
# Heterogeneity in local systems of innovation: evidence from Argentinean manufacturing SMEs.

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**Resumo/Resumen**

In this paper we show that the existence of heterogeneity within the national innovation systems (NIS) in productive performance is associated with different innovative trajectories. We will argue that the interaction between co-localized organizations leads to differentiated productive dynamics, and because of that the NIS approach has to be complemented with other concepts –such as the local innovation system one- which allow capturing the subsystems' heterogeneity and divergence. We suggest that the integration of both approaches is key to understanding the dynamics of innovation systems and sub - systems account the strong heterogeneity between firms, regions and sectors , especially in developing countries.

In the special case of SME´s in Argentina we highlight particularly a high heterogeneity in productivity between sectors and geographical domains as well as within them. This heterogeneity in turn is characterized by its persistence. We also show that there is a correspondence between regions (and sectors) performed more innovation efforts , more and better results obtained show productive performance in terms of total factor productivity and in terms of labor productivity.

Palavras Chaves/Palabras Claves :Local systems of innovation, SME´s, heterogeneity

## Introduction

The objective of this paper is to analyze the existence of heterogeneity within the national innovation systems (NIS) in the matter of productive performance, associated with different innovative trajectories. We will argue that the interaction between co-localized organizations leads to differentiated productive dynamics, and because of that the NIS approach has to be complemented with other concepts –such as the local innovation system one- which allow capturing the subsystems' heterogeneity and divergence.

Since the publication of Schumpeter's main works, innovation is considered as an endogenous variable of capitalism and the driver of the economic development (Schumpeter, 1912, 1942, 1947). Under this view, the National Innovation System (NIS) approach explains the emergence of innovation in the national space as the result of a systemic process of competence building which enhances capabilities of firms and individuals and allows the technological progress as well (Edquist, 2004; Freeman, 1995; Lundvall, 1992; Nelson, 1993). Of course, it is also an analytical tool for explaining the obstacles that this process could face.

In this respect, during the last 20 years, several efforts have been addressed to apply the NIS approach to developing countries, the focus of which is on the importance of the processes of learning and competence building (Edquist, 2001; Nelson and Dahlman, 1995; Viotti, 2002). Some of them derive from cross-country comparisons, and assume underdevelopment is a matter of distances between developed and developing nations in a set of key innovative dimensions (Alburquerque, 1999; CEPAL, 2008; Cimoli, 2005; Godinho et al., 2004; Nelson and Dahlman, 1995; OECD, 2007). Other explanations are based on the idea that underdevelopment is the result of historical economic and institutional instability and a productive structure that is biased towards low-tech and low income-elasticity sectors (Arocena and Sutz, 1999; Cassiolato and Lastre, 2008; Dutrenit et al., 2010; Dutrenit and Katz, 2005; Katz, 2007; Lugones and Suarez, 2010; Porta, 2006; Yoguel and Robert, 2010). From these studies one can conclude that there is a multidimensional gap between developed and developing countries, which is the result of historical processes of disarticulation between the productive sector, knowledge infrastructure, and public policies, together with recurrent cycles of recession followed by unequal growth.

However, the existent analyses based on the NIS approach cannot provide a satisfactory answer to the high level of heterogeneity and divergence in the productive performance of local systems –industrial clusters, industrial districts, local milleau, local system of innovation, learning regions- which constitute two of the most common features of capitalist productive structures (Bellandi, 1989; Boschma, 2004; Boschma and Kloosterman, 2004; Boschma and Lambooy, 1999; Camagni, 1991; Camagni and Capello, 2004; Capello, 1999; Conti, 2004; Lambooy, 1980; Markusen, 1995; Morgan, 1995; Saxenian, 1996; Storper, 2009)(Becatini, 1990; Beccatini and Rullani, 1993; Storper, 1995; Rullani, 2000; Florida, 1995; Asheim and Herstad, 2004).

These two features (heterogeneity and divergence) are more present in developing countries' economies, where sectors and regions with productive performances over and under the media co-exist over long periods of time. In this context, the NIS approach fells short on explaining these heterogeneities and complementary concepts gain explicative power, such is the case of the local systems approach (Albuquerque, 2004; Boscherini et al., 1998; Carrillo et al., 2012; Coraggio, 1987; Fernandez et al., 2008; Gorenstein, 1993; Lastres et al., 2003; Lugones and Sierra, 1999; Meyer-Stamer, 1998; Quintar, 1993; Rearte et al., 1997; Vazquez Barquero, 2000; Yoguel et al., 2009; Yoguel and Boscherini, 2001; Yoguel and Lopez, 2000)

In order to analyze the characteristics of this heterogeneity, we will analyze a set of 1322 Argentinean manufacturing small and medium enterprises (SMEs) for the period 2006-2008 which participated in the Mapa PyME (in English: SME map), which is an industrial database gather by ministry of industry. The novelty of this study lays in the analysis at the local level but from a national perspective. In this direction, in this paper we show that the dispersion in productivity levels, as a proxy for the heterogeneity of the productive performance of local systems can be understood as the result of interactions between co-located firms leading the heterogeneity intra-system is smaller than between-systems. So, the interactions lead to a deepening of the differences between them.

This paper is structured as follows. In the first section, the theoretical framework is presented, where the concept of NIS is analyzed in terms of its historical evolution, potentialities and limitations to account for the intra-system heterogeneity, especially in developing countries. We claim that the concept of local system could complement the NIS concept under a system-subsistems approach which allows to explain the national reality. In section two, the propositions referred to the existence of heterogeneity and divergence between groups of locally and sectorially defined firms are discussed. The methodology used to identify the groups is presented in section three, which is followed by the analysis of the results (section four). Finally, some conclusions are discussed.

## 1. THE NATIONAL INNOVATION SYSTEM APPROACH

The National Innovation System approach derives from Lundvall's (1992), Nelson's (1993) and Freeman's (1987) ideas about innovation as an interactive learning process where knowledge is generated, combined and applied throughout a process of competence building.[1] In its most simple and broad definition, a national innovation system (NIS) is the set of organizations, institutions, and relationships, historically conditioned and nationally rooted, that account for the innovative dynamics of a given environment at a given time, under the assumption that the dynamic of the system will determine the direction and rhythm of the knowledge and capabilities that lead to innovation (Freeman, 1987; Lundvall, 1992, 2009; Nelson, 1993).[2] Given this definition, the evolution of the concept has been guided by the search of conceptual elements to apply it to concrete cases (nations, sectors, regions) in order to identify the strengths and, especially, the obstacles that nations face in the search for innovation and technical change (Albuquerque, 2004; Arocena and Sutz, 1999; Borello et al., 2006; Breschi and Malerba, 1997; Cassiolato and Lastre, 2008; Dutrenit et al., 2010; Dutrenit and Katz, 2005; Edquist and Lundvall, 1993; Gilsing and Nooteboom, 2006; Godinho et al., 2004; Katz, 2007; López, 2003; Lugones and Suarez, 2010; Malerba, 2004; Marin and Arza, 2008; Narula, 2003). In this respect, the analyses mentioned in the introduction represent a good summary of the multiplicity of conceptual and methodological approaches aimed to explain why some nations move forward and why others lag behind. In terms of the methodology, these studies are based on the comparison of different indicators which are assumed to account for the differences between countries which are sometimes combined with a historical perspective where the impact of structural determinants is taken into account. Regarding the results, they all find

[1] In a brief historical review, this approach originates in List's (1841) concept of National Production System, and probably even two centuries earlier, in the mercantilist ideas of Antonio Serra (Reinert and Reinert, 2003). In recent decades, the systemic aspect of these ideas were taken up by Freeman in a report for the OECD in 1982 (Freeman, 1982) and were finally internationally disseminated through the aforementioned work of Lundvall (1992), and through Nelson (1993) and Freeman (1987).

[2] Another author whose work can be included at the origins of the approach is Edquist (2004). This author proposed that the NIS approach should have a more robust theoretic ontology in order to facilitate its empirical application. Lundvall's (2009) response to that was focused on the fact that a theoretical background for the NIS approach can be found in Freeman´s (1974) work, who complemented Schumpeter's work by introducing the role of the demand within the innovation process, and Nelson's (1991) evolutionary theory and his work about interactive learning and the historically-friendly approach to the evolving path of the firm's development.

significant differences in key innovation determinants such as investments in research and development (R&D) and skilled human resources. They also find divergent paths in terms of the main science and technology (S&T) institutions explained by a historical process of disarticulation between them, the productive structure and the public policies.

A great attention has been paid to the limitations of these studies and the possibility of extrapolating their conclusions to all developed and developing counties (Edquist, 2001; Metcalfe and Ramlogan, 2008; Suarez, 2006; Yoguel and Lopez, 2000). In this respects, critics were based on the static perspective adopted to analyze innovation indicators and in the lack of consideration of cultural, social and political determinants, and international relationships, among many other things affecting innovation but not directly measured as such. In this respect, we claim that the critics were mainly addressed to the conceptual and methodological translation of the concept of NIS, which led to the proliferation of alternative empirical approximations aimed to complete the picture. In other terms, critics were focused on how the NIS approach was translated into elements that could be measured rather to a lack of relevance of the concept to address a complex and heterogeneous reality. This worked against the discussion and review of the theoretical foundations of the approach, together with the appearance of alternative perspectives aimed to narrow reality down, such is the case of the concepts of regional, sectorial, local and technological innovation systems (Cassiolato et al., 2000; Malerba, 2004; Malerba and Nelson, 2007).

The scarce attention to the process of market competition and how it impacts on the innovation process is another common element of the NIS literature (Metcalfe and Ramlogan, 2008) In relation this respect, the NIS approach recognizes the iterative nature of innovation, to some extent based on Nelson and Winter's (1982) ideas about interactive learning and routines but also on Kline and Rosenberg's (1989) and their criticisms of the Linear Model of Innovation. Under this conception a firm is a network of routines, subroutines, repertoires and individuals interacting who can transform knowledge into competences. These authors explain the interaction between the supply-push and demand-pull forces and argue that innovation is an iterative process between the development of knowledge, the needs of the market, and the real possibilities of producing goods. From this perspective, innovation could be interpreted as an emergent property of a system with a non-linear logic. However, the role of the competition process in the matter of innovation incentives is an absent element within the approach.

