THE CERAMIC INDUSTRIAL DISTRICT: IDENTIFICATION AND INNOVATION IN THE PROVINCE OF CASTELLÓ

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Abstract

This work studies the Ceramic Industrial District in the province of Castelló. Main theoretical concepts which characterize industrial districts are given, as the socioeconomic view, agglomeration, "industrial atmosphere", "district effect" and its strategic implications. The work is focused on the main features of the Ceramic Industrial District, activities forming the sector, data and how it has evolved since the last crisis in 2007 and, finally, innovations in the district, how important they are and the main innovation in last years in the ceramic industry, InkJet technology.

Keywords: Industrial district, Innovation, Ceramics, Castelló

JEL Classification: L61, O32, D2

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1. Introduction

1.1. Work justification

At the present time, there is a widespread recognition that changes in technology, new ways of communicating and competition have led to a decline in the traditional roles of business location. Until seventy years ago, since the Second World War, companies were mostly vertically integrated and resorted to economies of scale to produce serial items with lower production costs. Nonetheless, clusters or geographic concentrations of interconnected companies are a striking feature of nearly all regional, national, state and even metropolitan economies, especially of those most advanced nations (Porter, 2000). These clusters of companies or industrial districts have played a crucial role in the growth of many regions and countries (Porter, 1990).

Accordingly, it is compulsory to study this not so new form of business organization, given that it is interesting from an academic point of view and to the extent that governments can promote new industrial policies.

1.2. Motivation and objectives

Industrial districts or clusters have long been studied and increasingly given the importance they deserve in terms of development and competitiveness of the regional economy. The most important and powerful ceramics industrial district of Europe is located in Spain, concretely in the province of Castelló, and Italy. This district is formed of different private and public institutions, which make interactions possible. From small private companies that are only in charge of a step in the production process or others which specialize in more craft work, to large multinationals of the sector, research centers, such as technological institutes, and even provincial, national and European public administrations.

Firstly, a theoretical introduction to what an industrial district implies in economic and social terms will be seen, emphasizing the socioeconomic concept proposed by Giacomo Becattini (1979), the so-called “district effect”, interpreted as district effect when translating it into English, as well as the competitive advantages of the industrial district. Secondly, characteristics necessary for the origin and identification of industrial districts will be given according to a specific methodology and the first studies on industrial districts in Spain will be examined. Consequently, the province of Castelló and the municipalities most involved in the ceramic district, will be placed in a geographic context, as well as the activities that form the sector and the district’s leading research center. Data from the sector will be discussed as to acquire an idea of

the importance of the ceramic industry district at the provincial, state and global levels and its recovery since the past economic crisis. Lastly, the objective of this work will be to comment on the existing innovation in the industrial districts in general and, particularly, in that of ceramics.

1.3. The history of the industrial district concept

In the early 1970s, a profound crisis, driven by certain supply shocks and a change in demand characteristics, led to a redefinition of markets and the competition model. This situation resulted in an increase in the trend as regards business organization, towards small business and the emergence of scholars and academics who have tried this new way of understanding the new business organization, both internally and externally.

Traditionally, there have been different authors and economists who have mentioned the first ideas about industrial districts, what Becattini would name it, or what Michael Porter would call a cluster in 1990.

First, Alfred Marshall in his work "*Principles of economics*" (1890), already points to industrial districts as concentrations of specialized sectors in a specific locality, concentrations whose interaction creates advantages for the companies located there. Marshall describes the functioning of the British industry at the time, concluding that for certain types of production, there were at least two efficient ways of doing so: firstly, that consisting of large vertically integrated production units within the company and, secondly, that based on the concentration of many small plants located in one or more areas, with the characteristic of being specialized in the manufacture of different phases of the final product (Fuertes, 2005).

Marshall explains that one of the keys is the mutual trust between entrepreneurs to generate favorable conditions for the creation of innovations and their diffusion among the companies that constitute the industrial district (Blacutt, 2013) and recognizes that the economy is organized in space and that location and place have an important influence on the economic process. Additionally, Marshall, apart from identifying the main factors of production as Adam Smith already did (land, capital and labor), highlights knowledge as the most powerful engine of production and adds that organization aids knowledge (Galletto, 2014).

Almost a century later, Becattini recovers Marshall's concept in 1979, when he wrote the article *"Dal settore industriale al distretto industriale: Alcune considerazioni sull'unità d'indagine dell'economia industriale"*, to interpret the processes of

industrialization and as a way of viewing the industrial district as an instrument of public intervention (Galletto, 2014). Ten years later, Becattini, in his work "*The Marshalian Industrial District as a Socio-Economic concept*" (1989), uses the term agglomeration and adds, on what Marshall explained, that for a true industrial district to exist, it is essential that companies integrate with the local population, its reservoir of culture, values and social norms adapted by an industrialization process from below (Blacutt, 2013). For Becattini, the industrial district represents an intermediate entity between a singular subject (the workers of the area) and the general economic system, which assumes the description of a local community together with the industrial one; that is, an industry defined through the local community rather than through the productive technology (Sforzi, 2008).

Sometime later, Michael Porter (1990) in his book "*The Competitive Advantage of Nations*" uses the word cluster to refer to these same industrial districts, with some differences. A cluster is a geographic concentration of interconnected companies, service providers, companies in related industries and partner institutions (for example, universities) that in a particular field compete but also collaborate (Porter, 2000).

As it can be seen, this phenomenon is long-standing and has been studied in depth by several well-known authors of the regional economy.

2. Theoretical framework

Now that it has been mentioned how the concept of industrial district has changed from Marshall to Becattini, and finally adding Porter when talking about cluster, what an industrial district means will be now theoretically commented.

Becattini and Porter differ in terms of industrial district and cluster. On the one hand, Porter pursues, through the clusters, a global type development and focuses on competitiveness by looking for the sources of competitive advantages of the locations (Lazzeretti, 2006) and develops a "diamond" model to explain the factors of competitive advantage of the clusters, being four: access to the production factors, conditions of demand according to the life cycle, the competitiveness of the sector and the related industries. Moreover, for Becattini, the industrial district is a socio-territorial entity that is naturally and historically limited to a community of people and a population of industrial companies (Soler, 2008).

As Soler (2008) states, the cluster concept of Porter is more modern, but Becattini's concept seems to adapt more to the business reality of Italy and Spain. The new socioeconomic logistics are associated with profound spatial changes that define new forms of the territory organization: this organization is largely determined by the formation of a space of constantly evolving flows which, although intangible, affects, in a very concrete way and at very different scales, the dynamism of the various territorial areas (Caravaca, 2002).

Hence, Becattini defines the industrial district as "a socio-territorial entity characterized by the active presence of both a community of people and a population of businesses in a natural and historically delimited area" (Becattini, 2017). In this definition, it is noted that the importance of social relations in the productive systems of the district is then identified, the industrial districts become a socioeconomic concept characterized by the incorporation of the economic relations in the local systems (Galletto, 2014), for which they are comprised the historical socio-cultural legacies of the local community and consolidates economic relations with interpersonal relations (Lazzeretti, 2006). According to Sforzi and Boix (2015), the concept of industrial district has three parts: it is an economic classification unit to define industry; it is a research unit to undersand economic change; and it is a socioeconomic concept to understand the organization of production.

Two characteristic elements can be extracted from Becattini's interpretation. The first is the community of people living and working in the district. This also includes informal institutions (values, attitudes and implicit norms of behavior) and formal institutions

(social partners, local government, training centers, etc.). The second characteristic is the territorial concentration of companies in an industry, in addition to those subsidiaries to it. That is, in the industrial district are present all or most of the phases of the production process ("*la filiera productiva*", what Becattini calls it) (Galletto, 2014).

What sets Becattini in 1979 in his seminal work apart from other academics who studied Marshall industrial district was that he approached his theoretical system from a completely different perspective to the traditional one, since Becattini understands and interprets how Marshall speaks about his so-called social philosophy which is no more or less, how he conceives work; neither a commodity, nor a pure means of existence, but the end of life or, life itself, in Marshall's words (Sforzi, 2008). Besides, Becattini focused on the socioeconomic key of the definition, which allowed him to highlight the role of elements like trust and cooperation as mechanisms for risk reduction and economic governance among companies (Galletto, 2014). This is why Becattini has such an impact on the concept of worker knowledge within the industrial district, why Marshall, in his Principles, says that by work, workers should be understood, together with their knowledge and ability to organize them for productive purposes, to conclude that the worker is depicted in much of the place where he lives ("industrial atmosphere"). All this offered Becattini the possibility of interpreting the industrial organization from the point of view of the local community (Sforzi, 2008).

Thus, according to Becattini (1979, 2002), the industrial district is characterized by:

- Economic relations which generate a peculiar combination of competition and cooperation which is not explained by a purely market logic.
- Competition between small manufacturers specialized in the different stages of production helps to maintain costs low and creates a favorable environment to the innovations that appear in the production processes.
- A high level of professional and social mobility that makes it possible to exploit in the best possible way the present and future potential of all individuals.
- The presence of local authorities controlling some intrinsic aspects to the accumulation process (for example, building regulations) determines an acceptable adjustment of the capital-labor conflict (Bianchi, 2009).

