments. Currently, the High Technology Park consists of approximately 100 companies involved in all these key areas: computer, robotics, automation, chemicals, electronics, genetics, and new materials. Furthermore, contacts are also launching a new real estate venture which requires the installation of a second technology park.

All this movement of recent years indicates a clear trend to consolidate the city and region of São Carlos as a unique center of generation and dissemination of knowledge based on science and technology.

Specially the optical sector is relatively new in this region and it is composed of small companies formed from the Optics Group of the Institute of Physics of São Carlos / USP. In fact they can be considered spillovers of this excellence in research center.

There are about 25 companies, most of them small and newly established (over the last decade). The biggest one is *Opto Electronics*, that was created in the 80s and employs approximately 320 employees (March 2007). There are other 5 medium size companies with about 60 employees,



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most of them with high educational degree. Together such companies bill about \$ 54 million (March 2007). In synthesis this could be considered an “emergent cluster”.

The main strengths, weaknesses, opportunities and threats in light of this optical cluster in São Carlos are shown below:

Strengths

- Strong ties with the excellent research institutes;
- Highly innovative and knowledge-intensive (C & T) cluster;
- Region privileged in infrastructure;
- Presence of quality educational institutions (all levels);
- Region with high quality of life.

Weaknesses

- Low level of production;
- Financial dependency (need for venture-capital);
- Poorly developed processes.

Opportunities

- New Business (new applications of this scientific branch);
- Explore external markets;



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- Attracting venture capital;
- Search for new lines of funding (National Bank for Social and Economic Development – BNDES, eg).

Threats

- High risk to be dealing with new technologies;
- Loss of business due to lack of investment.

Final remarks

The phenomenon of industrial agglomerations (clusters) composed by technology-based firms created from the phenomenon of technological spillover has grown in many parts of the world and especially in developing countries. In the case of Brazil experiences are still incipient. The case of the Optical Cluster of São Carlos city could be considered a good example to prove the convergence of private and public initiatives, efforts and investments in order to create small businesses that produce various types of goods of optical technology. Besides the sources of scientific and technological knowledge coming from universities and research centers, there is also the presence of private institutions and local government that perform a lot of joint actions and provide conditions (infrastructure, for example) for the development of that high-tech cluster.



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