Abstract:
This research compares the innovation capacity of the most important ceramic tile industrial districts located in Europe.
Our analysis shows: Firstly, a similar level of competition within them but a far weaker cooperation in the Spanish district. Secondly, that the scarcity of technology and advanced services providers in the Spanish district relegates it to a follower role in the adoption process of innovation. And thirdly, that the presence in the Italian district of horizontal technology enterprises raises the innovative tension because of the technology diffusion across districts and it is favoured by the mobility of qualified workers.

JEL - codes: L61, -, -
ABSTRACT
This research explores the innovation capacity of the two most important ceramic tile industrial districts in Europe, the Italian (Sassuolo) and the Spanish (Castellon) districts, following the Regional Innovation Systems and the Industrial Districts theoretical approaches. In both districts innovation is to play a definitive role in allowing companies to maintain their competitiveness in a globalising market. Our analysis shows i) a similar level of competition within the districts of both countries but a far weaker cooperation in the Spanish district compared to the Italian one. ii) The scarcity of technology and advanced services providers in the Spanish district releages it to a follower role in the adoption process of innovation. And iii) in the Italian district the presence of horizontal technology enterprises raises the innovation intensity because of the technology diffusion across districts and also because it is favoured by the mobility of qualified workers.
LITERATURE REVIEW

Globalization and industrial restructuring is challenging innovation in mature industrial regions. In recent years efforts have been made to understand how innovation is achieved and special emphasis has been put on the role of networks. Whereas some approaches have set the boundaries of their focus to the geographical unit, others have done so towards the sector analysing how firms generate and utilize the new products and technologies within a sector (Breschi and Malerba 1997).

One of the most important analysis in this field was started with the seminal work of Becattini in 1979 that developed the Industrial Districts theory derived from the new economics of Marshall. In this perspective the focus of the industrial development analysis is on the district, the stress is on the region and not on the sector. The benefits derived from the adoption of this perspective have improved understanding of regional development, especially when dealing with the analysis of the relations between enterprises that share a common space. The main characteristics of an industrial district are flexible specialisation, cooperation between enterprises, geographic proximity, and the social relations of enterprises (Staber and Morrison, 1999). This perspective implies that the aggregation of a variety of small and medium enterprises producing in the same goods chain and in a concrete area can cause innovation. And innovation is caused by means of the special synergies driven by a cooperative versus competitive tension within the different actors. These synergies, elicited by close relations among elements within a district, affect innovation production and innovation transfer in several forms. These means include incrementing qualitative and quantitative transfer of information, increasing confidence between the different elements in the district, lowering transaction costs, or improving access to experienced and highly skilled human capital. In addition, industrial districts also promote innovation in a variety of forms, because of the privileged perspective of those inside the district, the social capital available inside the district, the pressure of competitiveness, and the availability of resources inside the district (Becattini, G. 1979 and 2002; Pyke, F. et al 1992 and 1994; Sengenberger, W. et al 1992; Bellandi, M. 2002; Camagni, R. 1999).
The relevance of the concept of innovation systems has been growing during the last decades as has it has become clear that technological change cannot longer be considered as exogenous factor when analyzing economic growth. National systems of innovation are defined as “the network of institutions in the public and private sectors whose activities and interactions initiate, import and diffuse new technologies” (Freeman, 1987).

The present research combines the sectoral innovation system and the industrial district perspectives to analyse the relationship between the structure and the innovation capacity of industrial districts.

METHODOLOGY

We performed a case study analysis on a relevant industrial district in the east of Spain: the ceramic tile industry located in Castellon, and its Italian counterpart in Sassuolo. The research was built on by revising previous research on the aforementioned districts, by analyzing recent secondary statistical data on the sector and, by carrying out more than two dozens semi-structured interviews with representatives of both districts.