An interesting and characteristic term in the definition of industrial district is "agglomeration", defined as the benefits that appear when companies and individuals are concentrated in a certain geographical location. These types of economies improve the productivity of the area and the sector, allowing access to inputs and skilled workers. Being located within an industrial district implies access to cheaper costs of

specialized inputs such as components, machinery and personnel, which means greater efficiency of the production factors, be it capital or work. Thanks to the agglomeration and the “district effect”, even small businesses are able to compete even though, internally, they fail to achieve economies of scale that allow them to reduce costs and achieve high levels of efficiency, competitiveness and innovation (Porter, 2000).

Thus, according to Dei Ottati (2006), the "district effect" is the set of competitive advantages derived from a highly interconnected set of external economies of those unique but internal enterprises to the district. These economies depend not only on the territorial concentration of productive activities (agglomeration economies, which have been explained previously) but also (and this is the main characteristic that distinguishes the industrial district) on the social environment in which these activities are integrated. The "district effect" involves cost reductions and increases in productive, static and dynamic efficiency (improving innovation capacity) (Galletto, 2014). Likewise, another determining factor in the increased productivity of these areas is access to information. Extensive market, technical and other specialized information, is accumulated by local companies and institutions, which within the cluster can be used at a lower cost. In addition, personal relationships between workers and companies improve this flow of information (Porter, 2000). The dissemination of information drives new ways of producing based on the continuous and increasingly rapid incorporation of innovations, which allow substantial changes in business location models that are now less constrained by the distance factor and which lead to the development of an "information society" (Caravaca, 2002). Hence, according to much of the cluster literature, these characteristics would generate a tacit knowledge and high-quality information exchanges and, consequently, promote innovation led by companies (Molina-Morales, Martínez-Cháfer and Valiente-Bordanova, 2018).

Something that Camisón and Molina-Morales (1998) explained very well, are the strategic implications of the district existence, where a series of externalities are generated and can be identified as shared resources based on information and knowledge flows that they generate, which implies a clear competitive advantage for companies. Shared resources are generated by, as it has already been discussed, stable interrelations between organizations sharing the same space. The existence of these resources means that the external scope of the company is dominant over the internal. In order for this endowment of external resources and capacities to generate the competitive advantage of the companies of the industrial district, it is necessary to possess the requirements that the resource approach establishes as common features

of intangible assets and the capabilities that mobilize them: to be forms of knowledge with different degrees of specificity, codification and complexity. These assets are very difficult to imitate by third parties that do not belong to the industrial district given that they have a series of qualities related to physical reasons (location), temporary (long period of time for accumulation), informative (causal ambiguity or difficulty in identifying the resource or capacity that generates the advantage) or inseparability of other competences. The small dimension that characterizes the companies of the industrial districts is not only a necessary condition for the district conformation, but also a consequence as a result of the external advantages for the company and which are developed in the heart of the districts. These small and medium sized companies operate in each activity and in each territory under conditions of full competition and where it is difficult to find formal relations of cooperation, even though sometimes it is found. However, the competition between companies itself, at the productive phase level, leads to the emergence of a strong informal cooperation, productive interfaces that, in short, it is what allows the emergence of economies of scale and product differentiation for the sector, through external economies and the "productive environment" that exists in the district (Ybarra, 1991).

These competitive advantages of the "district effect" can be divided into two components: on the one hand, efficiency in the use of resources, especially work and intermediate inputs; on the other, innovation, as a result of the accumulation of specialized human capital, competitive dynamics and rapid dissemination of information (Galletto, 2008a).

With regard to the district, the fact that the activity is industrial, in general it differentiates what is an industrial district of an "economic region". One characteristic of industrial districts is that not all production can be sold within the district, which means that it has to be sold abroad through exports (Becattini, 2002). This is something tangible of the commercial reality of the ceramic district in Castelló, in which, as will be seen more extensively in the following sections, it is exported up to 75% of its tiles production.

3. Origin and identification of industrial districts

For Becattini (2002), there are two conditions for the emergence of an industrial district: "local supply" conditions and "general demand" conditions. From the supply side it is necessary a "cultural" complexity made up of values, knowledge, institutions and behaviors, a productive structure formed at the same time by factories, handicraft workshops, home working and familiar self-production and a credit structure that finances smaller and more promising initiatives. On the demand side, it is spread by broad middle layers of many countries of the usual standard of comfort, understood as a threshold in which when it is exceeded, conditions are created for the emergence of new core of needs with high social and "qualitative" content, which in turn give rise to highly variable demands for differentiated and personalized products. This presence of the two conditions harms the traditional large business, based on large-scale internal economies, on the production of standardized products and on continuous production processes, and at the same time it favors the agglomeration of small and medium sized companies that manufacture products differentiated for that middle class that has exceeded the standard of comfort.

Since the publication of Becattini's article at 1979[1], there have been many authors who have tried to identify and analyze industrial districts in Spain and its importance as a source of advantages in the production ("district effect"). Most of these studies have been implemented at a regional level and using different methodologies, which makes them little comparable to each other. Accordingly, the problem that the identification methodologies of industrial districts must overcome is that of determining in an empirical way the territorial unit capable of approximating the socio-economic concept of industrial district, in which the productive structure and the social structure interact (Galletto, 2008b). In addition to the academic interest that the identification of industrial districts may have, it is interesting to see how governments and institutions can implement specific economic and industrial policies with the aim of further improving the industry and the district.

In order to solve this problem, ISTAT[2] defined in 1996 a quantitative methodology that aims to approximate the essence of the industrial district definition and its basic characteristics. The methodology consists of two parts: the first is the identification of the territorial unit of analysis and the second is the identification of the industrial districts. The territorial reference unit used for the district study is the Labour Market

[1] Translated in the Revista Econòmica de Catalunya (1986).
[2] Instituto Nazionale di Statistica Italiano.

Areas (LMA)[3], which according to ISTAT, are “sub-regional geographical areas where the bulk of the labour force lives and works, and establishments can find the largest amount of labour force necessary to occupy the offered jobs”. LMA consists of data on the occupational population and residence-labor mobility (Galletto, 2008b) and, a very important feature to take into account, is that the identified municipalities must be contiguous, there can be no municipalities isolated from the others. Once obtained the LMA, a set of nested concentration coefficients, of a socio-economic nature, are used to identify which of these units show characteristics of industrial district (Boix and Galletto, 2005). LMA will have to successively exceed some thresholds of coefficients and specialization indexes to finally be considered "industrial districts" (Galletto, 2008b). It should be noted that this methodology is also known as Sforzi-ISTAT for the contribution made by this academic in its development.

3.1. Industrial districts in Spain

As discussed before, it was in 1996 that ISTAT, together with Sforzi, launched this method of identification. However, in Spain there was already an academic interest in this type of territorial organizations, inasmuch as Ybarra, in 1991, was a pioneer in the study and identification of industrial districts in Spain and, more specifically, in the Valencian Community. Of course, he did not use the methodology of the LMA. Instead, he designs a methodology based on the registration of new establishments of the *Movimiento Industrial*, elaborated by the Ministry of Industry (1975-1986), from where the sectors that can constitute a district are identified (Galletto, 2014). Ybarra (1991) uses three variables identifying the industrial districts:

1. Productive specialization,
2. The identification of much of the productive resources of a space with an activity,
3. The channeling of productive relations through Pequeñas y Medianas empresas.

Through these three variables, Ybarra obtains the existence of 11 industrial districts strictly distributed throughout the Valencian Community in 1991.

In 2005, Boix and Galletto applied the methodology created by ISTAT to identify industrial districts in Spain. 806 LMA are consolidated, from which 237 industrial districts can be identified in the strict sense of the definition. Of the total manufacturing industry in Spain, 46.84% of the employed people belong to an industrial district,

[3] As ISTAT states, but it is also called Local Labour Systems (SLL) or Local Labour Markets (LLM).

pointing thus to the importance of such organizations for the industry. What is more, among the autonomous Communities, the Valencian Community stands out among them by the number of industrial districts identified within its borders with a total of 54, in which 150,003 employees are employed. The main arch of industrial districts in Spain extends from the north of Catalonia and through the Valencian Community to Murcia, containing 41% of the DI and 66% of the occupation in DI of Spain (Boix and Galletto, 2005).

4. The Industrial District of Ceramics

4.1. Location

The Industrial District of Ceramics is located in the Valencian Community, in the province of Castelló. It extends in a radius of about 30km around the city of Castelló de la Plana and is composed of 25 municipalities that comprise an urban area of about 415.000[4] inhabitants and where practically all the production of tiles is concentrated in Spain, manufacturing thus almost half of European production and a tenth of world production (Budí, 2008). Moreover, although the city of Castelló has been mentioned as the epicenter of the Ceramic Industrial District (CID), its relative share in terms of employment and sales, is low. This happens for the reason that most of the population is engaged in services or other industries that have little or nothing to do with the CID.

For the identification of the CID, this work has been based on the classification used by Fuertes (2005). The ISTAT methodology and the LMA are not used, but a set of statistical sources to combine sectoral data and by municipalities. This is partly due to the fact that the CID extends over a territorial dimension that is between the province and the municipality, that is, it encompasses several municipalities, but is not so large as to consider its existence throughout the province, so data collection can be complicated. The methodology based on LMA takes into account specialization ratios, in addition to proximity and work movement, data that are difficult to obtain and, in the case of this study, unnecessary data to corroborate the existence of the industrial district.

