MARSHALLIAN INDUSTRIAL DISTRICTS AND INNOVATION IN SPAIN: 1991-2015[1]

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The debate on innovation is a complex and stimulating topic. Throughout the twentieth century it became an essential mantra (Godin, 2015) not only for its relationship with economic growth and social changes, but also with welfare, the latter being the most important.

Innovation is a multidimensional phenomenon. As such, there are many theories that explain it and the ways to measure it. In this article, we have focused on innovation as a social phenomenon and –by extension– geographical, and related to development in a broad sense. From this perspective, the unit of analysis to study innovation is not the firm, the corporation, the university or the research centre, but the place. A place (of living) is a determined and circumscribed part of the territory where a human group lives and where the economic activities with which it makes its living are localized; where the majority of everyday social relationships are established and people seek the satisfaction of their need for social integration.

In the research on innovation and territory, contrast between diversity/specialization and between cities/manufacturing places has been proposed, and often a supply-oriented innovation that assumes demand as given (see, for example, Florida, Adler and Mellander, 2017).

This article provides a different perspective. Innovation is generated not only in cities, but in other types of places, such as Marshallian industrial districts (MIDs). In our analytical framework, cities and MIDs are types of LPSs that shape the national economy. In this regard, it is noteworthy that the empirical analysis of socially and economically complex places, such as Barcelona in Spain, highlighted that cities and MIDs can integrate to form a metropolitan area (see Trullén and Boix, 2017, Aguilera and Galletto, 2018).

Notably, the article investigates the possibility that MIDs are more efficient in producing innovation than other types of LPSs, and how their innovative efficiency has evolved over time. With this goal in mind, the notion of district effect in innovation (iMID-effect) is introduced, and an innovation analysis on Spanish MIDs over a period of 25 years (1991-2015) is carried out.

1 The authors wish to thank Joan Trullén for the encouragement to write this summarized article on innovation and territory. We also wish to thank Vittorio Galletto, with whom we share this line of research on MIDs and innovation, the collaboration in data processing and the always-stimulating discussion about methodological issues and results. This article is dedicated to the late Giacomo Becattini, a master and a friend going back a long way, who passed away in 2017.

The article has four sections. After the introduction, section 2 sets up the concepts of MID and iMID-effect. Section 3 explains the methodology, the data used, and the results of the analysis for the Spanish economy. Section 4 gives the conclusions.

2. iMID-effect and technological innovation

2.1. Marshallian industrial districts (MIDs)

Becattini (1989, p. 29) defines the MID as «a socioterritorial entity which is characterized by the active presence of both a community of people and a population of firms». The MID is a new approach to economic change (Becattini, 2000), which is based on the fact that economic change cannot be understood outside a specific place where the community of people and the population of firms are mutually embedded and where the economic and social forces confront each other and cooperate (Sforzi and Boix, 2015, 2018). In this view, the unit of analysis shifts from the firm or the sector to the place, which can be empirically approached by a geography of local production systems (LPSs). The mapping of local labour systems (LLSs) fits the geographical definition of LPSs (Sforzi, 2012).

MIDs have been identified as a widespread phenomenon in industrialized countries (Becattini, Bellandi and De Propris, 2009), with an outstanding quantitative importance in Italy and Spain.

2.2. District effect and static district effect

The notion of district effect was coined by Signorini (1994) to explain the high efficiency rates of the firms located in MIDs. Dei Ottati (2006, p. 74) defines the district effect as the «competitive advantages derived from a strongly related set of economies external to the individual firms but internal to the district».

The empirical investigation of the district effect focused initially on the static economic effects, that is, the effects on costs-productivity and exports-comparative advantages. Boix and Galletto (2009) and Galletto and Boix (2014) carried out a comprehensive review of this bibliography. They concluded that, in general, the results provide evidence of the district effect in the form of increased productivity, increase of efficiency, export quota, export probability or comparative advantages.

2.3. Dynamic district effect: the iMID-effect

Research on the dynamic district effect, linked to MIDs' capacity for innovation, is the most recent line of research on district effect.