The interviewees were selected for being either managers from ceramic, electro-mechanical or glaze companies; representatives of employers’ and workers’ associations; representatives of public institutions specialized in technology or trade; directors of research institutions responsible for R&D for the industry; or for being academics whose work had intensively been focused on the issue. In the interviews information was obtained regarding different aspects on the innovation process. More specifically our interest was directed to understand innovations’ achievement and dissemination in the market and the role of the different agents that participated in the innovation processes, i.e. how innovations were stimulated and diffused in the sector. Besides more general questions about the sector evolution, global trends in production, new competitors or trade affairs, were also included.

Once all interviews were conducted, the information obtained, together with the statistics available on the sector, was used to test the validity of two non-excluding hypotheses regarding the innovation capacity of industrial districts.
For setting up our hypotheses we followed Nelson’s primary typology of enterprises (Nelson, 1993). In his work he distinguishes three types of industries based on the characterisation of their technical change process. In a similar way, our research classified the enterprises of both ceramic districts into the following categories. Type A enterprises, which corresponded to bulk commodities in Nelson’s typology, grouped the enterprises’ producers of the commodity (i.e. ceramic tiles) characterised by minimal product and process innovations, and by obtaining their main sources of innovation from equipment and input suppliers. Type B enterprises, namely providers of technology and advanced services (i.e. mechanics, electronics or design ventures) grouped the remaining two types of industries, B1 complex systems producers and B2 chemical products producers that are responsible for the innovation in the ceramic tile district as we will see in the next section. However, the following differences between B1 and B2 enterprises must be noted. Whereas in B1 enterprises (complex system producers) technical advance tends to proceed through improvements in components and system design, thus having innovation an incremental nature, in B2 enterprises (chemical products producers), innovation is mainly achieved through the introduction of new products. Consequently, input suppliers, such as component and material producers and system designers, do play an important role for type B1 enterprises innovation processes, whereas their role is not so important in the innovation processes of B2 enterprises, whose products do not involve complex systems. From the above it follows that type B2 enterprises are more dependent on their own R&D and on the close relation with clients, whereas type B1 enterprises depend on the innovative performance of their input supplier.

Having settled the abovementioned typology we can proceed to the analysis of our two hypotheses: H1 and H2. The first hypothesis (H1) states that the innovation in a given industrial district is strongly dependent on the structure of the district in terms of the kind of enterprises that compose that district. This is a positive dependence in terms of the number of type B enterprises, that is to say, the higher the number of type B enterprises in a district, the higher innovation capacity that district will have. Furthermore, the different composition, within type B enterprises, between types B1 and B2 will influence the type of innovations predominantly created.

Our second hypothesis (H2) affirms that the innovation capacity of a district depends on the strength of the relations that the type B enterprises in that district have with
other type B enterprises in other geographically close districts. This may be especially important when type B1 enterprises predominate for being more dependent on input suppliers than B2 enterprises. In other words, innovation in a given industrial district might be more influenced by innovations developed in neighbouring districts if it is facilitated by the relation between type B1 enterprises.

In brief, the two contrasted assumptions are that the innovation capacity of a district is positively affected by a) (H1) the presence, magnitude and composition of type B firms in a given district and b) (H2) the strength of the relationships that these companies have with type B enterprises of neighbouring districts.

DATA AND ANALYSIS

As statistics show and interviewees confirmed, both industries of ceramic tiles in Spain and Italy have strongly developed a good command in tile production, being leaders in both sales on international markets, and, after China, in production (see Figures 1 and 2) though competition from newer producers has increased the need for continuous improvements and innovations in both districts. Therefore both districts are confronting the same scenario under conditions that are becoming progressively similar (in terms of internal market, quality requirements, environmental restrictions, etc.) since the entry of Spain into the European Union in 1986.