Three sources of information are then used to identify the existence and scope of the CID. The first is the registration in the Business Activities Tax (IAE), which is based on the census of all the business activities that are carried out in the municipality. The second source is the INEM of Castelló, more specifically in the Occupational Observatory. The link between the social security contribution group and the type of activity is established. Thereby, CNAE[5] codes are used for the classification of workers according to municipalities, sector of activity and size of the company. Finally, the third source uses data from sectoral associations such as ASCER[6] or ANFFECC[7] (Fuertes, 2005).

As already mentioned, the CID is composed of 25 municipalities, which Fuertes classifies in 3 levels according to the historical moment in which they are incorporated

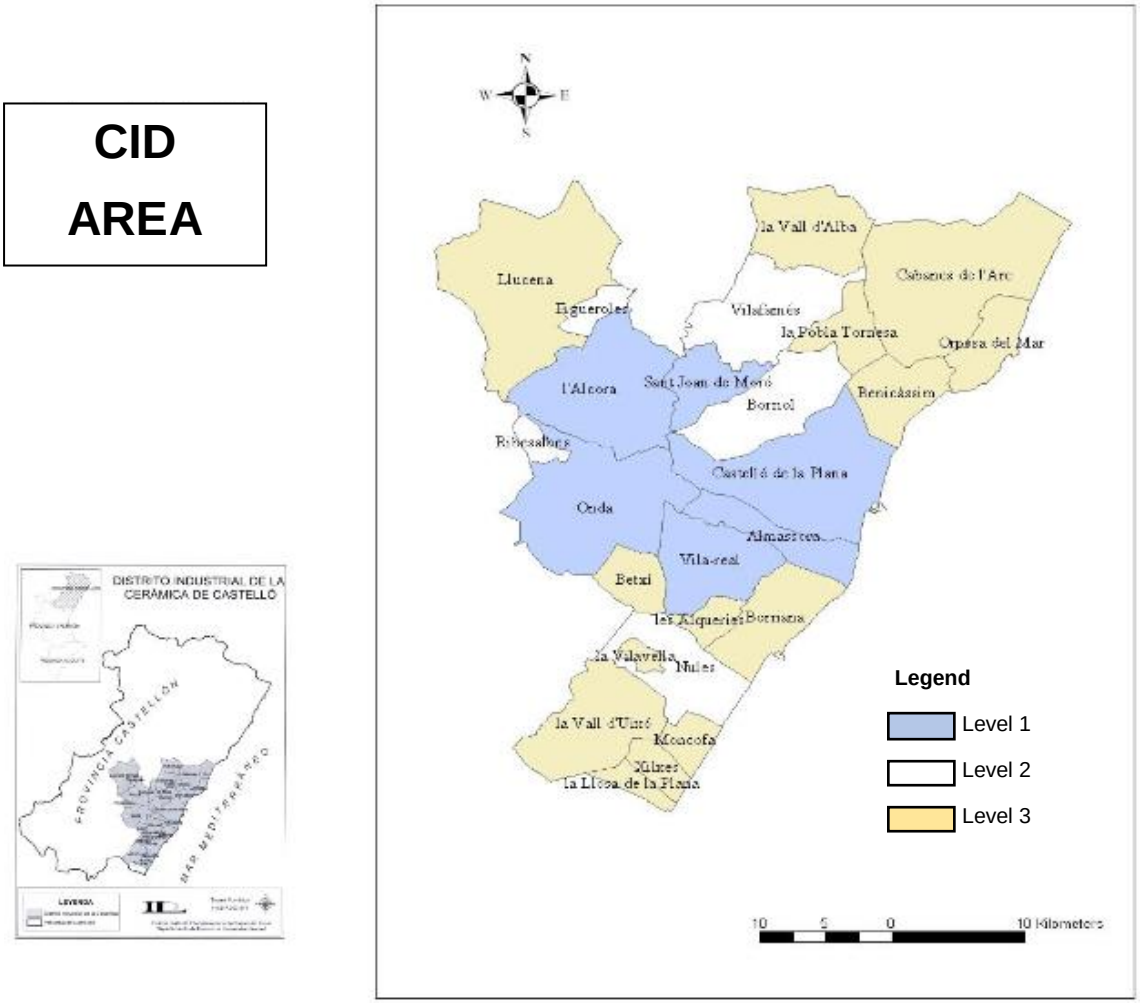
[4] Data from 2018 of INE.
[5] Código Nacional de Actividades Económicas.
[6] Asociación Española de Fabricantes de Azulejos y Pavimentos Cerámicos.
[7] Asociación Nacional de Fabricantes de Fritas, Esmaltes y Colores Cerámicos.

to the district and to how much its labor market and the municipal economy are affected by the existence this district:

- Level 1: Constituted by those municipalities that are pioneers in the ceramic industry and that maintain their protagonism within it, both for employment and production and for the typology of the companies installed. The municipalities to which we refer are l'Alcora, Onda, Sant Joan de Moró, Castelló de la Plana, Almassora and Vila-real.
- Level 2: Formed by the first expansion of the sector and which has allowed the configuration of the industrial district as such, with the extension of activities and the cohesion of the socioeconomic environment. It consists of Nules, Borriol, Ribesalbes, Vilafamés and Figueroles.
- Level 3: The remaining municipalities that either have production facilities or their municipal terms fall within the perimeter defined by the CID are included in this level. Thus, municipalities such as Les Alqueries, Benicàssim, Betxí, Borriana, Cabanes de l'Arc, la Llosa de la Plana, Llucena, Moncofa, Orpesa del Mar, la Pobla Tornesa, la Vall d'Alba, la Vall d'Uixó, la Vila or Xilxes (Fuertes, 2005) can be found.

Lastly, it should be added that Fuertes (2005) includes Castelló de la Plana as a municipality belonging to the CID, where the specialization of employment is diluted within the set of existing activities, and also includes Benicàssim, Orpesa del Mar, Vilavella and Borriana, municipalities which do not have ceramic companies as such, but have relative weight in the number of people employed in the ceramic sector.

Figure 1. CID area with the different levels. Source: Fuertes (2005)



4.2. Activities forming sector

Under the name of Industrial District of the Ceramic of Castelló, a whole set of activities related to the production of tiles are identified (Fuertes, 2005). Although the production of floors and tiles is the main industry in the district, there are subsectors that compose the different levels of the production chain and other sectors. The industrial district of Castelló has specialized in the production of ceramic floorings and coating, which are products made from clay compositions and other inorganic materials that are pressed, dried and glazed and finally cooked at an appropriate temperature. Around the production of ceramic floors and coating, which is the main activity of the process, a strong auxiliary industry has been developed, as well as and a large number of service activities (Molina-Morales and Martínez-Fernandez, 2004).

Other important but secondary activities in the manufacture of pavements are: the manufacture of frits, glazes and ceramic colors, the obtaining and treatment of clays as

an exponent of the raw materials, the construction of machinery specific to the sector, design activities, commercial and technical assistance to the production and even an own network of public bodies and organizations created to cover and support the development of the ceramic sector. All these activities make it possible to identify the industrial environment of the urban area of the city of Castelló de la Plana as an authentic industrial district (Fuertes, 2005).

Using as a base the classification made by Fuertes in 2005 and Budí in 2008, the term "ceramic sector" includes the following agents:

- Manufacturers of ceramic tiles, floors and coatings: This is the group of companies that constitute the core of the industrial district and that perform in a generalized way all the phases of the productive process of the tile (Fuertes, 2005). This activity is the most important of the CID, both in terms of employment and billing (Budí, 2008). Within this group of companies, there is a distinction between those with a more industrial character and with a larger workforce, of those smaller ones that are dedicated to productive plots that require a greater degree of specialization or that only develop concrete phases of the productive process (Fuertes, 2005). Some internationally renowned companies in this ceramic subsector would be Pamesa or Porcelanosa. According to a study by IVACE[8] in 2017, the Valencian Community was the first exporting region of Spain of these products, with a share of 96%, of which practically all production was from the CID.
- Manufacture of frits, glazes and ceramic colors: According to ANFFECC, frits are a glassy material that results from a high temperature raw material melting process. The main application of the ceramic frit is the manufacture of ceramic coating so, by adhesion to the ceramic bisque[9] tile and joint cooking, the tiles can be waterproofed, protected and decorated. Some of the most important companies in terms of this part of the production process are Ferro or Torrecid. The development of the glaze industry, both within the district itself and through its significant international expansion, has reached such an extent that it has placed the sector in a position of global leadership. In addition, its behavior strategy based on the R&D&I component has made it possible to provide the technical response demanded by the sector (Fuertes, 2005). According to Budí (2008), the manufacture of frits is the most important way of innovation and creation of new products in ceramics.

[8] Institut Valencià de Competitivitat Empresarial.
[9] Result of the first clay cooking.