Discussing the concept of NIS, Metcalfe and Ramlogan (2008)differentiate between innovation ecologies -individuals inside organizations that are repositories and generators of the existence and new knowledge-, and the system making connections, which refer to the connections between the components needed to make knowledge to circulate to specifics purposes. From this perspective a division of labour that characterize the production of knowledge can be found in these systems, similar to the ideas stated by Lundvall, Nelson and Freeman. However, they argue that the NIS approach focus mainly on institutional differences when analysing technological and economic performance across countries, which neglects the required complementarities to move from invention to innovation and later to diffusion. Moreover, in spite of considering firms as learning organizations embedded in a broader national institutional set-up, the globalization and the rivalries at the meso level are absent.

In spite the NIS approach stresses the importance of non-market institutions in fostering innovation, the approach misses that the market processes and the innovation systems are mutually embedded. As a result competition among firms is the absent element in understanding the innovation process. Therefore, the fact that innovation is a highly uncertain process that relies on new perceptions of market opportunities as much as in new technologies is not properly accounted for.

As knowledge about market opportunities is key for innovation to happen, a supply oriented theory –such as the NIS approach-, misses half the story. It is within the market - as an instituted process of rules, routines and regulations- that firms take decisions about what to produce and how to combine inputs, capital and human resources. It follows that the performance of the firm within the market is an important element of the innovation process. Therefore, innovation systems have to be studied like the intersection between science and technology and market processes(Metcalfe and Ramlogan, 2008).

The consideration of the characteristics and impacts of micro-heterogeneity is another weak element both in the initial formulations and the subsequent analyses. At the origins of the NIS approach there is the claim that the innovation process depends on the firm's ability and efforts to generate new knowledge, which in turn results from the ability to absorb and recombine external knowledge. The impact of these efforts in learning and improving will be mediated by the firm's ability to absorb and increase knowledge generated elsewhere but also by the firm's capabilities (Nelson, 1991a, b). Since technological progress within the firm is a process with path dependence characteristics that also depends on the firm's ability to identify, develop, and adapt technology, decisions taken today have impact on future decisions, and thus on the path of technological change. The result of these decisions, in turn, determines the accumulation process within the firm and its possibilities for sustaining differential rent (Nelson and Winter, 1982).

The direct consequence of the existence of multiple behaviors is what Lundvall refers as the "variety of the system" (Lundvall (1998) and it explains the fact that no two systems are identical in either morphology or competitive dynamics. However, since the competition process has a secondary role in the explanation of innovation, the concept of variety is not enough to account neither the existent heterogeneity, nor the impact of this heterogeneity on the innovation process at the aggregate level. In this respect, three main issues at the origins of the theoretical formulation of the approach limit its capability to account for heterogeneity.

Firstly, the emphasis of the approach in explaining technological development has led to a bias in the empirical analysis towards explaining firms' innovative dynamic as if, when deciding how to compete, firms most frequently opted for innovation as the means to do so. In this line, there is little explanation of how a firm is able to survive without investing in technological or organizational improvements.

The second limitation is derived from the latter. The Schumpeterian creative destruction process is accepted as part of the approach and firms with lower productivity levels are supposed to disappear from the market. The evidence, however, suggests that in some markets this selection process is weak, which means that markets are made up of firms with different productivity levels (Bottazzi et al., 2010; Salter, 1960). This micro-heterogeneity impacts decisions about the innovation process within the firm. As some less productive firms are also part of the market, the higher profitability levels of the most productive enterprises are not eroded, and so new incentives to innovation cannot appear. As a consequence, the market will be made up of a heterogeneous set of agents, not only in terms of Lundvall's (1992) variety or Nelson's (1991a) skills and behaviors but also in terms of the productivity level.

This brings up a third limitation of the approach: the existence of heterogeneity associated with different levels of productivity determined by different the competition mechanisms, the different institutional set-ups and the different network of organizations that could be find in sub-national systems. In this sense, it seems that the emphasis on the history of the system as a whole has worked against the literature's capability to explain differential reactions and trajectories and the emphasis on the distances in terms of the main available indicators has worked against the dynamic nature of the innovation process which is cause and consequence of a network of co-localized organizations.

In this respect, even when there has been a large body of literature devoted to the definition of alternative sub-national innovation system approaches, there have been few attempts to analyze how they can complement the NIS approach, and even fewer attempts to integrate the partial analyses into a national picture. This is precisely the aim of this paper. The existence of heterogeneity is a constant across the literature and the inclusion of this concept into the NIS approach could shed light on how the partial analyses could complement the national picture and, the other way around, how the national system could be disaggregated and analyzed in terms of sub-national ones.

To a large extent, all these issues are captured by the literature about local innovation (industrial clusters, industrial districts, local milleu, regional systems of innovation, learning regions, among others). In this respect, what we will try to show is that to characterize this heterogeneity based on the local system of innovation approach could improve our understanding of the divergent paths among sectors and regions and that it has to be integrated into the NIS approach when proposing public policy criteria to foster innovation and development.

## 2 HETEROGENEITY, DEVELOPING COUNTRIES AND LOCAL SYSTEMS

The NIS approach explains the differential performance of national economies based on the main institutions and organizations within the national territory and the interactions among them. On the base of empirical evidence from developing countries, several authors (Edquist, 2011; Viotti, 2012) have pointed out that the innovative dynamics of these economies have specific characteristics that require the use of an approach that accounts for the large differences in the capabilities and the performance of institutions and organizations located in various regional areas within each country. In this regard, several efforts were made to adapt the NIS approach to the explanation of the innovative dynamics of these economies. Edquist (2001), for example, has proposed the concept of Systems of Innovation for Development (SID), which is a variant of the general NIS approach that emphasizes developmental features in order to improve its relevance and usefulness. In this variant, diffusion is more important than technological development, process innovations explain more than product innovations, and technological change must be sought in traditional sectors rather than high-tech sectors . In this direction, Viotti (2002) suggest that NIS approach is not appropriate for dealing with the processes of technical change typical of developing countries, which are extremely different from those of industrialized countries. This is so because this process is largely shaped outside the realm of those institutions that are at the core of the innovation (stricto sensu) process. The use of the broad understanding of NIS could still be of little help in dealing with developing economies if the analysis remains based on the kind of notion of innovation that is, in practice, subjacent to the majority of NIS's studies. He proposes the notion of National Learning Systems (NLSs) indicating that the dynamic engine of late industrialization is technological learning, rather than innovation. According to this author, NLSs are prone to follow a technological strategy directed essentially towards the absorption of already existing techniques, and the generation of improvements in the vicinity of acquired techniques. In this sense, learning is considered as the process of technical change achieved by diffusion and incremental innovation.

Despite these efforts, the NIS literature remains limited as it does not allow to account for intra-system heterogeneity, defined at the country level. The general conclusions derived from this approach hides virtuous technological dynamics that can take place at a much smaller scale and can be identified by considering the existence of heterogeneous subsystems with divergent performances.[3] Thus, although the NIS components and relationships are central to understanding the innovative dynamics of firms and to explain the differences between countries in terms of technological dynamism, the scope of this approach is limited to analyze the heterogeneity within the same system, where local factors and institutions that make up the immediate environment in which firms operate play a central role.

From an evolutionary perspective, heterogeneity is not simply a statistical regularity without theoretical interest (Nelson, 1981, 1991b). On the contrary, it is persistent (Bottazzi et al., 2010) and occupies a central place in evolutionary dynamics. The heterogeneity is closely related to the interactions between firms and their environment and this causes differential effect on the construction of technological and organizational competencies -competence building in the sense of Lundvall (1992)-. Within certain "spaces", interactions tend to reduce this heterogeneity without ever completely eliminate it. This means that the heterogeneity between firms from different sectors

[3] In this respect, it is worth noticing that even when more than a decade ago, Freeman (2002) claimed that the coherence of the different subsystems within the national borders was a key element to understand capitalist development, this relationship remained absent in the NIS literature.

and regions is greater than within them. Of course, the heterogeneity within these "spaces" is high, especially in relatively larger regions.

These "spaces" have been studied from different streams of the innovation studies based on the concepts of cluster, industrial district, local mileu, local systems, among others (Boschma and Martin, 2010). The different perspectives share the idea that the agglomeration of productive activities in general and innovation in particular, have been frequently associated with the local presence of relatively immobile factors, such as the institutions and the knowledge embedded in people and organizations that make a local system, including institutions to promotion of innovation (Storper, 2009).

In this context, the firm's productive performance would be determined not only by its innovation efforts and learning processes but also by: (i) the characteristics of the productive and intangible assets, such as the quality of institutions and knowledge (Becattini, 1990; Camagni, 1991)(Belussi, Pilotti, 2001), and (ii) the current interactions between firms of the same production system, socially rooted (socially embedded) (Granovetter, 1985).

Thus, the knowledge generated in the local environment leads to collective learning processes (Capello, 1999; Maskell and Malmberg, 1999) fueled by the knowledge generated within firms, in the interactions between firms and between firms and institutions that are part of the local environment. In this respect, Hirschman (1958) emphasized the nature and meaning of relationships between firms. From his perspective, development requires the mobilization of hidden resources and the public space building. His thinking gave rise several studies focused on qualitative attributes of production systems (Fredriksson and Lindmark, 1979), unequal power relationships within these systems (Coraggio, 1987)(Rofman, 1984; Taylor and Thrift, 1983) and the role of interactions in reducing uncertainties (Storper and Walker, 1989). When production systems are analyzed from the territorial point of view, new concepts emerged such as territorial production complexes (Smith, 1981; Storper and Walker, 1989), clusters (Humphrey and Schmitz, 2000),and territorial circuits of production, circulation and accumulation (Coraggio, 1987; Rofman, 1984), and industrial district" (Markusen, 1995)..[4]. Some authors understood the industrial district as a cognitive laboratory producing spillovers of knowledge related to the public good concept (Bellandi, 1989; Becattini,

[4] . The term "industrial district", originally used by Marshall, refers to the geographical concentration of closely interrelated firms for the purpose of producing certain products. The industrial district idea was later taken up by scholars who emphasized that learning and innovation took place within spatially concentrated production systems (Markusen, 1995).