Despite their similar environments, our analysis shows that the internal differences between both European districts are remarkable. In the next sections the most important differences between both tile districts are discussed. Section 1 focuses on the main elements of the tile sectoral innovation system. Section 2 analyses the elements of the tile production process. And, finally, in section 3 the two hypotheses are tested.
Figure 1

Export share

Percentage

Italy, Spain, China, Brazil

1998 1999 2000 2001 2002 2003 2004

ASCER 2002 and 2004

Figure 2

Production share

Percentage

Italy, Spain, China, Brazil

1998 1999 2000 2001 2002 2003 2004

ASCER 2002 and 2004
Section 1: The Sectoral Innovation System

The main environments of the tile sectoral innovation system are represented in Figure 3. The approach, adapted from Fernandez de Lucio (Fernandez-de-Lucio et al. 1996), shows three environments (the productive, the scientific and the technological) influenced by the legal and institutional framework.

Figure 3

**Sectoral Innovation System**

(Adapted from Fernandez-de-Lucio et al. 1996)

The technological progress and the competitiveness of a sector depend intensively on the institutions and supporting organizations, that is why we performed a comparative analysis of the Spanish and the Italian districts.

At the institutional level, our analysis shows that the Spanish tile sector has a more fragmented associative level than the Italian one. For instance, in Italy is observed a clear hegemony of the tile manufacturers’ association (Assopiastrelle) and to a lesser degree the manufacturers of machinery and equipment association (ACIMAC). In contrast, the Spanish sector shows a multiplicity of agents of which the principal is the manufacturers’ association (ASCER) but also relevant are the frits and glaze
manufacturers’ association (ANFFECC), the manufacturers of machinery and equipment association (ASEBEC), the ceramic technicians association (ATC) and the ceramic and building materials distributors’ association (ANDIMAC). Although this atomisation favours the heterogeneity of the interests defended in the Spanish tile industrial district, it also limits the strength of each single voice in representing the district interest as a whole. Moreover, the leadership on international exhibitions is for the Italian ceramic and technological fairs (Cersaie and Tecnargilla respectively) rather than for their Spanish counterparts (Cevisama and Qualicer). Finally, nor the Italian nor the Spanish districts have direct policies being applied to favour them, although the Spanish district has a more favourable attitude from its institutional environment.

At the scientific level, it is worth distinguishing between educational and research activities. Firstly, the Spanish educational supply, through the Jaume I University (Castellon), offers high quality chemistry degrees that are specifically oriented to the ceramic process, while the management, commercial and the industrial engineering supplies are scarce and deficient. On the contrary, the Italian educational supply at the Modena and Reggio Emilia University has only recently engaged on chemistry specialities, being its strength traditionally placed on business administration and industrial engineering. Secondly, the research activity is more evolved in the Castellon district, supported by a university (Jaume I University) and two research centres (Instituto de Cerámica y Vidrio, and the Instituto de Tecnología Cerámica), than in the Sassuolo district where the Centro Ceramico di Bolonia (CCB) carries out most of the research effort derived from the scientific level.

Concerning the technological and advanced services providers’ environments, in the Castellon ceramic district the technological innovation is driven by the glaze sub-sector in close cooperation with the ITC (Instituto de Tecnología Cerámica), whereas in the Italian ceramic district the technological innovation comes mainly from the machinery providers together with the design studios, the CCB not being comparable to its Spanish counterpart. In the Spanish district the role of the ITC is remarkable for its major contribution not only to the formative process (being 80% of the teaching staff of the Chemist Engineering with specialization in Ceramic Technology also integrated in the institute), but also for its R+D activities. The Sassuolo district, for instance, has a greater training on design, management and commercialisation, but it
lacks the cooperative strength of a technical association as the Spanish ATC (Asociación Española de Técnicos Cerámicos).

As regards to the productive environment, both districts present differences in many aspects. Firstly, Spanish enterprises are younger and smaller in size (see table 1), being more flexible and dynamic than their Italian counterparts, but having a more limited capacity of doing research autonomously. Being older, the Italian companies have overcome, in a higher proportion than the Spanish, the more familiar way of running the company, based on the intuition of the owner or main shareholder, and have assumed a more management-like approach where shareholders adopt strategic decisions in steering committees. Moreover, Spanish enterprises are in general not specialized, producing several product typologies, significantly subcontracting and having little cooperation in common projects with other enterprises, whereas Italian enterprises do have product specialisation, and the implication of these enterprises in their sectoral innovation system articulation is greater. Finally, the Castellon tile product position in the high market segment is weak, whereas Sassuolo’s position is that of leadership in almost all relevant markets.