Cainelli and De Liso (2005, p. 254) argued that the causes for which this line of research has long remained in the early stages are partly explained by the literature on MIDs, which considers external economies affecting the firm-performance associated with low levels of innovation, and partly are due to the difficulty of getting geo-referenced microdata on innovation.

The first statement is controversial, since members of the Florence school (Becattini, 1991 and 2001, Bellandi 1989 and 1992) and the school of Modena (Brusco, 1975, Russo, 1986) emphasized the MID's innovative capacity. Although it is equally true that other authors continue to have a negative opinion about the innovative capacity of MIDs, because these are environments of small and medium-sized enterprises (SMEs). But what does the empirical evidence suggest?

Leoncini and Lotti (2004) showed that district firms are more likely to patent, despite the fact that the probability of carrying out research and development (R&D) is lower than for firms located outside the MIDs. They came to this conclusion using survey data from an Italian region with a high density of MIDs (Emilia-Romagna). Muscio (2006) obtained the same amount of empirical evidence proving that the probability of firms introducing innovation is higher for the firms located in the MIDs. Santarelli (2004), using data from European patents, found inconclusive evidence about the existence of a district effect.

On the other hand, Cainelli and De Liso (2005) proved that district firms implementing product innovations perform better than firms located outside the MIDs; and that firms located in the MIDs innovating their product perform better than those innovating their processes.

Boix and Galletto (2009) introduced the notion of district effect in innovation (or iMID-effect) when they investigated the innovative capacity of MIDs with regard to the rest of Spain's LPS. Their results made known that Spain's MIDs showed on average an innovative intensity (patents per million of employees) 40% higher than the Spanish average. Then, Boix and Trullén (2010) disaggregated the territorial and sectorial component of the effect. They concluded that the effect was more robust with regard to the territorial component than to the sectorial one and, therefore, that the greatest innovative intensity of the MIDs was due to their socioeconomic organization more than to their sectorial specialization. Later, Galletto and Boix (2014) and Boix, Galletto and Sforzi (2018) have shown that the district effect on innovation occurs even when considering the potential value or quality of patents.

MIDs are more efficient in producing innovation, and how their innovative efficiency has evolved over time

2.4. The engines of innovation in MIDs: the sources of the iMID-effect

The literature on MIDs highlighted that the district model contributes to maintain the innovative capacity of firms and supports the adoption of innovations. From a theoretical point of view, there are two points that can explain the iMID-effect.

1. The existence of "decentralized (or diffused) industrial creativity" (Becattini, 1991 and 2001, Bellandi, 1989). Basically, this idea is similar to flexible integration process: if the innovation can be carried out in large firms and in a planned manner, the innovative process can also be subdivided into multiple small-interconnected "firms of phase" in an unplanned way. Decentralized industrial creativity is reinforced by a decentralized model of absorption of new knowledge, which in turn circulates as a self-regulating result of the interactions between local firms. It is a result obtained more from search strategies and multiple cooperative interactions between firms than from planned and deliberate efforts to carry out R&D activities, as proposed in a typical linear innovation model.

These interactions – and the related feedback – occur throughout the supply chain and the different inter-firm networks of a MID, where firms cooperate in the manufacture of different products, product components or production phases. When existing knowledge is combined within a firm, a new knowledge is generated that can be translated into either a simple imitation or a variant of the original innovation. In this regard, marginal changes occur through different sources: design activities, learning processes in manufacturing, interactions with customers and suppliers, re-use and re-working of pre-existing external knowledge. This decentralized model of knowledge absorption conceives the innovative process as a circular process with feedback and information connections between the wants of the market and the processes of design, manufacturing and research of new solutions, that is, in the form of a cognitive spiral (Becattini, 2001). This behaviour is associated with Marshallian external economies (labour markets, subsidiary industries – both manufacturing and business services – and shared knowledge among firms specialized in different phases of the same production process).

2. The iMID-effect can also be explained by the joint functioning of the theory of differentiated knowledge bases and that of modes of innovation. Asheim and Parrilli (2012) differentiate between three types of knowledge base: analytical (science-based), synthetic (engineering-based) and symbolic (creativity-based). These types of mixed tacit and codified knowledge are intertwined with two modes of innovation: STI and DUI modes.