1990). Other approaches highlighted the importance of the informal sharing of knowledge among economic agents as a source of competences (Camagni, 1991; Capello, 1999; Maskell and Malmberg, 1999), while studies carried out in Silicon Valley and Denmark, Sweden and Norway (Saxenian, 1996) (Dahl, 2002; Power and Lundmark, 2004; Stambol, 2003) have shown that the spread of knowledge resulting from worker mobility within a local system increases collective competences and generates economies that are internal to the industry and external to firms. In terms of the NIS literature, these concepts find their correlate in the notion of regional innovation systems, sectorial innovation systems, and local innovation systems.

In this article we adopt the notion of *local innovation system* (LIS), due to the fact that our main objective is the study of the heterogeneity in terms of productivity and innovation. LIS is understood as the space of interaction among firms and institutions in a common geographical location that includes relationships of both competition and cooperation. These systems are heterogeneous and have very different levels of complexity and, therefore, LIS is a "gradient-type" concept, and not an "ideal type". This means that, a concrete local innovation system may be placed anywhere along a scale of situations ranging from the most virtuos (mature in terms of Lundvall, et al.(2009)), -with significant learning processes, dynamic competitive advantages, high innovative dynamic and high productivity, to the other extreme in which the opposite situation takes place (Yoguel et al., 2009). The adoption of this approach is in line with the stated objective, which aims to analyze the heterogeneity within the system (intra-national) expected to be associated with different innovative dynamics and productivity level of different sub-systems. The dispersion in productivity levels can be considered as a proxy for the heterogeneity of the productive performance of local systems and can be understood as the result of interactions between co-located firms leading to intra-heterogeneity to be smaller than between-systems (Robert, 2013).

There is a large body of literature about the study of local systems both in Argentina (Casalet et al., 2005; Yoguel et al., 2003) (Bisang and others, 2004; Albornoz, Milesi and Yoguel, 2004;),and in other Latin America countries (Lastres et al. (2003) in the case of Brazil, Dutrenit et al, (2009) in the case of Mexico, just to name a few). Most of these works analyze specific cases of co-location of firms, although there are also articles that attempt to compare different systems. The general conclusion of these studies lead to identify a set of stylized facts about local innovation systems in Latin America. Among them, Yoguel, Borello and Erbes (2009) indicate that heterogeneity is a central feature of these systems, linked both to its external features and its particular way of working and managing knowledge. The authors propose that heterogeneity can be acknowledged by means of the analysis of various aspects such as: i) the extension of the system (measured in km2, population, gross product), ii) the public and private actors, iii) the type of institutional architecture (top-down, bottom-up or a combination of both), iv) the intensity of competition, v) the knowledge appropriation level by local actors, and vi) the birth and death rate of enterprises.

In order extract from these analyses a general framework capable of accounting for the national reality several comparability requisites have to be fulfill and this has worked against the integration of the local approaches into a general explanation of the national heterogeneity. This type of research would require mainly the availability of comprehensive and varied information, which in the case of developing countries is usually inexistent. Given this limitation, and although to address all the above factors is not possible, this article seeks to contribute to the discussion of heterogeneity from an aggregated view. The idea is to identify -under one methodology- the different sub-systems in order to make them comparable in terms of productivity and innovation. The underlying assumption (and main motivation) is that the concept of LIS, which has been built from the above mentioned literature, could help to reduce the complexity of the local realities into a comprehensive methodology capable of providing key criteria for public policies aimed to foster growth and development based on local potentialities and constraints.

## 3. DATA AND METHODOLOGY

In this section we present the empirical bases to test for the existence of heterogeneity in terms of productive performance and innovative behavior of SMEs located in different geographical areas in Argentina. We have constructed a micro-database made up of 1377 Argentinean SMEs from different industrial and service sectors. The primary data belongs to the SME Map, based on information collected by the Secretariat of Industry, Trade, and SMEs of the Argentinean Ministry of Economy and Production .

The data collected by the SME Map presents a number of advantages for the study of local systems made up by SMEs. First, it is one of the few panels of micro-data on Argentinean companies that contains information on a wide range of geographic domains (the survey was carry out in more than 300 towns and cities spread across the country). Second, the questionnaire inquires about: (i) the firm's economic evolution (disaggregated revenues and expenditures, capital stock and its depreciation, investments, amount and composition of personnel, payroll, etc.), which allow us to estimate firm level productivity (as valued added per employee as well as total factor productivity); (ii) innovative behavior (innovation efforts and results, novelty of innovations, innovation constraints); (iii) organizational skills (quality assurance, training, qualification of labor, etc.), and (iv) linkages (with institutions promoting innovation [IPIs], their objectives, and sources of information). Third, the sample is regionally and sectorally representative, which allows regions of increased specialization/diversification to be identified. Fourth, it is made up entirely of SMEs, which allows the effect of the interactions mediated by the competitive processes to be limited to companies of the same size that also belong to the same sector and geographic location. We are aware that the reference group defined by sector and region are not local systems (strictu sensu), however they are a good proxy since the variation within these groups tend to be less than among them.

The database was built so as to discard those firms for which observations do not exist for all period 2006-2008, and the following were also eliminated: (i) micro enterprises (companies with fewer than 5 employees), (ii) firms whose aggregate value estimated turned out to be zero or negative, (iii) firms whose aggregate values were found to be outliers[5], and (iv) in the case of models with total factor productivity, firms that did not report data of capital stock for 2006. Those firms that made up reference groups with fewer than four observations also had to be eliminated. In short, the panel was composed of 1377 firms (1233 with data for TFP).

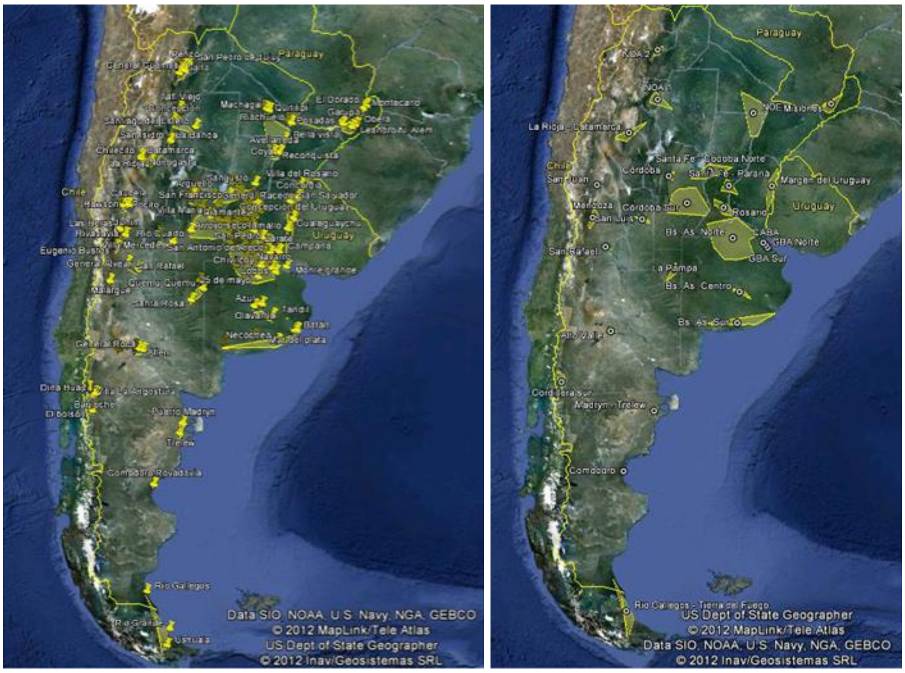
### 3.1 Sectoral and geographical classification criteria

To define sectors, we used two-digit ISIC (International Standard Industrial Classification) categories. Activities predominantly undertaken by large companies (Tobacco and Basic Metals) were dropped. On the other hand, some service activities were considered since the SME Map collects innovation-related information on these (software and information services, communication services, professional services, and medical care services). An ad-hoc definition of geographic domains was made. Firms' locations were identified using their postal code and town or city name. We then proceeded to group these towns and cities following a geographic proximity criterion that

[5] Outliers were defined as those observations that were outside the three standard deviations for the mean, considering firms' distribution by size (into five groups: from 5 to 10 employees, 10 to 30, 30 to 60, 60 to 100, and more than 100) and activity (industry and services).

considers the existence of direct access between the different locations (roads and highways). The result is a classification of 27 geographic areas (see Map 1).

**Map 1. Towns and geographic areas**




Source: Own elaboration based on SME Map.

In summary, the 1377 firms were classified into 18 sectors and 27 geographic domains. Of the 486 possible reference groups, 323 were discarded because they had no observations or because the observations did not reach the minimum level of 4. Thus, the analysis accounts for 163 reference groups.

### 3.2 Indicators

The indicators used in the econometric estimation are concerned with: (i) firms’ productivity level, (ii) firms’ absorptive capacities and linkages, which are used to identify differences within the groups in terms of access to local externalities, and (iii) firms’ innovative behavior.