Table 1

<table>
<thead>
<tr>
<th>Firms and employment in 2003</th>
<th>Italy</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms</td>
<td>315</td>
<td>294</td>
</tr>
<tr>
<td>Employees</td>
<td>30.264</td>
<td>25.200</td>
</tr>
<tr>
<td>Mean</td>
<td>96,1</td>
<td>85,7</td>
</tr>
</tbody>
</table>

(ASCER and ASSOPIASTRELLE)

Section 2: Elements of the tile production process

As shown in Figure 4, we identified six central elements in the tile production process. In this section we make a descriptive analysis of these elements by measuring its contribution to the value chain and examining how that activity is developed on each district and by whom.
The most basic activity in the tile production process is raw material extraction (mainly clay, but also silica, etc.). Clay quality (i.e. its organic composition) determines its suitability for tile production and therefore its final cost is, to a great extent, dependent on the distance from the mine to the plant. In fact, two types of clay are used for tile making, namely red and white clays. Red clay used to be predominant in both Spain and Italy, but nowadays it is only predominant in the former. It must be noted that, due to its lower organic content, Spanish red clay quality is higher than the Italian. In contrast, white clay has to be imported from Eastern Europe (Germany and Ukraine), but offers the possibility of colouring the tile without adding frits. The use of this type of clay has exceeded that of the red one in Italy, thus noticeably increasing the transport costs. In Spain, however, the close vicinity of the extraction mines causes red clay to be predominantly used.
Machinery and equipment activities cover all the activities of the tile production process from clay grinding to the storing, including pressers and kilns, and also machinery for frits and glaze production. The acquisition of new machinery is the way in which most tile companies innovate. Therefore the relationship between tile and machinery manufacturers is of strength cooperation. The majority of machinery providers are Italian and cover all the activities. The Spanish machinery providers are reasonably specialized in machinery for glazing, machinery for frits and glaze preparation, and maintenance. Consequently the presence of Italian machinery delegations in the Castellon tile district is very important. Furthermore, Italian machinery providers are responsible for most process innovations. Particularly important, as signalled by Russo (1996), are the generic innovations coming from neighbouring districts, such is the case of the atomizer machine, which was initially developed for the process to obtain powder milk, or the furnace tunnel.

Glaze production is also of a great importance for the tile process except for the case of the production of non-enamelled porcelain, which is nevertheless minoritary (see table 2). Aesthetic become increasingly relevant for product differentiation as markets become mature. In fact, this component, which is consumed in great quantities by the tile industry, is responsible for the final properties and appearance of the product, apart from allowing the addition of a variety of decorations. Glaze companies are also partly responsible for innovations in designs and applications. As regard to nationality, most important glaze companies are established in both districts having delocalised, to avoid environmental constrains, from Italy to Spain during the seventies and eighties. However, Spanish glaze companies have also absorbed silk-screen printing design for their clients as an added service, and offer a complete design-and-application provision.
Production typology in 2002

<table>
<thead>
<tr>
<th></th>
<th>Italy</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porcelain tile</td>
<td>329.379</td>
<td>55.335</td>
</tr>
<tr>
<td></td>
<td>54.4%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Enamel</td>
<td>453.502</td>
<td>608.034</td>
</tr>
<tr>
<td></td>
<td>74.9%</td>
<td>93.4%</td>
</tr>
<tr>
<td>Not Enamel</td>
<td>151.975</td>
<td>42.966</td>
</tr>
<tr>
<td></td>
<td>25.1%</td>
<td>6.6%</td>
</tr>
<tr>
<td>Wall tile</td>
<td>122.306</td>
<td>240.870</td>
</tr>
<tr>
<td></td>
<td>20.2%</td>
<td>37.0%</td>
</tr>
<tr>
<td>Floor tile</td>
<td>438.171</td>
<td>410.130</td>
</tr>
<tr>
<td></td>
<td>79.8%</td>
<td>63.0%</td>
</tr>
<tr>
<td>Total</td>
<td>605.477</td>
<td>651.000</td>
</tr>
</tbody>
</table>