- Extractive industries and atomizers: Supply the raw material used by the sector. The clay is either in the form of a mineral or subjected to an atomization treatment, a process by which the impurities are removed. 70% of the used clay is red, coming from the cluster itself and its surroundings, while the remaining 30% is white and comes from the sea in the form of imports. One of the competitive advantages of CID has been the presence of these clay mines (Budí, 2008), although it is not a determining factor for the future development of the mine. These activities have benefited most from the collaboration between different companies, given their high initial investment requirements, both in the concerned geographical area, as in the increasingly frequent mining operations distant from the CID (Fuertes, 2005).
- Construction of machinery: It is the weakest part of the Spanish ceramic sector and where there is a greater dependence on companies outside the district, generally machinery coming from Italy. This generates a subordination towards this country since it is the main European competitor that the CID has (Fuertes, 2005). Despite this weakness, there has been a high degree of collaboration between ceramic and machinery companies, which has helped the end customer, either by participating in the design or by including improvements (Budí, 2008).
- Auxiliary industry and support institutions: The auxiliary industry encompasses a multitude of sectors such as: companies in charge of the preparation and installation of exhibitors, manufacture of packaging, services to other companies, specialized transport, etc. (Budí, 2008). These subsectors would have no reason to be in other industrial contexts than the industrial district. Moreover, the evolution of its level of activity is closely linked to the ceramic industry as a whole. With regard to support institutions, the ceramic production of Castelló has an extensive network of these institutions, both public and private (Fuertes, 2005). Of these institutions, it must be highlighted associations of producers (such as ASCER and AFFECC), technicians and workers and promotion, administrative, educational and technological centers with institutional support (as the Institute of Ceramics Technology, linked to the Jaume I University) (Budí, 2008).

4.3. Technology Centres and the Institute of Ceramics Technology

Research centers are key in the development and growth of industrial districts due to their innovations, research, support and studies. Fuertes and Budí (2003) define the technological or research centers as specialized entities in the research of the sector of activity to which the industrial district belongs and that has the necessary dimension and means for the development of tasks of investigation. These centers play the role of generating specific knowledge and facilitating ideas that are then disseminated by workers and companies that form the industrial district. To this must be added the educational and training component according to the specific needs of the industry and which has the necessary knowledge for the adoption of new techniques and processes developed by the research center (Budí, 2002). Despite the central role that these centers have in the transmission of knowledge and innovation, the company that wants to obtain and maintain a technological advantage that sustains its competitiveness is destined to combine the acquisition of technology offered in the market, within the reach of everyone, with its own research and development (Corma, 2007).

With respect to the CID, the historically associated technological center, since 1969 being a sectoral reference, is the Institute of Ceramics Technology (ITC[10]), which is located within the campus of the Jaume I University of Castelló. It belongs to the IMPIVA[11] network of technological centers, and forms an agreement with the same university and AICE[12]. It was established in 1969 as a response to the needs and requirements of the ceramic district industries. The center's objective is the research as the main path of sectoral development, thus improving the sector's business competitiveness in international markets (ITC, 2019).

It could then be said that the ITC's activity is carried out in four areas:

1. The research, development and technological advisory component, which corresponds to the knowledge generation phase.
2. The technology transfer component that is integrated into the dissemination phase of knowledge to the different members of the industrial district and that, in practice, it also involves the adaptation of technology deriving from other sectors of the industrial activity.
3. Training activity, which is of considerable importance in terms of increasing the human capital of its technical staff.

[10] Due to its name in Spanish.
[11] Instituto para la Pequeña y Mediana Empresa Valenciana.
[12] Asociación de Investigación de las Industrias Cerámicas.

4. Offer of technological services. They range from the conducting of rehearsals, testing and quality certification to having a research center or providing help and support on other topics (Fuertes, 2005).

5. The ceramic sector in data

As has been commented, the Castelló ceramics sector is the leading producer and exporter of Spanish ceramics by concentrating, according to data from ASCER in 2018, 94% of the national production and 80% of the companies of the Spanish ceramic sector. This high concentration and specialization in the province of Castelló allows the extension of most of the results and observations of national character to the CID area of influence. Furthermore, it is the leading European producer of tiles, together with Italy, and has a high position worldwide.

The success of ceramics in the industrial district of Castelló compared to the Italian ceramic district, is based on increased competition in the production phases (in terms of availability of higher quality and low cost raw materials, better working conditions, better infrastructure network, greater institutional support and less environmental control) and increased efforts in training and research in general (Budí, 2002).

The evolution of the ceramic sector in recent years strictly has been linked to the evolution of the construction sector. This is why the so-called construction boom in the period from 1996 to 2006, as well as the Spanish and international economic crisis that began in the middle of 2007, had an immediate effect on the numbers of the sector. The drop in sales provoked the deepest crisis the ceramic sector has faced to date and from which is still recovering (Veral, Lázaro and Mira, 2018).

5.1. Ceramic tiles, floors and coating

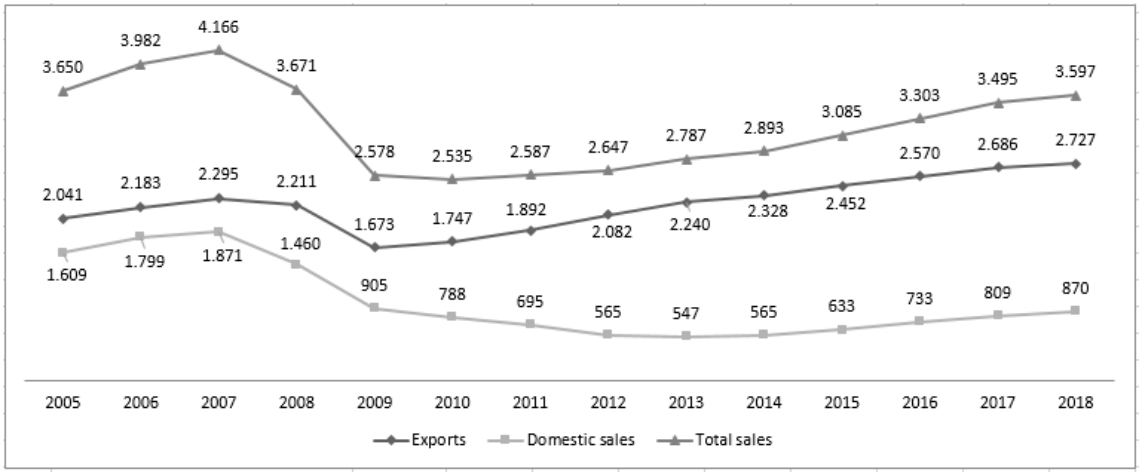
According to ASCER data, during the years 2005 and 2006 there is a peak in the production of tiles and pavements (609,2 and 608,4 million square meters, respectively) and in the value of the total sales in 2007, reaching 4.166 million euros, both data from years before the crisis. From this point on, between 2007 and 2009, sales fall by almost 35%, as does actual production. After a year, from 2009 to 2010, with decreasing but much more stable sales after these two crucial periods, a steady and continuous increase in total sales started, driven mainly by the increase of exports, with an increasing difference from domestic sales. Lastly, the year 2018 ends with both total sales, exports and domestic, growing, but without reaching figures prior to the crisis.

Table 1. Exports, domestic sales and total sales of ceramic tiles, floors and coating sector between 2005 and 2018. Data source: ASCER

YEAR	EXPORTS	DOMESTIC SALES	TOTAL SALES
2005	2.041	1.609	3.650
2006	2.183	1.799	3.982
2007	2.295	1.871	4.166
2008	2.211	1.460	3.671
2009	1.673	905	2.578
2010	1.747	788	2.535
2011	1.892	695	2.587
2012	2.082	565	2.647
2013	2.240	547	2.787
2014	2.328	565	2.893
2015	2.452	633	3.085
2016	2.570	733	3.303
2017	2.686	809	3.495
2018	2.727	870	3.597

Unit: In milions of euros

Graphic 1. Exports, domestic sales and total sales of ceramic tiles, floors and coating sector between 2005 and 2018 Data source: ASCER

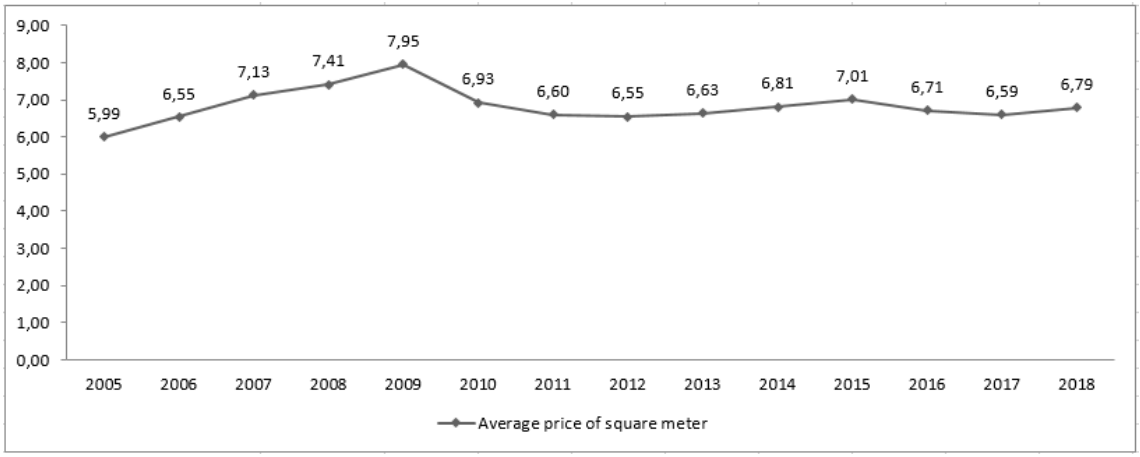


Unit: In milion of euros

If the value of the production between the square meters is divided, the result is an approximation of the average price per square meter in the Spanish sector. A peak of prices is obtained in 2009, reaching 7,95€/m2, followed by a somewhat steep drop and finally, from 2011, it remains stable until reaching the last available price, which is 6,79€/m2 in 2018. As a comparison, thanks to Confindustria Ceramica[13], the average price of the Italian m2 in 2016 was of 13,07€, which means more than double the price of Spanish ceramics in the same year, which was 6,71€/m2.