The STI mode of innovation (Science, Technology and Innovation) is associated with the production of analytical knowledge generated in deductive and formal models of science and technology, and is highly codified. An example of this mode is the linear model of innovation, based on science, R&D and the generation of disruptive innovations. The pharmaceutical industry is the typical example of this model.

The DUI mode of innovation (Doing, Using and Interacting), more associated with the synthetic and symbolic knowledge, is based on the generation of innovation through the learning and the resolution of problems in the daily work development, because workers (entrepreneurs and their employees) have to meet continuous changes and interact with customers, which forces them to face new problems and solve them. The search for solutions to these problems strengthens the skills and knowledge of workers and makes extensive use of tacit and often localized knowledge. The DUI innovation mode is customer-driven and mainly produces incremental innovations, although in practice it is also capable of producing radical innovations. Examples of this model are numerous in the mechanical, ceramic or furniture industry.

The innovative process in MIDs share similarities with the DUI mode. Therefore, it implies knowledge that can be largely tacit and specialized in its context of development and application. This mode brings back the importance of the experience presented in the learning-by-doing, by-using and by-interacting models formulated by Arrow (1962) and Rosenberg (1982).

Both issues, decentralized creativity and synthetic/symbolic knowledge, are intertwined (Bellandi, 1989) to such an extent that marginal modifications serve to meet and increase market demand. The existence of a broader market increases the profitability resulting from a larger division of labour between firms, since this specialization increases economies of scale and scope. During this process of growth, some district firms generate new knowledge, introducing radical innovations. When these innovations spread throughout the MID, they make it more competitive. Furthermore, there are MIDs that experienced a growth in which continuous learning has led to a process of intense product differentiation, powering the competitiveness of their firms (Belussi 2009, p. 470). The working of these processes makes the MID show a positive innovative differential (i.e., a iMID-effect) with regard to other types of LPS.

Boix and Galletto (2009), Boix and Trullén (2010), Galletto and Boix (2014) and Boix, Galletto and Sforzi (2018) have modelled the determinants of the iMID-effect in Spain during the period 2001-2005 using patent data and a categorization of LPSs based on the 2001 census. The results show that the MIDs generate almost 30% of the patents of the Spanish economy and that, despite the lower average expenditure in R&D, they have an innovative intensity above the Spanish average. Although public and private spending has a positive effect on innovation for MIDs, the high intensity of innovation is mainly associated with external economies of specialization (Marshallian), and even more than with economies of diversity and variety or with variables related to formal education.

3. Empirical evidence on MIDs and technological innovation in the Spanish economy: 1991-2015

3.1. Methodology and data

To follow the evolution of the iMID-effect in the Spanish economy, the current study uses the indicators based on averages as proposed in Boix and Galletto (2009). Innovative intensity is measured as the number of patents per million employees in a given period. Data are indexed on the average of Spain, so that they show the differential with regard to the Spanish average in each established period.

Technological innovation is based on the registers of Spanish patents and utility models (Spanish Patent and Trademark Office), European patents (European Patent Office) and global patents (Patent Cooperation Treaty). Data are geo-localized from the inventor's mailing address (alternatively, the applicant's address is used when the inventor's address is not available and there is no way to assign it). The geo-localization allows grouping the data by LPS. The patent is assigned to the year in which the registration period has been requested since it is considered the closest to the year of invention. The current study covers a period of 25 years, from 1991 to 2015. For this period, the database incorporates around 130,000 registers.[2]

Galletto and Boix (2014) proposed a method to weigh patents based on the potential value of the type to which they belong (i.e., Spanish, European and global patents). The use of this procedure allows the patents to be weighed for their potential quality and provides a complementary indicator.

The current analysis uses two series. The first one uses annual data, and allows the sensitivity to the effects of the economic cycle to be observed. The second uses three five-year data cuts (1991-1995, 2001-2005, 2011-2015). Data aggregation by groups of years is quite usual in innovation studies and aims to eliminate the effects of random annual fluctuations (see Aguilera and Galletto, 2018).