***Labor productivity and total factor productivity***

Labor productivity ($ProdL$)—value added per employee—and total factor productivity (TFP)—as a residual of the production function (Cobb-Douglas)—were estimated as follows:

$$ProdL_{it} = \frac{VA_{it}}{L_{it}} \quad (3.1)$$

$$PTF_{it} = \frac{VA_{it}}{L_{it}^{\propto(j,t)} . K_{it}^{1-\propto(j,t)}} \quad (3.2)$$

In the case of labor productivity, the firm’s value added per employee was calculated from the available information on firms’ sales, labor costs, and intermediate consumption. All monetary data were deflated by a 3-digit ISIC producer price index.

The estimation of total factor productivity required the estimation of elasticity $\alpha_j$ at industry level (2-digit ISIC code). Each $\alpha_j$ was econometrically estimated, assuming a Cobb-Douglas production function with constant returns to scale.In order to estimate the capital stock per firm, the perpetual inventory methodology was used. According to this, capital stock at *t*+1 is equal to capital stock at *t* plus net investment.

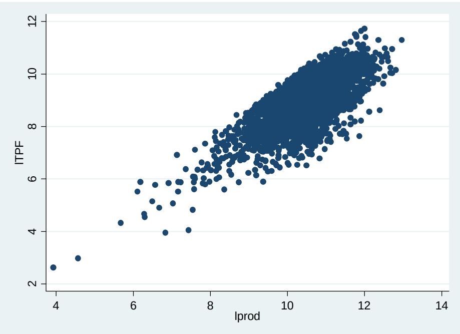
$$K_{t+1} = Kt\ (1-\delta) + I_t \quad (3.3)$$

Both labor productivity and TFP have advantages and disadvantages as proxy estimators of productive performance. The main advantage of labor productivity lies in the fact that it does not require any assumptions to be made regarding the firm’s production function or its returns. However, it can be argued that in a study involving a variety of productive sectors, the disadvantage of labor productivity is that differences in capital intensities or labor force skills between sectors may lead to estimations that are not comparable for firms belonging to different sectors. The greater variance in productivity between sectors may be more a result of the technological characteristics of different sectors than a reflection of different productive performances of individual firms. The greater variance in productivity between firms in different sectors may be due more to each firm’s technological characteristics than a reflection of different productive performances.

With TFP, the incorporation of capital stock enables the effect of different factor intensities among sectors to be corrected, but at a high cost. Including the capital stock implies: (i) estimating these stocks at the firm level, which entails multiple difficulties from the valuation of capital stocks of different ages to estimating their present value considering depreciation and inflation and (ii) making assumptions about the production function and capital-labor substitution at the firm level. Nelson (1981) states that one of the crucial problems of total factor productivity is that interactions between factors cannot be considered within its framework. According to this author, the introduction of new machinery requires a redefinition of workers’ profiles, which brings about simultaneous changes in employee numbers and qualifications. Therefore changes in the capital stock would imply changes in the production function that would be impossible to predict. Thus, the production function becomes too rigid a framework to account for the changes in firms' production processes that originate in their innovative activity.

After considering the arguments presented above both for and against the two indicators, we decided to perform the two estimations and present both sets of results. From an empirical perspective, labor productivity and TFP are strongly correlated.

**Graph 1. Correlation between productivity indicators**




Note: Correlation coefficient = 0.7264. Variables are taken in logs.
Source: Own elaboration based on SME Map.

***Absorptive capacity***

Firms' absorptive capacity is defined as the ability to recognize new information, assimilate it, and apply it (Cohen and Levinthal, 1989, 1990). This capacity allows them to access existing knowledge in the environment, identify useful knowledge, and generate new knowledge from this. In this direction, absorptive capacity is at the center of a theory of knowledge, which emphasizes the integration of internal and external sources of knowledge and complementarity between them (Antonelli, 2008). Firms' absorptive capacity allows localized technological change to be introduced, but it cannot develop automatically and is not distributed equally between organizations. The context in which the organization operates affects the firm's possibilities of developing this capability, but doing so successfully is the result of the firm's efforts to develop (Zahra and George, 2002) (Van den Boch, et al. 1999).

The literature proposes various indicators for absorptive capacity (Zahra and George, 2002). Among these, the degree of training and formal education of workers is one of the most popular. In this paper we propose to estimate the absorptive capacity of firm *i*, belonging to sector *j*, as the percentage of professional and technical staff in total employment at firm *i* over this same percentage at sector level.

$$\text{Cap\_abs}_{i,j} = \frac{prof_{i,j} / total\_employment_{i,j}}{\sum_i^n prof_{i,j} \; / \; \sum_i^n total\_employment_j} \qquad (3.4)$$

***Innovative behavior***

To evaluate the innovative behavior of firms, indicators of both innovation efforts and innovation results were considered. Regarding innovation output, the indicator used is dichotomous and indicates whether each firm reached process or product innovation results during 2006–2008. The literature on the relationship between innovation and productivity tends to agree on the positive effect of process innovation on productive performance. On the other hand, although the situation is more ambiguous, product innovation can also increase value added per worker since it can raise product quality and, therefore, total sales (Bartelsman and Doms, 2000; Crépon et al., 1998; Duguet, 2007; Griliches, 1986; Griliches and Mairesse, 1981; Mairesse and Sassenou, 1991; Nelson, 1981). Moreover, the results of process and product innovations are highly correlated, since the development of new products may involve changes in production processes, while new processes could lead to improvements in product attributes, such as quality. The results indicate that 39% of firms have introduced innovations (be they product or process). In turn, 33% claimed to have introduced process innovations, and 38% product innovations. On the other hand, as anticipated, there is a strong correlation between these variables: 1% of the firms declared only product innovations and 6% process innovations.

Regarding innovation efforts, we considered whether each firm performed activities in the following areas: (i) R&D, (ii) acquisition of machinery associated with new products or processes, (iii) acquisition of licenses and patents, (iv) design, (v) training activities linked to innovation, and (vi) marketing.

***Linkages with IPIs***

With regard to linkages, due to data restrictions, all interactions that firms maintain with IPIs were taken into account, distinguishing between institutions with country-wide and local scopes.

The institutions considered nationwide were: Inti (National Institute of Industrial Technology, aimed at helping firms with technological problems), Sepyme (Secretariat of SMEs, aimed at assisting SMEs in several areas, including investment projects, innovation, quality assurance certification, consultancies, etc), and Fontar (a fund for financing innovation projects that depends on the Ministry of Science, Technology, and Innovation). The local institutions taken into consideration were: consultants, local business chambers, local development agencies (public-private agencies aimed at helping firms solve productive and technological problems), local government (which usually has an industrial development office), and universities.

## 4. STATISTICAL ANALYSIS

The most significant feature of the panel is the high heterogeneity observed. In this section we discuss the main indicators considered in this investigation with special emphasis on heterogeneity of firms between both, sectors and geographical areas, as well as within them. Obviously, composition issues could give rise to differences between these groups –ie, Bahía Blanca region (South of Bs. As. Provice) has a better productivity level because high productivity sectors (i.e. petrochemicals) are agglomerated in it. In order to cope this problem, we look at differences between references groups, defined by firms belonging to the same sector and region. A higher heterogeneity between reference groups than within them, we will interpret as evidence that support the idea that interacions between co-located firms tends to reduce intra-group heterogeneity and increase the heterogeneity between groups in divergent paths.

In this sense, we analyze the sectorial and regional distribution of firms by: (i) size, (ii) productive performance estimated through labor productivity and total factor productivity, (iii) absorption capacity, (iv) innovative behavior and (v) linkages with IPIs. We propose to show the differences between sectors and geographical area in these five dimensions. We use a set of descriptive statistics, including proportions, means and variability coefficients. The strong differences between sectors and regions do not override differences between regions within a particular sector and between sectors within a particular region. We present a set of Anova tables in order to show that size, productivity and absorption capacities levels differs between sector, regions and reference groups. Finally we propose a set of tables that shows the joint distributions of firms and references groups in order to show that high productivity firms tends to be located in high productivity reference group and vice versa. Once more, we will interpret this result as evidence that support the idea that co-located firms tend the have similar productive performance due to interactions between them.

We will stand that is not obvious why, for example, metalmechanical firms located in Córdoba City and surroundings region have systematically better performance than firms belonging to the same sector but located in Northeast of the country. In this regard the empirical evidence presented in this section is associated with the idea that there are local systems in which differences in productivity tend to reduce vis á vis differences between local systems.

**4.1 Sectorial distribution**

Table 1 shows differences between sectors in size, productivity and absorption capacities during 2006-2008. Regarding size, companies in sectors such as computer services, textile or electrical appliances are between 18% and 21% bigger than the average of the panel. At the other extreme, sectors such as metalworking or wood and furniture show in average a size about 25% smaller than the whole panel. Obviously these differences could be attributed to the factor intensity of each of these activities; however, the internal variability to each of them is very high. The average variability coefficient (standard deviation on mean) around 90%, and, in some cases, it is over 100%. This shows that, despite the specificity of each sector in terms of its factorial requirements, the rule is high size heterogeneity.