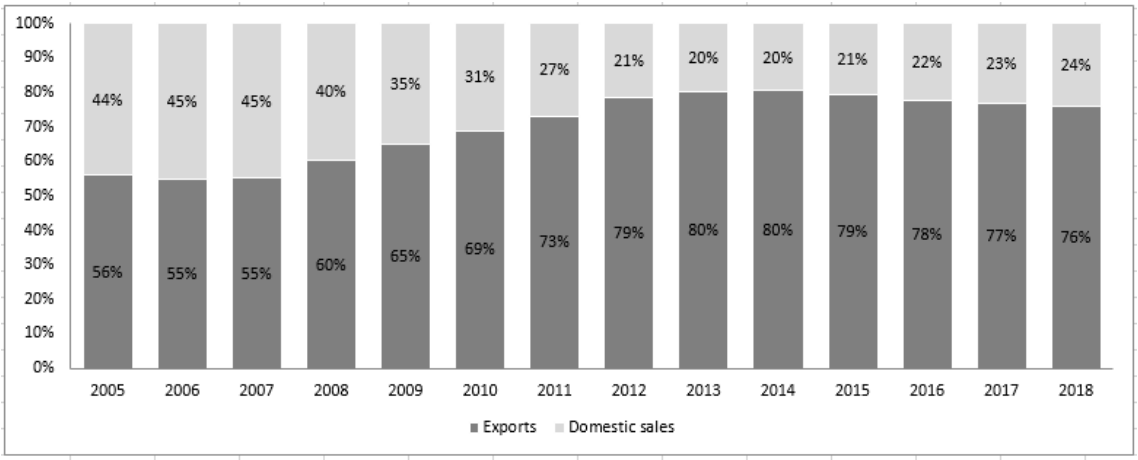
[13] Former ASSOPIASTRELLE. Patronal of Italian ceramics.

Graphic 2. Average price of square meter of tile between 2005 and 2018Data source: ASCER and Cofindustria Ceramica



The internationalization of its sales is very significant in the industrial districts, since, quoting Becattini (2002), not all production can be sold within the district, which means it has to be sold abroad through exports. According to data from ITC's Ceramic Market Observatory, there has been a rapid and continuous increase in the distribution of exports and domestic sales over total sales. Based on data from 1965, exports accounted for 1% of total sales. In 2008, at the onset of the crisis, exports accounted for 60% of total sales. In subsequent years, exports increased rapidly, while domestic sales decreased. Thus, in 2013, exports account for 80% of total sales, because of the low domestic demand due to the drop in the construction of new housing. As of 2015, the situation is reversed and domestic sales are increasing over exports, albeit at a very slow pace. Finally, data from 2018 show 76% of exports and 24% of domestic sales.

Graphic 3. Difference between exports and domestic sales of ceramic tiles, floors and coating sector between 2005 and 2018 Data source: ASCER



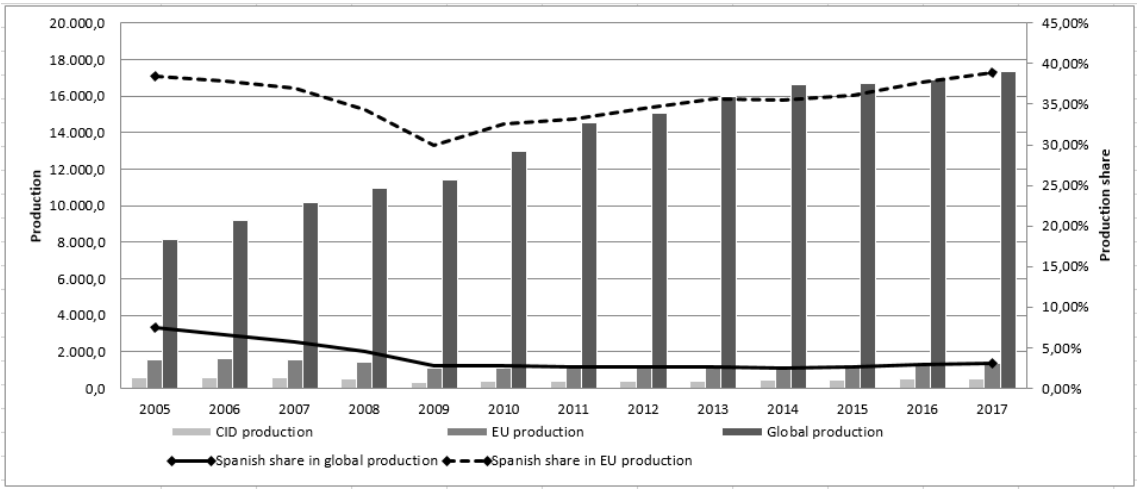
Regarding the production share, the data provide a number of relevant information, both at European and global level. Spain and Italy are the main exporters in the European Union, while China is the world's largest producer. In terms of world production, Spain accounted for 7,49% in 2005 and decreases steadily until 2014, when there is a minimum share of 2,55% of world production. Ultimately, in the latest data available (2017), an increase to 3,06% of production is observed. As can be noticed, the ceramic district has not been able to recover the production share prior to the crisis, partly because it has not been able to return to a level of production as in 2005 and 2006 and its world competitors have indeed increased their respective productions. The European Union overview is somewhat different. The market share in 2005 is of 38,49%, falling to 29,94% in the years of deepest crisis. Here, the difference with respect to the global scale, can be observed. The European production share reverses the decline rapidly until the 2005 share (the largest to date) is finally exceeded by 38,89%. Whereas, globally, it takes 10 years to stop decreasing the share, in the European market only 5 are needed. This indicates a higher value added per unit of product.

Table 2. CID production, EU production, global production, Spanish share in global production and Spanish share in EU production of ceramic tiles, floors and coating sector between 2005 and 2017. Data source: ASCER

YEAR	CID PRODUCTION	EU PRODUCTION	GLOBAL PRODUCTION	SPANISH SHARE IN GLOBAL PRODUCTION	SPANISH SHARE IN EU PRODUCTION
2005	609,2	1.583	8.131	7,49%	38,49%
2006	608,4	1.604	9.166	6,64%	37,92%
2007	584,7	1.581	10.185	5,74%	36,99%
2008	495,2	1.442	10.955	4,52%	34,33%
2009	324,4	1.083	11.423	2,84%	29,94%
2010	366	1.125	12.986	2,82%	32,52%
2011	392	1.184	14.530	2,70%	33,11%
2012	404	1.173	15.032	2,69%	34,43%
2013	420	1.179	15.965	2,63%	35,65%
2014	425	1.194	16.652	2,55%	35,57%
2015	440	1.222	16.670	2,64%	36,03%
2016	492	1.306	16.913	2,91%	37,68%
2017	530	1.363	17.324	3,06%	38,89%

Unit: Production in milion of square meters and sales in milion of euros

Graphic 4. CID production, EU production, global production, Spanish share in global production and Spanish share in EU production of ceramic tiles, floors and coating sector between 2005 and 2017. Source: ASCER

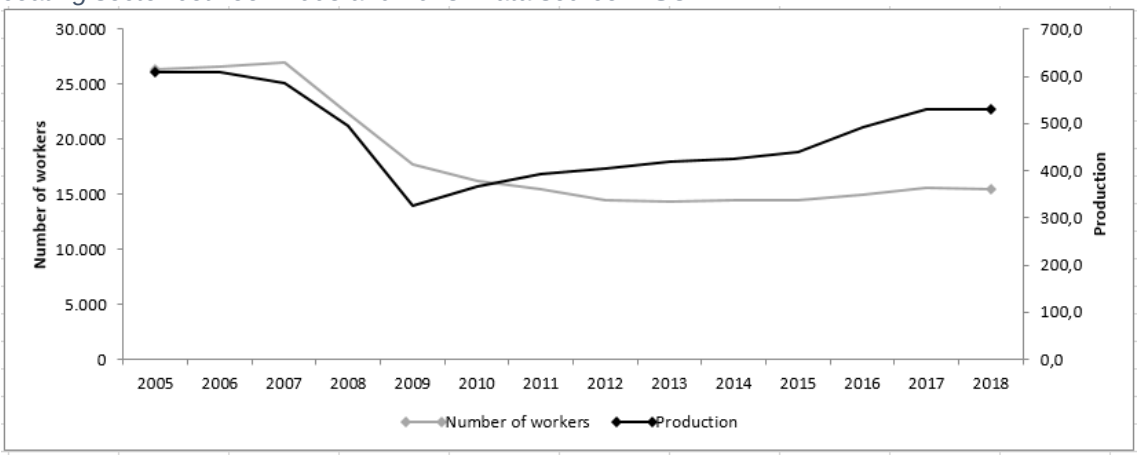


Unit: Production in milions of square meters and sales in milion of euros

With regard to employment, as has been discussed throughout the work, it is very important in industrial districts, either for the dissemination of information, knowledge or the productive specialization of its workers. In the CID, it is especially so because in some municipalities, such as Onda or l'Alcora, the relative importance of employment is fundamental for their local economies. Just before the crisis, in 2007, there was a maximum of workers employed in the manufacture of tiles, with 27.000. The following two years, in the midest of the economic recession, it falls to almost 5.000 workers per

year, until it stabilizes in 2010, although with increasingly low numbers. Lastly, a minimum is reached in 2013, with 14.300 employees and increases until 2018, with 15.400. As can be seen from Graphic 5, there is a comparison of the number of workers with effective production. While the effective production begins to increase from 2010, employment continues to decline. The fact that production is increasing while employment is decreasing is a consequence of the increase in productivity per worker achieved by the CID after the crisis.