The mapping of MIDs and other types of LPS can be updated every ten years, at census. This fact allows mappings that change during the period under study (i.e., the 1991, 2001 and 2011 maps) to be used or that a map at a given time is selected. For the current analysis, we opted for the mapping of 2001 – the intermediate year of the period under study – to simplify the measuring of the innovative intensity of the Spanish MIDs during the period 1991-2015.

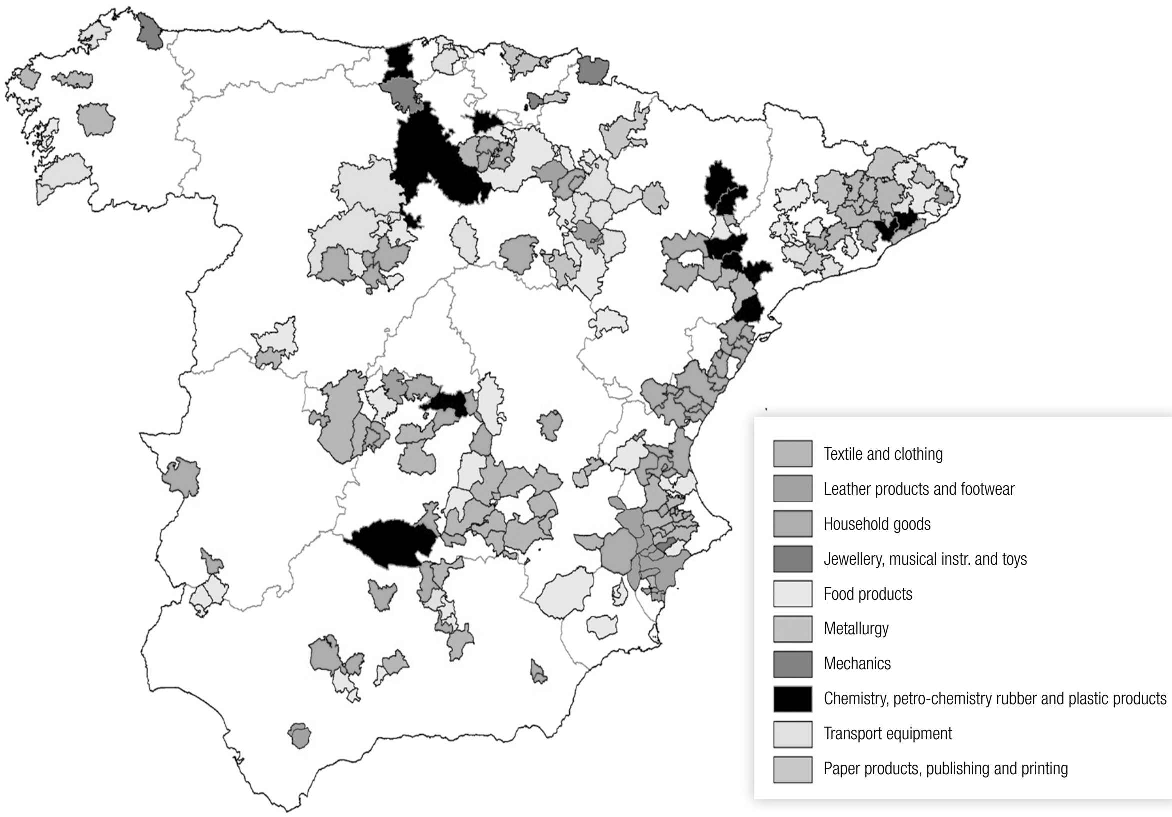
3.2. MID and typology of LPSs

The standard procedure for the identification of MIDs is known as Sforzi-Istat, and it is explained in detail in Sforzi (2009)[3]. Boix and Galletto pioneered in Spain this methodology (2006 and 2009), with revisions and updates (Galletto and Boix, 2014). The last update can be found in Boix, Sforzi, Galletto and Llobet (2015 and 2018). They define the 2001 and 2011 mapping of MIDs. An extension of the procedure (Boix and Galletto, 2009) allowed the rest of LPS – those that are not MIDs – to be classified based on their specialization in agriculture and primary activities, mining, construction activities, large-scale manufacturing and other manufacturing mixed

2 See Boix and Galletto (2009) and, for more details, the recent study by Aguilera and Galletto (2018).

3 The methodology has two stages (Sforzi, 2009). The first stage identifies local labour systems (LLSs) using data on inter-municipal daily journeys to work. The second stage identifies the LLSs with district characteristics, that is LLSs with a main specialization in manufacturing (among those manufacturing, of business services and consumer services) and the dominance of small and medium-sized enterprises (SMEs) both in the LPS as a whole and in its main manufacturing industry (what defines its specialization).