Regarding the analysis of the productivity, the heterogeneity between firms also highlights. Average productivity differences between sectors are greater in the case of labor productivity than in the estimation of total factor productivity. Again, the differences between sectors factor intensities may explain to great extent this characteristic. However, the dispersion within each sector is higher in the case of TFP than in the case of productivity. In this direction, when estimating productivity takes into account both labor and capital, the diversity in the productive performance of firms is very high even within the same sector. This might provide an approach to differences in productive capacities of the firms that give rise to different forms of organization with different impact on their economic performance. (Table 1)

The hierarchy of activities according to the level of productivity, tends to be the same between the two productivity indicators. For example, the productivity of chemical industry, machinery and equipment, electrical appliances, among manufacturing and software development among the services, are noted for their higher relative productivity. At the other extreme, leather products, wood and paper, have the lowest relative productivity. (Table 1)

Sectorial differences in absorption capacity are significant. In particular, computer services and medical services show absorption levels well above the total average (4 and 3 times the average of the panel), while among industries, chemicals, along with machinery and equipment are of the major average absorption capacity (between 40% and 50% above the average of the panel). However, the high variability of the absorption capacity within each sector is striking. On average, for the whole panel, the dispersion of the absorption capacity (145%) is greater than the size dispersion (87%) of the total productivity of the factors (85%), and even labor productivity (95%), in which to some extent its variability can be attributed to differential use of capital. Moreover, the activities with the lower-absorption capabilities happen to be those with the greatest variance, as in the case of food and beverage, wood and furniture, and Rubber and plastic. (Table 1)

**Table 1. Sectoral distribution of size, productivity and absorptive capacity**

| | Size | | | Labor productivity | | TFP | | Absorptive capacity | |
|---|---|---|---|---|---|---|---|---|---|
| Sector | Number of employees | Ratio of sectoral average to total panel average | Variability coefficient (sd/mean) | Ratio of sectoral average to total panel average | Variability coefficient (sd/mean) | Ratio of sectoral average to total panel average | Variability coefficient (sd/mean) | Ratio of sectoral average to total panel average | Variability coefficient (sd/mean) |
| | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | 2006 | 2006 |
| Food and beverages | 61 | 1.05 | 0.89 | 0.9 | 0.89 | 1.07 | 0.87 | 0.57 | 1.46 |
| Textiles | 68 | 1.18 | 0.86 | 0.88 | 0.72 | 1.32 | 0.65 | 0.7 | 1.43 |
| Garment | 63 | 1.09 | 0.95 | 0.81 | 0.92 | 1.08 | 0.76 | 0.49 | 1.39 |
| Leather and its products | 63 | 1.08 | 0.69 | 0.83 | 0.65 | 0.61 | 0.66 | 0.33 | 1.34 |
| Wood and furniture | 43 | 0.74 | 1.05 | 0.79 | 1.01 | 0.59 | 0.74 | 0.51 | 1.76 |
| Paper and its products | 67 | 1.15 | 0.68 | 0.82 | 0.69 | 0.44 | 0.57 | 0.49 | 1.31 |
| Editorial industry | 59 | 1.01 | 0.89 | 0.87 | 0.7 | 0.66 | 0.66 | 1.27 | 1.06 |
| Chemicals | 65 | 1.11 | 0.96 | 0.96 | 0.83 | 1.04 | 0.69 | 1.46 | 0.92 |
| Rubber and plastic | 57 | 0.98 | 0.75 | 0.99 | 0.82 | 0.84 | 0.71 | 0.61 | 1.55 |
| Non-metallic minerals | 54 | 0.93 | 0.87 | 0.98 | 0.88 | 0.3 | 0.68 | 0.56 | 1.28 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Metal products | 43 | 0.75 | 0.86 | 0.99 | 0.79 | 1 | 0.7 | 0.6 | 1.12 |
| Machinery and equipment | 61 | 1.05 | 0.82 | 1.02 | 0.76 | 1.04 | 0.7 | 0.78 | 1.13 |
| Electrical machinery | 68 | 1.18 | 0.78 | 1.03 | 0.84 | 0.98 | 0.71 | 1.18 | 1.12 |
| Automotive | 59 | 1.01 | 0.84 | 1.02 | 0.68 | 1.41 | 0.66 | 0.58 | 1.18 |
| Mail and communication | 45 | 0.78 | 0.78 | 1 | 0.84 | 1.17 | 0.84 | 1.4 | 1.15 |
| Software and IT services | 70 | 1.21 | 0.78 | 1.02 | 0.41 | 1.97 | 0.42 | 4.38 | 0.46 |
| Consulting business services | 65 | 1.12 | 0.79 | 1.01 | 0.71 | 1.27 | 0.69 | 1.87 | 1.17 |
| Medical services | 56 | 0.97 | 1 | 1 | 0.71 | 0.86 | 0.71 | 3.41 | 0.5 |
| Total | 58 | 1 | 0.87 | 1 | 0.85 | 1 | 0.95 | 1 | 1.45 |

Source: Own elaboration based on SME Map

In terms of innovative behavior, there is correspondence between the sectors that performed best innovation efforts, obtain results, and show better performance in terms of productivity. In this direction software companies, the machinery and equipment, automotive, and chemicals highlights among different activities. Although there are some sectorial specificities, like garment that outstand in design activities. (Table 2)

**Table 2. Sectoral distribution of innovation behavior variables**

| Sectors | Innovation outputs | Innovation inputs | | | | | |
|---|---|---|---|---|---|---|---|
| | | Internal R&D | Machinery acquisition | License and patent acquisition | Design | Training | Marketing |
| Food and beverages | 0.34 | 0.128 | 0.240 | 0.029 | 0.099 | 0.079 | 0.103 |
| Textiles | 0.362 | 0.085 | 0.234 | 0.021 | 0.17 | 0.064 | 0.064 |
| Garment | 0.327 | 0.173 | 0.269 | 0.038 | 0.288 | 0.077 | 0.038 |
| Leader and its products | 0.405 | 0.351 | 0.189 | - | 0.27 | 0.108 | 0.054 |
| Wood and furniture | 0.261 | 0.058 | 0.174 | 0.014 | 0.116 | 0.043 | 0.072 |
| Paper and its products | 0.349 | 0.116 | 0.256 | 0.047 | 0.163 | 0.116 | 0.047 |
| Editorial industry | 0.455 | 0.076 | 0.348 | 0.03 | 0.152 | 0.182 | 0.015 |
| Chemicals | 0.509 | 0.415 | 0.358 | 0.057 | 0.208 | 0.264 | 0.151 |
| Rubber and plastic | 0.414 | 0.254 | 0.263 | 0.026 | 0.254 | 0.175 | 0.096 |
| Non-metallic minerals | 0.447 | 0.263 | 0.316 | 0.105 | 0.184 | 0.211 | 0.105 |
| Metal products | 0.299 | 0.16 | 0.212 | 0.026 | 0.128 | 0.135 | 0.051 |
| Machinery and equipment | 0.568 | 0.398 | 0.382 | 0.041 | 0.423 | 0.211 | 0.089 |
| Electrical machinery | 0.484 | 0.29 | 0.355 | - | 0.226 | 0.194 | 0.161 |
| Automotive | 0.505 | 0.245 | 0.33 | 0.009 | 0.302 | 0.16 | 0.104 |
| Mail and communication | 0.233 | 0.138 | 0.172 | 0.034 | 0.034 | - | 0.069 |
| Software and IT services | 0.632 | 0.684 | 0.474 | 0.053 | 0.526 | 0.474 | 0.211 |
| Consulting business services | 0.3 | 0.155 | 0.191 | 0.045 | 0.091 | 0.127 | 0.045 |
| Medical services | 0.278 | 0.114 | 0.229 | 0.029 | 0.029 | 0.2 | - |
| Total | 0.388 | 0.204 | 0.267 | 0.031 | 0.191 | 0.14 | 0.08 |

Source: Own elaboration based on SME Map

Regarding linkages (Table 3), it is striking the low number of connections that establish Argentinian SMEs with different types of institutions that promote innovation (IPI). Again, standing out activities are precisely those of best performance in terms of innovative behavior and productivity. Independently of the partner, firms with greater linkages belong to the software sector, followed by machinery and equipment, chemicals and automotive sectors. However, there are also sectorial specificities according to the partner. Among the linkages with universities highlight software and chemicals sector, while the food and beverages, leader and its products, rubber and plastic and non-metallic minerals sectors reveal mostly linkages with local institutions.

**Table 3 Sectoral distribution of linkages**

| Sector | National institutions | | | Local gov. | Local business chambers | Local dev. agencies | Technological centers | Consultants | Universities |
|---|---|---|---|---|---|---|---|---|---|
| | Sepyme | Inti | Fontar | | | | | | |
| Food and beverages | 0.09 | 0.08 | 0.03 | 0.22 | 0.17 | 0.02 | 0.01 | 0.13 | 0.07 |
| Textiles | 0.11 | 0.19 | 0.04 | 0.09 | 0.15 | - | - | 0.02 | 0.04 |
| Garment | 0.02 | 0.12 | 0.02 | 0.06 | 0.06 | - | - | 0.06 | 0.04 |
| Leader and its products | 0.11 | 0.03 | 0.03 | 0.11 | 0.41 | 0.03 | 0.03 | 0.08 | 0.05 |
| Wood and furniture | 0.06 | 0.10 | 0.04 | 0.09 | 0.17 | 0.01 | 0.04 | 0.09 | 0.06 |
| Paper and its products | 0.07 | 0.12 | 0.07 | 0.16 | 0.14 | - | 0.05 | 0.12 | 0.09 |
| Editorial industry | 0.09 | 0.06 | - | 0.12 | 0.11 | - | 0.02 | 0.05 | 0.09 |
| Chemicals | 0.17 | 0.17 | 0.17 | 0.15 | 0.26 | 0.02 | 0.09 | 0.15 | 0.23 |
| Rubber and plastic | 0.12 | 0.16 | 0.09 | 0.18 | 0.16 | 0.03 | 0.07 | 0.12 | 0.06 |
| Non-metallic minerals | 0.08 | 0.03 | 0.05 | 0.16 | 0.24 | 0.03 | 0.05 | 0.08 | 0.16 |
| Metal products | 0.15 | 0.08 | 0.06 | 0.11 | 0.12 | 0.03 | 0.03 | 0.11 | 0.08 |
| Machinery and equipment | 0.19 | 0.19 | 0.20 | 0.18 | 0.25 | 0.06 | 0.04 | 0.18 | 0.11 |
| Electrical machinery | - | 0.16 | 0.10 | 0.13 | 0.26 | - | 0.10 | 0.10 | 0.16 |
| Automotive | 0.14 | 0.16 | 0.15 | 0.12 | 0.14 | 0.04 | 0.01 | 0.10 | 0.09 |
| Mail and communication | 0.03 | - | - | 0.27 | 0.10 | 0.03 | - | 0.03 | 0.03 |
| Software and | 0.26 | 0.0 | 0.32 | 0.11 | 0.11 | 0.11 | 0.16 | 0.26 | 0.37 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| IT services | | 5 | | | | | | | |
| Consulting business services | 0.10 | 0.03 | 0.04 | 0.12 | 0.10 | 0.01 | 0.04 | 0.06 | 0.15 |
| Medical services | 0.06 | - | 0.03 | 0.14 | 0.11 | 0.03 | - | 0.08 | 0.08 |
| Total | 0.11 | 0.10 | 0.07 | 0.15 | 0.16 | 0.02 | 0.03 | 0.11 | 0.09 |

Source: Own elaboration based on SME Map

### 4.2 Regional distribution

A similar analysis can be proposed to account for the differences between the considered geographical areas (Table 4). The data show that regional differences are even more striking than between sectors. For example, the size of firms of GBA north, is consistently greater than the rest of the panel (25%), beyond the sector under consideration. While companies of NOE and of the Cordillera South, are up to 40% smaller. In turn, the intra group variability is also remarkable, in some cases the variability coefficient is above the unit (which means that the standard deviation is bigger than the mean).