Graphic 5. Relation between number of workers and production of ceramic tiles, floors and coating sector between 2005 and 2018. Data source: ASCER



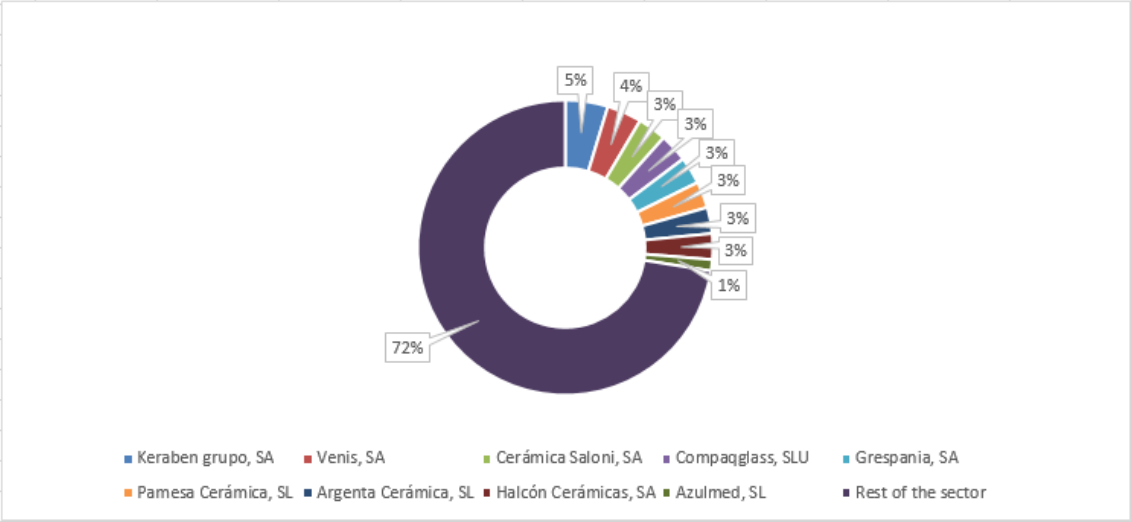
Unit: Production in milions of square meters

5.1.1. Corporate structure

Another feature of industrial districts in general, and ceramic districts in particular, is the increase of small and medium enterprises. According to Ardán[14], in 2017, the top ten companies in the sector accounted for 31% of total employment, highlighting Porcelanosa and the Keraben Group as the companies that employ the most, with 773 and 678 employees respectively. These ten companies are the largest and most important, and have a large turnover, but do not directly employ a large number of workers. This is a consequence of the specialization of other smaller companies in other phases of the production process and additional services.

[14]Business information service.

Graphic 6. Distribution of number of workers between ten main companies of the sector and the rest in 2017. Source: Ardán



Some interesting conclusions can then be drawn from these data on ceramic tiles, floors and coatings. The first is that after 10 years of the onset of the crisis, the sector has not been able to recover fully in either actual production or total sales. On the other hand, exports did increase, while domestic sales have declined dramatically (more than 50% between the onset of the crisis and the present day). The second conclusion relates to the first and it is the internationalization of the sector. Since the beginning of the crisis, exports have been fundamental in to total sales, also caused by low domestic demand. Lastly, as regards to market share, pre-crisis levels in European production share have been recovered and surpassed, but the share in the world market has decreased, so the CID has a pending subject in that regard.

5.1.2. Mergers in the ceramic sector

The 2008 crisis had a lot to do with the increase in mergers around the world. Increasing the size of companies means increasing the productivity and competitiveness of these companies. This is why, according to *El Mundo*, in the last six years, the ceramic sector has absorbed 46% of global business trade (El Mundo, 2019). Mergers can improve the competitiveness of the ceramic sector, as the entry of new investors means, in many cases, new investments in productive infrastructure, marketing and development of new products, as long-term operations are proposed (Economia3, 2018).

Moreover, according to *elEconomista*, in the last seven years 25 operations have been signed with the presence of ceramic Spanish companies, which include the taking of shares by institutional investors (entry of the US investment fund Lone Star in

Esmalglass or the entry of SK Capital Partners in Halcón Cerámicas), the purchase by multinationals (British upholstery manufacturer Victoria acquired Keraben and Saloni) or the growth of groups from Castelló within its sector (Pamesa has led several purchases that have made it double its production in recent years, such as the purchase of TAU Ceramics) (elEconomista, 2019).

Then, the existence of these mergers among ceramic companies and the purchases of shares by multinational firms and foreign investment funds means a rise of mundial interest of the ceramic sector and the willingness to be more competitive and innovator. The stage of economic expansion, globalization and economic development encourage this kind of practices.

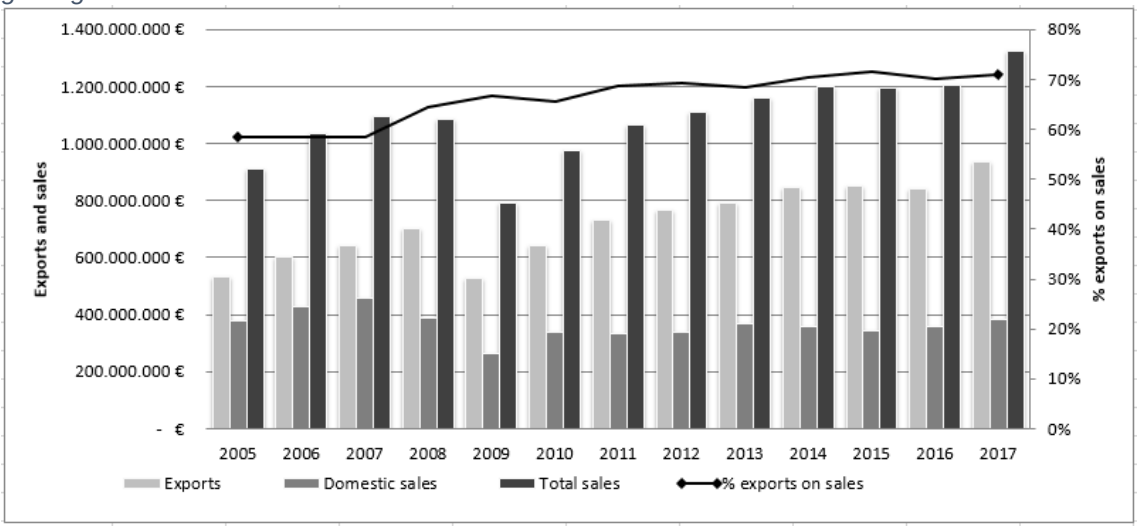
5.2. Manufacture of frits, glazing and ceramic colors

The sector occupies a key position in the development of the industrial district of Castelló, resulting both from the importance of its total sales and, above all, from the role it plays in R&D&I. In this way, the frits and glazing companies have a significant number of workers dedicated to R&D&I tasks, leading to the creation of new products that include both glazing, as the application procedure, and the final design of the tile (Budí, 2008).

As in the field of ceramic tiles, ceramic floors and coatings, the manufacture of frits, glazes and ceramic colors also suffered the brutal economic crisis, although it has been able to recover reaching a higher output than in the pre-crisis stage.

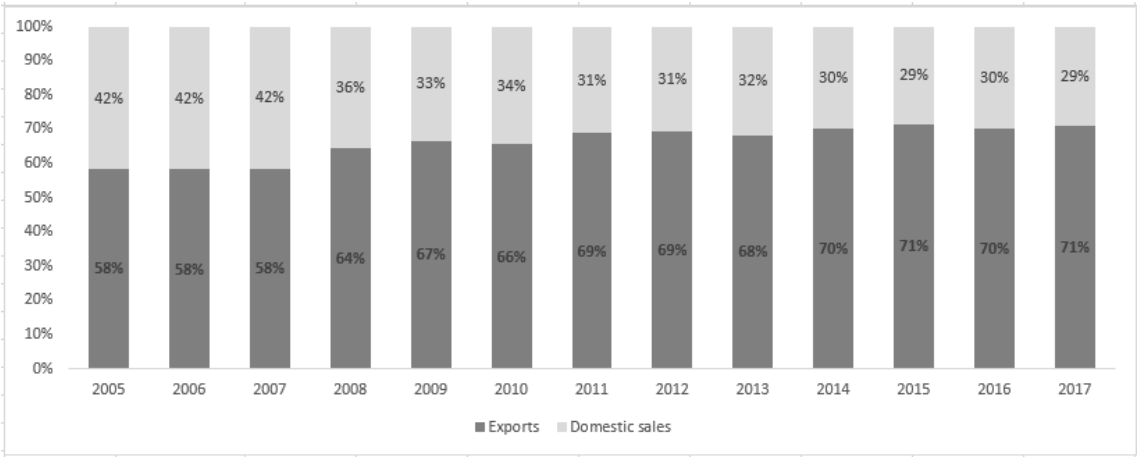
According to ANFFECC, before the crisis, a peak was reached in 2007, selling a total of 1.097 billion euros. Sales fall during two years after the beginning of the economic recession, reaching a minimum in 2009 with 794 million, which means a decrease of almost 30%. From this point on, the total sales of the sector grow continuously (with the exception of a small drop in sales in 2015) until 2017, with the latest data available, reaching 1.332 million euros. It should be noted that, while the numbers for tiles and pavements have nowadays not been able to reach levels prior to the crisis, those for frits and glazes exceed pre-crisis levels in five years, in addition to having a much smaller decrease in total sales in the same period (30% in terms of frits and 35% in terms of tiles). This is due to the innovative capacity of this ceramic subsector, which increases its competitiveness in international markets, as shown in the chart, the ratio exports / total sales has not ceased to increase during all these years.