Figure 1. The Marshallian industrial districts in Spain in the year 2001



Note: Boix, Sforzi, Galletto and Llobet (2015 and 2018).

sizes of firm, business services, consumer services, social services and traditional services.

The 2001 mapping of Spain by Boix, Sforzi, Galletto and Llobet (2015 and 2018) identified 677 LPSs, of which 215 had MID characteristics (figure 1). In 2001 MIDs accounted for 24% of the Spanish population (9.90 million inhabitants), 24.9% of the total employment (4.06 million employed persons) and 38.2% of the employment in manufacturing (1,088,582 employed). 70.7% of MIDs were specialized in household goods (26%), food products (22.8%) or textiles and clothing (21.9%). These three main industries of specialization also accounted for 60.9% of employment in the MIDs' manufacturing industry and 59.1% of that in the main industries.

3.3. Results: do MIDs show a better behaviour in the generation of technological innovation than the Spanish average?

Between 1991 and 2015, MIDs generated an average of 1,600 patents per year. During these 25 years they accumulated around 40,000 innovation patents, equivalent to 30% of Spanish patents, which is a remarkable result.

Have MIDs shown a better differential behaviour generating technological innovation than the Spanish average? The answer is positive. We can establish some stylized facts from Figure 2 and Table 1.

1. During the period 1991-2015, MIDs generated an amount of innovations per million employees 27% higher than the Spanish average (figure 2). In addition, the number weighted by the potential quality of the patents (see Galletto and Boix, 2014, Boix, Galletto and Sforzi, 2018) shows that the innovative intensity of MIDs remains on average 13% above the Spanish average (figure 2).

2. The innovative differential of MIDs is more sensitive to the economic cycle than the Spanish economy as a whole (figure 2). It decreases during recessions and increases during the growth stages. This behaviour is explained by: a) the high openness of MIDs to international markets; b) the greater sensitivity of its products to fluctuations in demand; c) the high adjustment of industrial employment in Spain during recessions; and, last but not least, d) the more conservative behaviour of SMEs when registering European and international patents (the registration costs being much more expensive than those for national patents), as the weighted indicator points out.

3. LPSs of large manufacturing firms and LPSs specialized in business services[4] also show an above-average innovative intensity, as well as the other manufacturing LPSs (combining mixed sizes of firms) (table 2). In the case of the LPSs of large firms, these doubled the Spanish average in the period 1991-1995 but decreased to 49% for the period 2011-2015 (unweighted indicator).

4. The rest of the LPSs – specialized in agriculture, mining, construction, consumer, social and traditional services – show an innovative intensity remarkably lower than the Spanish national average.

4. Conclusions

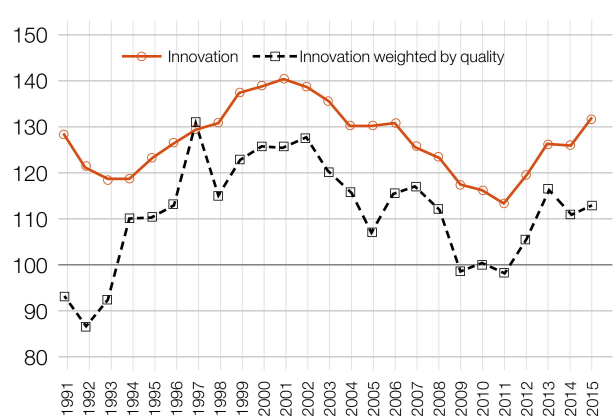
In Spain, the generation of technological innovation is a highly geographically localized process. The geographical gap of innovation is not so much between places that innovate a lot (manufacturing LPSs and business services-oriented) and places that innovate little (the rest of LPSs, a part of which corresponds to low-density geographies of population and employment or specialized in other services). In fact, the results suggest that: a) a complete model, associated with the core LPSs of the metropolitan areas of Barcelona and Madrid, with strong analytical, synthetic and symbolic knowledge bases; b) a partial model represented by MIDs and non-MIDs manufacturing LPSs (some of them having characteristics of geographical cluster à la Porter), and which show an intense synthetic knowledge base with lower analytical and symbolic knowledge bases; c) the rest of LPS, characterized by the weakness of their knowledge bases.