(ASCER 2004)

Nowadays design is of major importance for almost every consumer good, this is especially true for decorative goods such as tiles. Tile design can be decomposed on its three basic appearance properties i.e. size, texture and colour. Variations in these properties are developed by designers in collaboration with tile, machinery and glaze producers. The Spanish tile producers, for instance, first developed big format tiles with the help of Italian machinery producers. Also Italian tile producers have developed in close cooperation with Italian machinery producers porcelain tiles with a variety of textures that imitate natural stones surfaces. In addition, drawing designs in Spain are developed by frits and glaze companies in cooperation with tile companies, whereas in Italy the work is done inside tile firms and design studios. As it happens in many other industries, Italian design and fashion are the worldwide reference in which other companies look at, tile sector is not an exception to this trend.

Tile production is a highly integrated process because of the costs associated with the breaking down of the different process involved. Consequently, tile enterprises have, on average, a considerable size, higher that of Italian companies because of a more developed concentration process. Tile production has evolved a great deal since the sixties thanks to the increase in mechanization, the great reduction of time consumed in the process, and the simplification of the process itself (i.e. single firing).

Finally, distribution has largely been delegated to mediators and construction companies, especially in Spain. Only recently have leading tile companies noticed the importance of a direct deal with end users. As in many other businesses, also in
tile companies, distribution and associated services are becoming increasingly important and companies are therefore moving towards an integration and control of that final link of the value chain. Once again Italian tile companies are in an outstanding position derived from their experience on selective international markets.

Section 3: Hypotheses

Having seen the main characteristics of both the tile sectoral innovation system and the elements of the tile production process, we are in condition of testing the validity of our hypotheses.

Our first hypothesis stated that the innovation in a given industrial district was strongly dependent on the structure of the district in terms of the kind of enterprises that compose that district. We suggested a positive dependence between the number of type B enterprises and the innovation capacity of that district. Furthermore we expected that the different composition of type B enterprises also influenced the type of innovations predominantly obtained. Additionally, our second hypothesis assured that the strength of the relationships that type B1 enterprises have with type B1 enterprises of neighbouring districts also influenced the innovation of a given district.

Are our results in accordance to none, one or both hypotheses? Firstly, our results show that type A enterprises in the ceramic tile industry in Spain, are of a lower size than their Italian counterparts therefore limiting its innovative capacity. Secondly, it is also evidenced that the Spanish ceramic tile district has not developed suppliers of technology (B1 enterprises) with a critical mass big enough to cope with innovation other than that specifically relating glaze production and application, nor do they count with advanced service providers specialized in design. Therefore it is solely focused on the production of the commodity and, to some extent, on the production of components. The consequences of being basically specialized only on the production of the article of trade implies isolation and low cooperation between the elements of the value chain. Since these are the main prerequisites for innovation inside a district, we can conclude that our results support H1. Furthermore, considering their major role in innovation in an industrial context, the absence of providers of knowledge-intensive processes such as advanced services and technology has also an impact on the relation between university and industry.
Nevertheless, as shown previously, the ceramic tile districts do count with a component provider of an enormous importance for the process. This important sub-sector, which has developed around the ceramic tile makers, elaborates the glaze, a complex and highly scientifically dependent input for the tile making. In addition, in the Spanish district, the glaze makers also provide for services such as technical assistance and design, thus partially compensating the absence of specific service providers. Moreover, the presence in the district of glaze producers has made possible a strong cooperation with chemistry university departments in the region. This cooperation has enabled progress towards innovation mainly, but not exclusively, on those aspects related to the chemistry of the glazing. The existence of ties with university departments is also strongly related to the effort done by the enterprises in the ceramic tile sector on recruiting employees with medium specialized and higher degrees in chemistry. This has two important consequences for the sector performance. Firstly, as denoted by Putnam (1996) it has been found a strong relation between education and social capital, especially for the latest years of education, and social capital implies cooperation between agents in the system. The fact of having shared the experience of studying in the same places together with the high rotation of workers between enterprises strongly facilitates the necessary glue for cooperation and assistance between companions. Secondly, the human capital disposable in the district allows the absorption and development of innovation.