**Table 4. Regional distribution of size, productivity and absorptive capacity**

| | Size | | | Labor productivity | | TFP | | Absorptive capacity | |
|---|---|---|---|---|---|---|---|---|---|
| Sector | Number of employees | Ratio of sectoral average to total panel average | Variability coefficient (sd/mean) | Ratio of sectoral average to total panel average | Variability coefficient (sd/mean) | Ratio of sectoral average to total panel average | Variability coefficient (sd/mean) | Ratio of sectoral average to total panel average | Variability coefficient (sd/mean) |
| | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | Average 2006–2008 | 2006 | 2006 |
| Alto Valle (Río Negro valley) | 43 | 0.75 | 1.14 | 1.3 | 0.89 | 1.15 | 0.69 | 1.14 | 1.52 |
| Buenos Aires City | 67 | 1.16 | 1.47 | 1.23 | 0.79 | 1.26 | 0.86 | 1.41 | 1.26 |
| Comodoro Rivadavia | 51 | 0.89 | 1.29 | 1.22 | 0.86 | 1.62 | 0.83 | 0.71 | 1.7 |
| Córdoba City & surroundings | 59 | 1.01 | 1.17 | 0.84 | 0.72 | 0.80 | 0.85 | 1.10 | 1.4 |
| Cordillera South | 34 | 0.59 | 1.28 | 0.69 | 0.61 | 0.78 | 0.69 | 0.84 | 1.23 |
| GBA North | 73 | 1.26 | 1.51 | 1.24 | 0.82 | 1.07 | 0.81 | 0.88 | 1.48 |
| GBA South | 64 | 1.11 | 1.12 | 0.98 | 0.72 | 0.93 | 0.94 | 1.00 | 1.43 |
| La Pampa | 36 | 0.63 | 1.58 | 0.71 | 0.57 | 0.76 | 0.57 | 0.66 | 1.23 |
| La Rioja & Catarmarca | 40 | 0.69 | 1.48 | 1.07 | 1.01 | 0.82 | 0.87 | 0.83 | 1.4 |
| Uruguay River bank | 47 | 0.81 | 1.09 | 0.78 | 0.89 | 0.99 | 1.06 | 0.48 | 1.79 |
| Mendoza | 58 | 1.00 | 1.01 | 0.80 | 0.9 | 0.89 | 1.03 | 1.20 | 1.34 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Argentinean Northwest 1 | 44 | 0.77 | 1.04 | 0.9 | 0.79 | 0.85 | 0.81 | 0.83 | 1.43 |
| Argentinean Northwest 2 | 49 | 0.85 | 1.37 | 0.52 | 0.74 | 0.68 | 0.94 | 0.90 | 1.49 |
| Argentinean Northeast | 40 | 0.69 | 0.99 | 0.74 | 1.31 | 1.20 | 1.12 | 1.27 | 1.2 |
| Santa Fe North | 57 | 0.98 | 1.25 | 1.09 | 0.79 | 1.05 | 0.75 | 0.82 | 1.21 |
| Bs. As. Province–center | 58 | 1.00 | 1.08 | 0.86 | 0.84 | 1.29 | 0.70 | 0.69 | 1.7 |
| Bs. As. Province–center & north | 47 | 0.81 | 1.01 | 0.86 | 0.85 | 0.92 | 1.06 | 0.89 | 1.69 |
| Bs. As. Province–south | 47 | 0.81 | 1.32 | 0.93 | 0.67 | 1.17 | 0.70 | 1.26 | 1.37 |
| Valdez Peninsula | 37 | 0.64 | 0.92 | 0.91 | 0.59 | 0.62 | 0.65 | 0.95 | 1.49 |
| Rio Gallegos & Tierra del Fuego | 66 | 1.14 | 0.94 | 1.79 | 0.78 | 1.27 | 0.51 | 0.58 | 2.13 |
| Rosario & surroundings | 53 | 0.91 | 1.14 | 0.94 | 0.75 | 0.94 | 0.93 | 1.06 | 1.51 |
| San Luis | 57 | 0.98 | 1.3 | 1.9 | 0.81 | 1.26 | 0.71 | 0.59 | 1.24 |
| San Rafael & Alvear | 41 | 0.71 | 1.35 | 0.65 | 0.67 | 0.79 | 0.68 | 0.62 | 1.68 |
| San juan | 57 | 0.99 | 0.61 | 0.63 | 0.95 | 0.80 | 0.68 | 0.78 | 1.41 |
| Santa Fe, Paraná & surroundings | 61 | 1.05 | 1.22 | 0.89 | 0.72 | 0.94 | 0.82 | 0.89 | 1.37 |
| Córdoba south | 61 | 1.06 | 1.31 | 0.97 | 0.68 | 0.87 | 0.61 | 1.07 | 1.29 |
| Misiones | 72 | 1.24 | 0.96 | 0.61 | 0.68 | 0.57 | 0.70 | 0.79 | 1.52 |
| Total | 58 | 1 | 1.16 | 1 | 0.85 | 1 | 0.95 | 1 | 1.45 |

As can be seen the differences in productivity between sectors exceeds productivity between regions. Nevertheless the differences between regions are significant.

**Tabla 5. Regional distribution of innovation behavior variables**

| Sectors | Innovation outputs | Innovation inputs | | | | | |
|---|---|---|---|---|---|---|---|
| | | Internal R&D | Machinery acquisition | License and patent acquisition | Design | Training | Marketing |
| Alto Valle (Río Negro valley) | 0.39 | 0.21 | 0.30 | 0.03 | 0.12 | 0.12 | 0.03 |
| Buenos Aires City | 0.40 | 0.22 | 0.28 | 0.04 | 0.21 | 0.17 | 0.08 |
| Comodoro Rivadavia | 0.33 | 0.13 | 0.20 | - | 0.07 | 0.07 | 0.07 |
| Córdoba City & surroundings | 0.51 | 0.23 | 0.36 | 0.05 | 0.16 | 0.16 | 0.09 |
| Cordillera South | 0.20 | 0.07 | 0.20 | - | 0.13 | - | - |
| GBA North | 0.30 | - | 0.30 | - | 0.10 | - | - |
| GBA South | 0.38 | 0.19 | 0.27 | 0.06 | 0.20 | 0.14 | 0.11 |
| La Pampa | 0.35 | 0.16 | 0.25 | 0.04 | 0.20 | 0.13 | 0.06 |
| La Rioja & Catarmarca | 0.50 | - | 0.25 | - | 0.50 | - | 0.25 |
| Uruguay River bank | 0.17 | 0.06 | - | 0.06 | 0.11 | - | 0.17 |
| Mendoza | 0.25 | - | 0.20 | - | - | - | - |
| Argentinean Northwest 1 | 0.30 | 0.16 | 0.19 | 0.04 | 0.21 | 0.14 | 0.01 |
| Argentinean Northwest 2 | 0.21 | 0.11 | 0.22 | - | 0.11 | 0.17 | 0.11 |
| Argentinean Northeast | 0.32 | 0.09 | 0.17 | 0.06 | 0.09 | 0.17 | 0.06 |
| Santa Fe North | 0.32 | - | 0.11 | - | - | - | 0.05 |
| Bs. As. Province – center | 0.23 | 0.19 | 0.23 | 0.03 | 0.10 | 0.10 | 0.10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bs. As. Province - center & north | 0.46 | 0.29 | 0.33 | 0.02 | 0.31 | 0.29 | 0.10 |
| Bs. As. Province – south | 0.29 | 0.24 | 0.18 | - | 0.18 | 0.06 | 0.06 |
| Valdez Peninsula | 0.33 | 0.23 | 0.22 | - | 0.18 | 0.09 | 0.06 |
| Rio Gallegos & Tierra del Fuego | 0.33 | 0.18 | 0.18 | 0.03 | 0.13 | 0.08 | 0.05 |
| Rosario & surroundings | 0.43 | 0.29 | 0.29 | 0.07 | 0.14 | 0.21 | 0.07 |
| San Luis | 0.50 | 0.31 | 0.32 | 0.01 | 0.28 | 0.16 | 0.09 |
| San Rafael & Alvear | 0.21 | 0.07 | 0.14 | 0.07 | 0.07 | - | - |
| San Juan | 0.50 | 0.30 | 0.20 | - | 0.20 | 0.10 | 0.20 |
| Santa Fe, Paraná & surroundings | 0.22 | 0.11 | 0.22 | 0.11 | - | 0.11 | 0.11 |
| Córdoba south | 0.64 | 0.26 | 0.45 | 0.02 | 0.21 | 0.21 | 0.21 |
| Misiones | 0.58 | 0.38 | 0.43 | - | 0.30 | 0.25 | 0.15 |
| Total | 0.39 | 0.20 | 0.27 | 0.03 | 0.19 | 0.14 | 0.08 |