Theories such as decentralized creativity, differentiated knowledge bases and modes of innovation support that MIDs show a high innovative dynamic, based on territorial organization of the production process and on a differentiated and variable demand of consumers who aim at satisfying desires for variety and social distinction.

The MID is a different way to innovation, and a new approach to industrial change. The publication in 1986 in the first issue of the Revista Econòmica de Catalunya of the seminal article by Giacomo Becattini "From the industrial 'sector' to the industrial 'district': some remarks on conceptual foundations on industrial economics" (originally published in 1979, later re-published in Becattini, 2004), paved the way for district studies in Spain.

Within the Spanish economy, MIDs have proven to be an efficient way to organize production and generate innovation. When studies warning about the perverse effects of innovation on the destruction of employment and the polarization of income and spatial segregation begin to appear (see, for example, Florida and Gaetani, 2018), efficiency may not become the main objective. Becattini (2000) endorses the MID as a form of organizing production more compatible with equity and distribution objec-

Figure 2. Technological innovation (patents per million employees) in MIDs of Spain (1991-2015). Spain = 100 and ID of 2001



Note: LPS constants identified from 2001 census. Revised mapping (Boix, Sforzi, Galletto and Llobet, 2015).
Source: IERMB from 2001 census, Ministry of Employment and Social Security, OEPM, EPO Bibliographic data and PATSTAT.

4 **According to the revised 2001 classification, the biggest LPSs of large manufacturing firms include Barcelona, Zaragoza and Pamplona and those specialized in business services include Bilbao and Madrid. The averages have been calculated using the data aggregated by category. Therefore, the weight of Barcelona and Madrid affects the results on innovative capacity of LPSs of large manufacturing firms and business services.**

Table 1. Patents and utility models per million employees in LPSs identified from 2001 census, by type of LPS, 1991-2015. Spain = 100.

	Innovació			Innovació ponderada per qualitat		
Tipus de SPL/període	**1991-1995**	**2001-2005**	**2011-2015**	**1991-1995**	**2001-2005**	**2011-2015**
Agriculture	31,3	40,2	43,0	19,6	22,1	26,5
Mining	25,5	51,8	55,2	19,6	14,7	34,3
Manufacturing	147,9	149,0	133,8	145,1	154,7	143,1
Industrial district	**122,4**	**134,8**	**122,8**	**100,0**	**117,9**	**107,8**
Large firm	200,0	174,2	148,7	241,2	221,1	197,1
Others	146,9	146,7	152,8	135,3	149,5	177,5
Construction	39,1	47,0	53,1	31,4	28,4	28,4
Services	80,2	75,4	88,7	86,3	74,7	85,3
Business services	128,1	102,3	113,1	154,9	115,8	123,5
Consumer services	46,4	47,6	38,9	43,1	40,0	29,4
Social services	69,0	74,2	87,5	60,8	67,4	87,3
Traditional services	34,6	49,9	75,1	27,5	36,8	49,0
Spain	100,0	100,0	100,0	100,0	100,0	100,0

Source: IERMB from 2001 census, Ministry of Employment and Social Security, OEPM, EPO Bibliographic data and PATSTAT

tives (see Trullén and Boix, 2017). In a sense, the MID model of production is “a capitalism with a human face” (Becattini, 2004).

Nevertheless, the relationship between different types of LPSs, innovation and inequality has not yet been analysed for the Spanish economy.

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