On the other side we have shown how the Saussolo district is leader not only in technology mastering but also in commercialisation of the product and design. Emilia Romagna is recognized worldwide for both its reference position for fashion and design as well as its leading technological position in machinery for bioengineering, electronics and automobile engineering. Our analysis denoted, together with the already mentioned excellent performance in the production of the commodity, that the Italian district included most of the complementary activities that complete the value chain of the product. As opposed to the Spanish case, the Italian district counts with technology providers (B1 enterprises) inside the district and with advanced services providers, apart of components providers. This is of great importance for several reasons. Firstly, the fact that the producers of the commodity and the providers of capital goods are together in the same geographical area provides the confidence, information transfer and strong cooperation required for innovation. This
is sown by the fact that most process innovations have been developed by Italian capital goods producers, and those developments carried on in Spain are related only to the glazing process. This association provides further support for H1. Secondly, to have the advanced services providers on the same geographical area is also of a considerable importance for the enrichment of the transfer of knowledge. Finally, evidence supporting H2 is exemplified by cases, such as atomisation technology or furnace tunnel, in which providers of capital goods for tile manufacturing develop technology in close relation with surrounding industrial districts. Nelson pointed out that differences in the mix of industries between nations strongly influences the shapes of national innovation systems (Nelson, 1993). In our view, our results show that Nelson’s statement can also apply to industrial districts.

CONCLUSIONS

The emphasis of this study is made on understanding the links between innovation and the cooperation among the elements of a given industrial district and on the presence of enterprises providers of technology and horizontal advanced services common to a variety of districts.

Several conclusions that are relevant for testing the abovementioned H1 and H2 hypotheses can be outlined from the present comparative analysis of the tile industry districts in Castellon and Saussolo: 1) it is observed a strong role for competition within the Spanish district that is not accompanied by a similar strength in cooperation. This is exemplified by the results of the interviews that acknowledge a similar level of competition within the districts of both countries but a far weaker cooperation in the Spanish district compared to the Italian. 2) The scarcity of technology and advanced services providers (type B enterprises) in the Spanish district provokes that the important process and product innovations are carried out in Italy, relegating the Spanish districts to a follower role in most areas. 3) The existence of horizontal technology enterprises raises the innovative tension because of the technology diffusion across districts, and is favoured by the mobility of qualified workers. Taken together, findings from 1) and 2) provide evidence that supports the H1 hypothesis, while 3) is in accordance with H2. Therefore we conclude that exists a positively dependence of industrial innovation with both the relative amount of
technology and advanced service providers in a district and the strength of cooperation between these industries and similar ones from neighbouring districts. In addition, our analysis suggests that both districts require better links with university in order to enhance the possibilities of developing radical innovations. It is worth mentioning that some dependent innovations like the self-cleaning tile have not been developed in Italy or Spain despite the fact that these countries are the leading producers. Finally, it must also be noted that with the entry of new countries to the industrial production scene, delocalisation threatens a greater amount of firms in Spain because a bigger proportion of them are focussed on the production of the commodity. On the contrary, the enterprises providers of technology and advanced services, in addition to being more competitive, have a better chance to diversify their activities to new sectors.

REFERENCES