Source: Own elaboration based on SME Map

**Table 6. Regional distribution of linkages**

| Area geográfica | National institutions | | | Local gov. | Local business chambers | Local dev. agencies | Technological centers | Consultants | Universities |
|---|---|---|---|---|---|---|---|---|---|
| | Sepyme | Inti | Fontar | | | | | | |
| Alto Valle (Río Negro valley) | 0.18 | - | - | 0.15 | 0.12 | 0.03 | - | 0.03 | - |
| Buenos Aires City | 0.10 | 0.10 | 0.08 | 0.07 | 0.10 | 0.02 | 0.03 | 0.10 | 0.12 |
| Comodoro Rivadavia | 0.13 | - | - | 0.20 | 0.20 | - | - | - | 0.07 |
| Córdoba City & surroundings | 0.14 | 0.07 | 0.01 | 0.15 | 0.31 | 0.04 | 0.01 | 0.15 | 0.14 |
| Cordillera South | - | - | - | 0.20 | 0.07 | - | - | - | - |
| GBA North | 0.13 | | 0.05 | 0.16 | 0.14 | 0.01 | 0.04 | 0.12 | 0.03 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.15 | | | | | | | |
| GBA South | 0.09 | 0.13 | 0.05 | 0.12 | 0.13 | 0.01 | 0.04 | 0.08 | 0.08 |
| La Rioja & Catarmarca | - | 0.06 | - | 0.11 | 0.17 | - | - | 0.06 | 0.06 |
| Uruguay River bank | - | 0.15 | - | 0.15 | 0.10 | - | - | 0.15 | 0.05 |
| Mendoza | 0.08 | 0.04 | 0.07 | 0.10 | 0.19 | 0.04 | 0.03 | 0.15 | 0.07 |
| Argentinean Northwest 1 | 0.08 | - | - | 0.08 | 0.13 | - | - | 0.03 | 0.03 |
| Argentinean Northwest 2 | 0.05 | 0.11 | - | 0.32 | 0.16 | - | - | 0.11 | 0.11 |
| Argentinean Northeast | - | 0.03 | 0.03 | 0.29 | 0.16 | - | - | 0.06 | 0.03 |
| Santa Fe North | 0.10 | 0.28 | 0.20 | 0.20 | 0.26 | 0.06 | 0.04 | 0.02 | 0.14 |
| Bs. As. Province - center | 0.24 | 0.24 | 0.06 | 0.18 | 0.12 | 0.12 | - | 0.18 | 0.29 |
| Bs. As. Province - center & north | 0.09 | 0.12 | 0.10 | 0.19 | 0.10 | 0.03 | 0.02 | 0.08 | 0.15 |
| Bs. As. Province – south | 0.05 | 0.18 | 0.10 | 0.18 | 0.18 | 0.03 | 0.05 | 0.13 | 0.20 |
| Valdez Peninsula | 0.14 | 0.07 | 0.07 | 0.07 | 0.14 | 0.14 | 0.07 | 0.07 | 0.14 |
| Rio Gallegos & Tierra del Fuego | 0.10 | - | - | 0.20 | - | - | - | 0.10 | - |
| Rosario & surroundings | 0.16 | 0.09 | 0.15 | 0.14 | 0.17 | 0.03 | 0.08 | 0.14 | 0.08 |
| San Luis | 0.10 | 0.20 | 0.10 | - | 0.10 | - | - | 0.10 | 0.10 |
| San Rafael & Alvear | 0.11 | - | - | 0.22 | 0.44 | - | - | - | - |
| San juan | 0.14 | 0.07 | 0.07 | 0.14 | 0.21 | 0.07 | - | - | - |
| Santa Fe, Paraná & surroundings | 0.14 | 0.10 | 0.19 | 0.26 | 0.33 | 0.05 | 0.02 | 0.19 | 0.26 |
| Córdoba south | 0.18 | | 0.08 | 0.28 | 0.23 | 0.03 | 0.05 | 0.28 | 0.05 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.10 | | | | | | | |
| Misiones | 0.21 | - | 0.16 | 0.21 | 0.32 | - | 0.11 | 0.11 | - |
| Total | 0.11 | 0.10 | 0.07 | 0.15 | 0.16 | 0.02 | 0.03 | 0.11 | 0.09 |

Source: Own elaboration based on SME Map

There are regions that show productivity levels almost twice bigger than the panel average. Labor productivity shows, as could be expected, greater variability than TFP. Higher productivity regions are related to bigger and higher industrial developed cities and its surroundings. Also higher productivity correlates with higher diversify industrial profile. In this regard, it is no surprising that Buenos Aires city and GBA North were high productivity areas. Also, promoting areas, like Tierra del Fuego and San Luis show also high productivity due to the high value added derived of high salaries in those regions. Other high productivity regions are Río Negro Valley, Northeast, and different regions of Buenos Aires province (particularly, center of that province).

Regarding absorption capacity, the variability is increased not only between groups but also with in them. Although high productivity regions mostly have high absorption capacity, there are some regions of high absorption capacity that is not reflected in its productivity level. Some examples of the latter are: Mendoza, Córdoba city and surroundings, Rosario and Cordoba South.

Regional distribution of innovation variables seems to be correlated to absoption capacities (Table 5). Meanwhile the regional distribtions of linkages seesm to have its own logic, probable related to the strength of local institutions in each regions. (Table 6)

Table 6 shows that linkages with IPI vary not only with the sectors but also with the regions. Thus it appears that the presence of certain types of IPI home location becomes relevant only in some regions. Thus linkages with municipal governments and local agencies vary by up to 30% in some regions and 0 in others. Linkages with universities is also affected by the presence of universities in the region and, perhaps even more relevant a culture to link with the university.

### 4.3 Anova

The Anova test formalizes the results presented in the preceding tables to show significant differences between sizes, productivity and absorptive capacity not only between sectors and regions, but also between reference groups that consider these two dimensions.

**Table 7 Anova table for differences in firm size**

| Source | Partial SS | Df | MS | F | Prob>F |
|---|---|---|---|---|---|
| Model | 4922628.07 | 162 | 30386.593 | 1.53 | 0.0001 |
| Sector | 783664.929 | 17 | 46097.937 | 2.31 | 0.0018 |
| Area geográfica | 1058602.2 | 26 | 40715.4692 | 2.04 | 0.0015 |
| Grupo de ref | 3065360.26 | 119 | 25759.33 | 1.29 | 0.0228 |
| Residual | 24236432.8 | 1214 | 19914.8996 | | |
| Total | 29159060.9 | 1376 | 21145.0768 | | |

Number of obs = 1380 R-squared = 0.1688 Root MSE = 141.12 Adj R-squared = 0.0582

Source: Own elaboration based on SME Map

Table Anova 7 shows significant differences in the average number of workers between sectors and regions and it is even possible to establish significant differences between the reference groups (ie between groups of companies sharing the same geographical area and sector), even after controlling for differences entity sectors and regions. That is, the significance of the line for the reference group in the ANOVA table (row 4), to set the size differences between regions within the same industry and vice versa, are relevant. Notably, however, that the differences between groups achieved only explain a small portion of the total variability.

In the case of productivity differences, the ANOVA test showed significant differences between sectors, regions and reference groups. Labor productivity differences between sectors and regions are statistically significant even in a context of strong dispersion of productivity within them. The differences in average labor productivity between the reference groups are significant even controlling for sectors and regions. That is the same sectors located in different regions show different average levels of productivity. In this case, the variability explained by sectors and groups of reference regions account for 31% of the total variability, whereas only the differences between the reference groups explain 10% of the total.

**Tabla 8 Anova table for differences in firm labor productivity**

| Source | Partial SS | Df | MS | F | Prob>F |
|---|---|---|---|---|---|
| Model | 238.138014 | 162 | 1.12329252 | 3.39 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| Dominios G. | 77.2299675 | 17 | 3.6776175 | 11.11 | 0 |
| Sectores | 50.8891484 | 26 | 1.95727494 | 5.91 | 0 |
| Grupos de ref. | 73.6066221 | 119 | 0.44610074 | 1.35 | 0.0033 |
| Residual | 518.758054 | 1217 | 0.33105173 | | |
| Total | 756.896068 | 1379 | 0.42546153 | | |

Number of obs = 1377 R-squared = 0.3146 Root MSE = .575371 Adj R-squared = 0.2219

Source: Own elaboration based on SME Map

Regarding to total factor productivity can be noted a greater dispersion between sectors in the case of labor productivity, it becomes up to 40% above and below the average of the panel. The differences in TFP between regions are very strong but also related to that observed in the case of labor productivity.

**Table 9 Anova table for differences in firm TFP**

| Source | Partial SS | Df | MS | F | Prob>F |
|---|---|---|---|---|---|
| Model | 225.778835 | 162 | 1.39369651 | 5.07 | 0 |
| Dominios G. | 118.024882 | 17 | 6.9426401 | 25.27 | 0 |
| Sectores | 28.834584 | 26 | 1.10902246 | 4.04 | 0 |
| Grupos de ref. | 34.2032074 | 119 | 0.287421911 | 1.05 | 0.3558 |
| Residual | 294.746272 | 1073 | 0.274693636 | | |
| Total | 520.525106 | 1235 | 0.421477819 | | |

Number of obs = 1236 R-squared = 0.4338 Root MSE = 0.524112 Adj R-squared = 0.3483

Source: Own elaboration based on SME Map

In ANOVA tables it appears that these differences are statistically significant. The differences between self-explanatory sectors 30% of the total variability, while the differences between regions come to realize 8% of the total variability. In both cases the average variability between groups exceeds the total average variability.

When analyzing the differences between reference groups controlling for sectoral and regional differences respectively, they do not become statistically significant. In this case the average variability between reference groups found to be less than total (0.28 to 0.42). Return to this issue in the estimation of the models.