Graphic 7. Exports, domestic sales, total sales and % exports on sales of manufacture of frits, glazing and ceramic colors sector between 2005 and 2017. Data source: ANFFECC



As discussed above, the increase of exports has been vital in maintaining and increasing sales. Before the crisis, the export ratio / sales in the domestic market was stable with 58%, but when the crisis breaks out, this ratio increases to 67% in 2009 partly due to the decline in tile production since, let it be reminded, frits are intermediate products. Thereafter, the ratio follows an upward trend, with some decline in some specific year, until reaching the last year with data available, 2017, where 71% of exports over sales are reached.

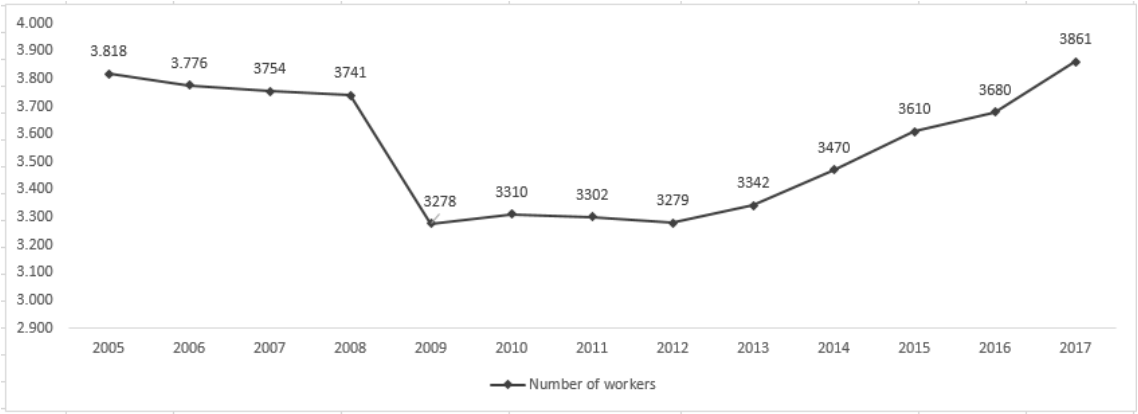
Graphic 8. Difference between exports and domestic sales of manufacture of frits, glazing and ceramic colors sector between 2005 and 2017. Data source: ANFFECC



As far as employment is concerned, there of course are not as many effective jobs as in the tiles and flooring subsector because it does not have the same sales volume and it is not the main subsector of the district. However, as with the total sales, it has been able to recover after the economic crisis and there are now more workers than in pre-

crisis times. There is a negative trend in the number of workers up to 2009, who completely suffer from the crisis, remaining thus 3.278 workers. Since then, there has been an upward trend (except for 2011 and 2012) in which in 2017 there are 3.861 employees, even more than in 2005.

Graphic 9. Number of workers of manufacture of frits, glazing and ceramic colors sector between 2005 and 2017. Data source: ANFFECC



6. Innovation and industrial district

The external competitiveness of a tradable sector, as the tile one is since it is open to international competition, means that products are offered at attractive prices compared to other countries (price competitiveness) or that the set of values perceived is attractive in comparison with those of other countries (overall competitiveness). Moreover, the sale at these competitive prices is a necessary condition for the company to be profitable, covering all types of costs, otherwise the companies will have to adjust their production structures or leave the market (Corma, 2008). Competitiveness is strongly linked to business innovation, as it is increasingly determined by the ability to develop innovations (Caravaca, 2002), which are possible by the spread of local knowledge (Hervás-Oliver *et al.*, 2018). Companies need to increase their technological and innovation efforts to reverse the effects of openness and globalization and generate better paid jobs (Corona, 2002).

Therefore, when it comes to innovation, the *Oslo Manual* (2018) defines it as "a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)". In addition, innovation is a concept that is associated with the creativity of companies and institutions.

The issue of identifying innovations is problematic. Galletto (2008a) differentiates between input indicators (such as expense or staff dedicated to R&D&I) and output indicators (such as patents and announcements of new products). While the former do not provide a good indication because they are very relative data to each company, the latter do, since the granting of a patent implies that innovation has characteristics of novelty and usefulness, has a cost for the company and it is assumed that the patented innovation has an economic value.

As it has been seen throughout the work, innovation, both in the CID and in the industrial districts in general, is key to its existence and competitiveness. The Marshallian "industrial atmosphere" promotes the circulation of knowledge and reciprocal learning, which causes an environment especially suitable for stimulating the industrial creativity of those who work there. This creativity is also driven by the high number of highly qualified people interacting with each other, and favored by the fact that existing skills in the district are varied but connected (Dei Ottati, 2006).

The district model contributes to maintaining the innovation capacities of enterprises and encouraging innovation adoption. The agglomeration of specialized economic activities contributes to the competitive behavior of local companies and strengthens

the relationship between "dynamic competition" (between district companies) and product innovation. Additionally, it is highlighted the relevance of learning by using and learning by doing processes and their diffuse innovative capabilities. The innovations that are usually achieved within the industrial districts and their technological centers are usually through small changes that improve products and processes, which assume a technological and organizational nature (Muscio, 2006), and led by the incoming companies that are, par excellence, the drivers of the renovation of the industrial district (Hervás-Oliver *et al.*, 2018).

Many authors agree on the existence of this innovative effect in the industrial district. Boix and Galletto, in 2009, investigated the innovative capacity of industrial districts in Spain compared to the rest of the territory using the number of patents per million people employed, as it is the most widely used indicator of technological innovation in specialized literature. The result indicates a strong innovative intensity in the industrial districts, higher than the national average. These two researchers call this phenomenon "I-district", which describes the existence of dynamic efficiency in industrial districts. This innovative behavior would not be understood within the district without associating it with the "spillovers" of knowledge, a trained labor market and specialized suppliers (Galletto and Boix, 2014).

6.1. Spillovers of knowledge

Griliches, in 1979, is the first author to be associated with the "spillovers" of knowledge. Galletto (2014) defines the spillover effect as “an overflow of knowledge within an industrial district. It occurs when any knowledge, whether full knowledge of an innovation or more generic knowledge, generated at a particular location or by a particular agent, is accessible elsewhere and by agents other than those who have generated it”. This overflow effect is due to characteristics of knowledge understood as economic good:

- Knowledge is a non-exclusive good: it is difficult to make it exclusive or to control it privately, and even more in environments such as the industrial district where informal relationships and information exchange take place so often.
- Knowledge is a non-rival good: that is, it is not run out by use. This implies that the transmission of knowledge is a positive sum game that multiplies the number of users of that knowledge indefinitely.

- Knowledge is a cumulative good: it can be considered an intellectual input in the process of generating new ideas and new goods. In other words, one idea leads to another, it combines and generates innovations.

The theory of the spillovers of knowledge explains the phenomenon of the tendency towards the geographic concentration of the innovative activity from the increasing performance that the concentrated location of the activity generates on the same innovative activity. Then, in the delimited areas (such as industrial districts), it is relatively easy to exchange information and to transmit contextual knowledge, made possible by close face-to-face relationships (Galletto, 2014) and, as Fuertes (2005) says, thanks to the high mobility of the district's technical staff. From these exchanges, cross enrichment processes take place between different companies, dynamic interaction between customers and suppliers, and synergies between research centers and local production units, resulting in superior innovative capacity. The location, technical capacity and specialization of the technology center are key, as they will determine the frequency of partnerships with companies in the industrial district. The specific nature of the research center will allow the company to externalize part of the R&D process and replace it with temporary or permanent collaboration agreements with the center (Budí, 2002). In localities with conglomerations, the effects and results of the R&D activities of the companies are not limited to the boundaries of the company, but tend to overflow, so that companies located in the vicinity can take advantage of activities carried out by other companies (Galletto, 2014) and continue to make innovations of previous innovations, creating products and machinery specific to them.

6.2. Innovations in the CID

Today, organizations and companies are constantly seeking to create and introduce innovative products, processes and services in the markets. In fact, a company's capacity for innovation has probably become one of the company's best indicators of value creation (Molina-Morales, Martínez-Cháfer and Valiente-Bordanova, 2017).

According to Corma (2007), the innovations clearly correspond to two specific factors: one is defensive and the other is preventive or offensive.

- Defensive use: 1) The increase in demand causes the sector to increase its supply and, for that end, innovations are used in processes such as the continuous automation of these; 2) Favoring demand factors such as the appreciation of some currencies; 3) The inherent difficulties as a consequence

of influential cost factors such as energy prices and their influence on the need for energy saving.

- Preventive or offensive use: 1) Favoring demand through new supply in the form of a differentiated product and associated innovations (usually in the product); 2) Supporting demand through competitive prices (costs) and, to that end, develop new innovations, mainly in processes and automation; 3) anticipate to the foreseeable influences such as energy costs, transport costs, competition in remote local markets, etc.