**Table 10 Anova table for differences in firm absorption capacities**

| Source | Partial SS | Df | MS | F | Prob>F |
|---|---|---|---|---|---|
| Model | 17.3650686 | 162 | 0.107191781 | 4.04 | 0 |
| Sector | 9.83173911 | 17 | 0.578337595 | 21.79 | 0 |
| Area geográfica | 0.452353785 | 26 | 0.017398223 | 0.66 | 0.9063 |
| Grupo de referencia | 4.3367536 | 119 | 0.036443308 | 1.37 | 0.0068 |
| Residual | 31.4277363 | 1184 | 0.026543696 | | |
| Total | 48.7928049 | 1346 | 0.036250226 | | |

Number of obs = 1347 R-squared = 0.3559 Root MSE = .162922 Adj R-squared = 0.2678

Elaboración propia sobre base del Mapa Pyme

### 4.4 A descriptive approach to co-localization interactions

In this section we present contingency tables, contour line graphs, and Anova tests in order to show some empirical evidence on the hypothesis of social interactions. The contingency tables and contour line graphs show the joint distribution of the productivity of firm and reference groups, not counting firm *i*. Using these, we show that low-productivity firms usually belong to reference groups where the rest of the firms also show low productivity. On the other hand, the Anova tables aim to show that the variance between sectors, regions, and reference groups is greater than variance within those sectors, regions, and reference group. This means that heterogeneity persists at different aggregation levels.

We first split the firms and reference groups distributions into quintiles and deciles.[6] we then proceeded to categorize each firm according to the quintile and decile it belongs to in the distribution of individual productivity, and according to the quintile and decile it belongs to in the distribution of reference group productivity (always excluding the productivity of firm *i*). This is

[6] Contour line graphs are presented in deciles, but quintiles were used in the contingency tables for the sake of clarity.

required in order to establish whether the position of firm *i* in the distribution of firms' productivity tended to coincide with the position that their peers occupy.

**Table 11 Joint distribution of labor productivity—Average 2006–2008**

| | | Distribution of reference group labor productivity (in quintiles) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | Total |
| Distribution of firms' labor productivity (in quintiles) | 1 | 35.87 | 23.55 | 18.48 | 14.13 | 7.97 | 100 |
| | 2 | 23.55 | 22.1 | 23.91 | 16.3 | 14.13 | 100 |
| | 3 | 19.2 | 18.12 | 26.09 | 20.29 | 16.3 | 100 |
| | 4 | 13.41 | 18.48 | 17.75 | 26.09 | 24.28 | 100 |
| | 5 | 7.97 | 17.75 | 13.77 | 23.19 | 37.32 | 100 |
| Total | | 20 | 20 | 20 | 20 | 20 | 100 |

Pearson chi2(16) = 163.6957 Pr = 0.000

Source: Own elaboration based on SME Map

**Table 12 Joint distribution of total factor productivity—Average 2006–2008**

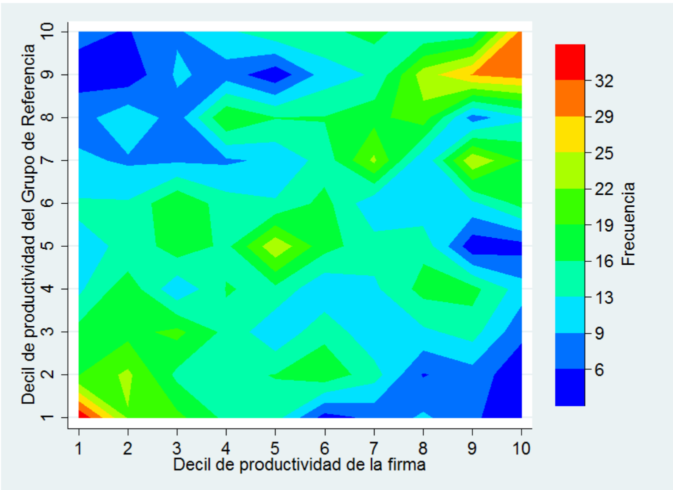
| | | Distribution of reference group TFP (in quintiles) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | Total |
| Distribution of reference group TFP (in quintiles) | 1 | 53.23 | 18.55 | 17.34 | 3.23 | 7.66 | 100 |
| | 2 | 22.27 | 25.51 | 24.7 | 15.38 | 12.15 | 100 |
| | 3 | 16.6 | 23.48 | 20.24 | 23.48 | 16.19 | 100 |
| | 4 | 3.24 | 19.84 | 19.43 | 28.74 | 28.74 | 100 |
| | 5 | 4.86 | 12.55 | 18.22 | 29.15 | 35.22 | 100 |
| Total | | 20.06 | 19.98 | 19.98 | 19.98 | 19.98 | 100 |

Pearson chi2(16) = 342.9749 Pr = 0.000

Source: Own elaboration based on SME Map

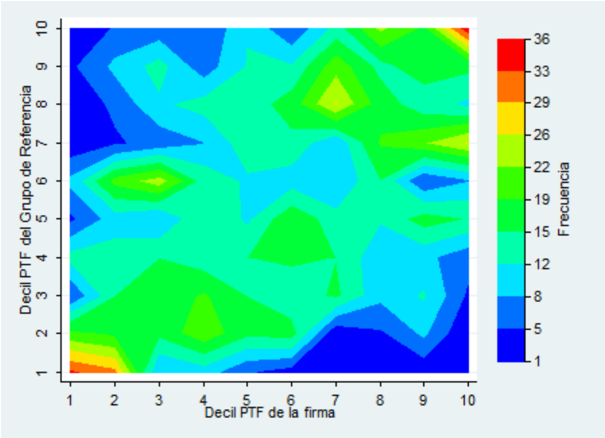
The data shows that in the cases of both labor productivity and TFP, there is a correlation between firms' location in the distribution of productivity and the location of their reference group peers. For example, 36% of the firms that are located in the first quintile of the firms' distribution of labor productivity have peers in the same quintile, while only 8% of the firms located in the first quintile have peers in the fifth quintile. The opposite situation can be seen at the other extreme of the joint distribution: only 8% of firms in the fifth quintile share their location with the first quintile of the reference group, while 37% coincide in the fifth quintile. The same situation, even more pronounced, can be seen in the case of the joint distribution of TFP. The estimated Chi-square tests show that firm and group level distributions (both, labor productivity and TFP) are not independent. Graphs 1 and 2 show a concentration of observations around the main diagonal (especially at each extreme). In this context, they provide a description that is compatible with that of the contingency tables: there is a direct relationship between the firms' productivity levels and that of those firms that are co-located in the same reference group.

**Graph 1 Joint distribution of firm and reference group labor productivity. Averages 2006–2008**




Source: Own elaboration based on SME Map

**Graph 2 Joint distribution of firm and reference group total factor productivity. Averages 2006–2008**




Source: Own elaboration based on SME Map

## 5. CONCLUSIONS

During the last thirty years the literature of NIS , on one hand, and LIS , on the other , have dominated much of the studies in the framework of the approach innovation economy and regional economic geography and evolutionary economics, respectively. These two branches of literature have seek explain the processes of innovation from a systemic perspective, that reinforce the concepts of feedback and positive synergies inside each system, have developed almost no attempts to seek complementarities. In this article, however, suggest that the integration of both approaches is key to understanding the dynamics of innovation systems and sub - systems account the strong heterogeneity between firms, regions and sectors , especially in developing countries.

The heterogeneity of productivity is the most important stylized fact of the paper. Neo-Schumpeterian evolutionary economics suggests that variety generation through innovation and the resolution of this variation through selection process are two sides of the same coin in the capitalist dynamic. However, the descriptive statistics in this paper included within- heterogeneity that show is as important as between- heterogeneity. In fact, a very high heterogeneity remains within groups which will explain disparities in accessing to external knowledge.

The tables presented are consistent with a number of empirical regularities already discussed in the theoretical framework and other already analyzed in the context of other surveys .

First, we highlight particularly high heterogeneity in productivity between sectors and geographical domains as well as within them. This heterogeneity in turn is characterized by its persistence , that is, every year the heterogeneity remains even in a balanced panel , which by definition invalidate the resulting variety of entry of new firms and the exit of incumbents . In this direction, we believe that the data show both the existence and the temporal persistence of differences in productivity levels within the same sector taken as the market proxy meso unit where concur . In this context , Anova tables estimated for different variables are consistent in their results , variability of firms tends to be lower among companies that share ( i ) industry , ( ii ) geographic domain and ( iii ) reference group differences between these groups and that this trend of lower variance occurs in a context of high variability.

Second, within this context of heterogeneity has been observed predominantly non-innovative firms and making innovation efforts, although with significant differences between sectors and regions. In this way it becomes clear that both the sectoral and regional differences are relevant to explain the innovative behavior of firms.

Third, there is also a clear geographical bias when it comes to that SMEs linkages established with IPIs. This is so, linkages with local institutions, which highlights the differences in local institutional settings, but also in the case of IPIs linkages with national character , which shows an unequal geographical access to promotion for innovation offered by institutions nationwide.

Fourth, it can be seen that there is a correspondence between regions ( and sectors) performed more innovation efforts , more and better results obtained show productive performance in terms of total factor productivity and in terms of labor productivity.

Finally , the data are indicating that firms with high productivity tend to be located in reference groups of high productivity, while firms with low productivity tends to occur otherwise. These results are consistent with the analysis of the joint distribution quintiles and deciles. Additionally, the data are said to equal productivity sectors, regions are able to account for a significant portion of the intra organizational.

So, the textile apparel sector productivity NOE is below the productivity of this sector in the south of the province of Buenos Aires (explained by the city of Mar del Plata in full) and two below the productivity of this sector in the City of Buenos Aires. The machinery and equipment industry displays better production performance in the north of the province of Santa Fe (determined strongly by Rafaela ) and Rosario and surrounding towns in the center of the Province of Buenos Aires and

Mendoza. This fact is also validated by ANOVAs tables speaks of the presence of local externalities.

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