In order to give an idea of the importance and innovative capacity of the industrial district, data from the Alfa de Oro awards have been used. These awards have been given by the SECV[15] since 1977 to the most innovative projects in technology and design that are presented to the International Competition for Industrial Design Alfa de Oro Awards, each year, and aimed at companies that fall within the industrial sectors of ceramic and glass. For that purpose, Table 3 has been made with the different prizes awarded during the last three years. As can be seen in thi table, all but one of the awards have been won by companies belonging to the ceramic industry district, thus reflecting their power of innovation. Additionally, all the companies belong to the ceramics sector and not to the glass sector, even though SECV could give it to them as well.

Table 3. Year, company, location and innovation of Alfa de Oro awards between 2016 and 2018.Source: SECV

YEAR	COMPANY	LOCATION	INNOVATION
2018	Rocersa and Digit-s	CID	Tridimensional production full digital
	Vernis, S.A.	CID	Luminescent InkJet development
	Excel Shower	Belgium	Design of shower cabin for people with reduced mobility
2017	Torrecid, S.A.	CID	Ecoink-cid technology development
	Ferro Spain, S.A.	CID	New InkJet technology development with catalytic functionality
	Peronda, S.A.	CID	Anti-slip tiles development
	Kerajet, S.A.	CID	Development of the first exclusive head for ceramics
2016	SMCHIMER&SWATRZ	CID	Development of recovery system and valorization of traditional silk screen inks
	Bestile and Neos Additives	CID	Ceramic compositions modeling software development
	Coloresmalt	CID	Development of transparent digital matte ink

Furthermore, CID has reached the best energetic efficiency ratio per product unity of mundial ceramic tile industry. This is due to the use of natural gas (the least polluting fuel) and the use of “cogeneration”, a more efficient way to obtain electricity.

The most important innovations have revolved around the cooking and pressing of the ceramic product. As a result, it has been created a flexible sector which is in continuous movement for high technical quality and aesthetics, efficiency and

[15] Sociedad Española de Cerámica y Vidrio.

optimization of processes based in the reduction of energy consumption, flexibility rise and a decrease of productive cycle (Budí, 2008).

6.3. InkJet Technology

The InkJet technology is the most important innovation in recent years in the ceramic sector and, from it, other improvements and innovations have been obtained. In 2001, tiles and mosaics began to appear at ceramic fairs, reproducing photographs or designs made by computers. Its origin was an innovation that appeared in the industrial district of Castelló: the InkJet technology applied to the decoration of the tile (Galletto and Boix, 2014). This technology was born as a consequence of the increasing need to launch new products with new aesthetic finishes, to environmental constraints and economic factors (Sanz, 2014). Until then, there were methods of printing by ink jet but only on paper, cardboard and textiles.

In 1998, a local Spanish entrepreneur who worked in the computing area and with a lot of experience in the ceramic tile industry, along with a chemist who worked in a multinational company leader in glazing and pigment, began to explore new possibilities with regard to the decoration of tiles based on digital technologies (Hervas-Oliver and Albors-Garrigos, 2012), using up to now a technology of pressing by rollers, slow, relatively expensive and with few graphical possibilities (Galletto and Boix, 2014). This led to a prototype in 1999 based on InkJet printing. The initial prototype proved its reliability and for this reason it was founded a company, Kerajet, due to another larger company of frits and glazing, Ferro. Based on a design consisting of multiple ink injection head systems, control hardware, software design transmission and ink jet management subsystems, Kerajet presented its first industrial prototype at CEVISAMA[16] in 2000 which was added to the acquisition of PTC patents (Hervas-Oliver and Albors-Garrigos, 2012). Other companies in the chemical sector, such as Ferro, Esmalglass and Torrecid, became leaders in the development and implementation of this technology (Hervás-Oliver *et al.*, 2018).

The presentation of this machine caused a great impact. However, the high price of inks and machines, the limited chromatic space obtained and their dependence on the glaze used, initially acted as a barrier to the rapid spread of this technology (Sanz, 2014). Notwithstanding, the technology was successfully implemented and is a way to continuous product innovation and improvement due to the stage decoration is one of the most important of value chain in the productive process.

[16] Fair for Ceramic Tiles and Bathroom Furnishings.

According to Hutchings[17] (2010), the advantages of the InkJet technology are based on three factors:

- It is a digital process. The location of each drop can be programmed by computer and can be modified, even in real time. Because the product to be printed is in the form of digital data, there may be significant cost savings in processes.
- It is a method without contact. The only power that is applied is the result of the impact of small drops of liquid. Easy substrates can then be processed which would be impossible to print by conventional methods.
- A wide range of materials can be deposited. Pigments, inks, glass frits and metal particles are easily printed from suspensions, as well as a wide range of materials that can be used to perform optical and electronic functions.

InkJet printing technology has been a milestone in enabling the three dimensions of business to be addressed simultaneously. It allows the business strategy to be based on differentiated products, to optimize the process and reduce manufacturing costs, and to improve relational marketing. Furthermore, this technology is being imposed globally. At the end of 2010, Spain and Italy had 76% of all installed machines in the world (410 out of a total of 538). By June 2012, however, this percentage had fallen to 48% (690 machines out of a total of 1422). By the end of 2010, China, India and Brazil had a relatively small number of installed machines, but this number has increased significantly and have become the third, fourth and fifth place respectively, in the number of installed InkJet machines, behind Spain and Italy (Sanz, 2014). While Spain and Italy have focused in the differentiation of product, the strategy of China and India is based in costs reduction.

Table 4. Digital printers installed yearly, total number of digital printers in operation and conversion rate to new techonoly in global ceramic sector. Data source: Elaborated by autors from Molina-Morales (2017)

YEAR	2010	2011	2012	2013	2014	2015
DIGITAL PRINTERS INSTALLED YEARLY	-	397	951	2049	1537	1216
TOTAL NUMBER OF DIGITAL PRINTERS IN OPERATION	333	730	1681	3730	5267	6483
CONVERSION RATE TO NEW TECHNOLOGY	5%	9%	21%	45%	60%	72%

So, the mature Spanish ceramic industrial district has positioned itself as a leader in industrial innovation. The ceramic industry in Spain is currently deemed as a model of dynamism and modernization that is able to compete with many other ceramic tile clusters around the world in terms of cost or quality. InkJet technology has allowed

[17] Emeritus Professor of Manufacturing Engineering at Cambridge University.

many CID firms to carry out a sectorial diversification. Different industries, such as wood panelling, fiberce -ment boards, glass, corrugated boards or the textile industries, among others, entrust an important part of their competitive strategy on design and, therefore, on printing (Molina-Morales, Martínez-Cháfer and Valiente-Bordanova, 2017).

Finally, companies of CID will have to face to a “ciberindustry”, also called “fourth industrial revolution”. It is not enough with the automation of the industrial processes and having the most advanced machinery: data management, innovation with internet tools, virtual reality, business cooperation and more qualified workers will be need to maintain the position of world leadership.

7. Conclusion

To conclude, the industrial district is a socio-territorial entity characterized by the active presence of both a community of people and a population of businesses in a natural and historically delimited area. Being part of an industrial district has some competitive adventages for companies, as “district effect”, formed by agglomeration and industrial environment where industrial activities are developed.

Since seminal works of Ybarra in 1991 to current ones, it has been demonstrated an increase in the amount of industrial districts in Spain, standing out among them the CID, which is the most important in Erope, togheter with Italy, in tiles and frits production. CID is formed by 25 municipalities around the city of Castelló de la Plana, and it is the area where the 95% of Spanish tile production is concentred. The sector is formed by: manufacturers of ceramic tiles, floors and coatings, manufacture of frits, glazes and ceramic colors, extractive industries and atomizers, construction of machinery and auxiliary industry and support institutions. Among these activities, stand out the manufacturers of ceramic tiles, floors and coating and manufacturer of frits, glazes and ceramic colors activities.

Regarding to ceramic sector data, it has been related to construction sector, so its growth has been conditioned by that sector. Economic and financial crisis in 2007 had a lot of impact on the sector, especially in tiles, floors and coating subsector, which has not been able to recover pre-crisis levels. However, the productivity of this sector has increased due to the decrease of labour market and the rise of production since the crisis. Mergers and acquisitions have proliferated in this sector by foreign investment funds, foreign industrial companies and other ceramic firms, which shows a rise on the interest in this industry and the desire to increase its competitiveness and productivity. On the other hand, frits, glazes and ceramic colors subsector has been able to recover and overtake pre-crisis levels, not only in terms of production, exports and total sales, but only in labour force, due to the sector innovative capacity.

Finally, innovations in industrial districts are consequences of their high competitiveness and productivity levels. The district structure with its interrelations among firms and workers, spillovers of knowledge, tacit knowledge and other qualities of the industrial district as “industrial atmosphere”, stimulate and increase those innovations. The CID is an innovation leader in ceramic sector. The most important innovations have come from the frits and glaze side, in the cooking and pressing of tiles. InkJet technology has been the most important innovation in the sector since 2000 and it is a way of innovation, yet.

The CID has a role play in the economy of the province of Castelló and everybody related with it, like companies, workers, technology centres and government institutions, is responsible of its good working applying policies which improve its development and the well-being of the population who live in its influence area.

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