INNOVATIONS AND INNOVATIVE PROCESSES IN THE CASTELLÓN CERAMIC DISTRICT

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ABSTRACT

"The traditional sectors attribute their crisis to low investment in R&D&I". This press headline is a reflection of many others in the publication media.

Business organisations insist that "…it is very difficult to undertake an R&D&I policy when you have small business units ..." (FEMEVAL), etc. It suffices to read the opinion poll published in the Valencian Business Confederation magazine 2004, to discover the reasons why, in the minds of businesspeople, the traditional sectors are in crisis. A common denominator appears: The lack of support for R&D&I.

Since 2004, following the presentation of the Valencian Chamber of Commerce report on traditional Valencian sectors, there has been a continuous debate about the necessary measures to improve competitiveness. The Chamber of Commerce as well as Business Organisations, Unions, Political Parties, IMPIVA (the Valencia Association for Small and Medium-sized Enterprise), the Economic Climate Observatory, and specialists on the subject have publicly taken part in the debate over this issue. The recurring issue is still "the scarce or non-existent investment in R&D&I".

The following questions need to be asked: Is there a relation between competitiveness and productivity? Is innovation a determining factor or does it form part of a group of contributing factors?

In order to answer these questions it is necessary to carry out some experimental tests. The first one[1] confirms a positive and significant relation between competitiveness as a latent variable and productivity. The aim of the current study is to examine the innovation process in businesses belonging to the ceramic district of Castellón. Innovations within a set period of time were analysed for the purposes of this study. The factors that potentially influenced these were investigated, as well as the generation process, and the introduction and dissemination of the innovations in the ceramic tile sector.

1. INTRODUCTION

As is the case with the ceramic tile sector, external competition in a marketable sector that finds itself open to international competition[2] means offering products at prices that seem attractive in comparison to those of other countries (price competitiveness) or a group of values are seen as attractive in comparison with those of other countries (general competitiveness). However, in addition to the aforementioned points, another important condition is that sales at these competitive prices allow the companies to be profitable, covering all costs. If this is not the case, the companies must adjust their productive structures or, regrettably, leave the market.

WORK PRODUCTIVITY will be used in this study as an indicator which is possibly the most frequently utilised measurement in productivity. It is understood as being the simple quotient between the value of production or the added value and the units of work used. Theoretical and empirical[3] studies in the last decades have allowed the establishment of a wide consensus on the principal determining factors of economic growth: fiscal capital, human capital, infrastructures, technological progress and economic and financial savings. In spite of this an important and large residual remains that is beyond the reach of comprehension of the experts and is defined as, "total factor productivity" (TFP). The TOTAL FACTOR PRODUCTIVITY is the most widely known indicator used as a comparison element.

There is a wide ranging amount of information available but it is very difficult to obtain it in a broken-down form, in other words, exclusively aimed at the ceramic industrial sector. The data gathered[4] are based on the methodological consideration of identifying the area we will call the Ceramic District (tiles, glazes, frits, colours and other related industries) with Castellón province, given that it accounts for than 70% of the provincial economic activity and close to 90% of the industrial activity.

The growth in work productivity in regard to Castellón province has risen continually since the 1950's.

Year	Agriculture	Industry	Services	Construction
1996	5.2	5.0	7.0	4.0
1997	5.0	9.2	6.5	13.5
1998	0.0	9.0	7.5	9.0
1999	0.2	6.5	7.0	20.0
2000	0.0	7.5	9.0	16.5
2001	5.0	6.0	8.0	12.0
2002	8.0	4.5	7.0	7.5

Source: FUNCAS

Figure 1. The growth rate of the sectoral GVA in the Castellón province (1996-2002). Data in real terms for 1996. Data in %

The data for construction are spectacular; however, apart from this segment, industry growth rates are similar to services whose relative contribution to the provincial GVA is fairly stable. Participation oscillated between 31.5% and 32.5% over the period analysed. This allows verification of the initial approximation for this period, identifying the sector with the industrial component in the province.

Year	Industrial Group	Ceramics and Frits
1996	5.0	5.5
1997	7.0	19.5
1998	10.0	12.0
1999	6.0	8.0
2000	4.5	13.5
2001	10.0	6.0
2002	7.0	4.5*

**Lowest year. Subsequent growth in 2003, 2004 and 2005.*

Figure 2. The growth rate for GVA in the industrial and ceramic sector in Castellón province.

Year	Ceramics and Frits
1996	-1,9
1997	-1,0
1998	-1,5
1999	-1,3
2000	-0,8
2001	2,1
2002	0,0

Figure 3. Employment growth rate. Data in %

Fig. 2 shows a dependency on provincial industrial activity, particularly that of the Ceramic District. The large increase in production in 1997-1998 and in 2000 is also observed, along with the subsequent decline in the years 2001-2003, and the recovery in 2004-2005 compared with the foregoing years. The big increase in productivity is evident from the conjunction of Fig. 2 and 3, by relating it with the growth of GVA and employment. However, if we compare it with the rest of the Valencia Region and Spain:

Year	Euro Zone	Spain	Valencia Region	Castellón
1996	1.0	4.1	4.2	4.8
1997	0.0	1.2	2.2	3.5
1998	2.5	4.4	5.4	7.8
1999	1.8	4.6	4.8	3.8
2000	0.9	3.8	4.2	4.2
2001	1.2	4.1	4.8	6.0

Figure 4. GNP growth rate in real terms. Data in %

Year	Spain	Valencia Region	Castellón
1996	2.1	1.0	1.0
1997	1.6	2.0	2.5
1998	3.1	4.8	6.6
1999	3.3	4.0	5.7
2000	4.2	4.6	4.6
2001	3.8	4.1	7.2
2002	1.6	1.9	3.8

Figure 5. GVB industrial growth rate. Data in %

The GNP growth rate in Castellón province is greater than that in the Valencia Region and Spain. However, the growth in GVA is even higher when compared to the industrial sector, the Ceramic District particularly, is the main component.

It is possible to calculate the PRODUCTIVITY values with the previous data which are understood as being a relative to Gross Value Added (GVA) and the number of employees.

Year	Castellón	Valencia Region	Spain
1995	36.2	31.2	35.2
1996	36.1	31.0	35.5
1997	35.9	31.2	35.8
1998	35.7	31.8	35.8
1999	35.8	31.9	35.9
2000	36.2	32.2	36.2
2001	36.5	32.9	36.5
2002	36.8	32.8	36.8

Figure 6. Relative productivity in the Castellón industrial sector, Valencia and Spain (thousand € 1995 per job)

The following basic conclusions can be drawn from Fig. 6:

- Industrial productivity in Castellón province (fundamentally ceramics) is above that of the Valencia Region.
- There are similar levels throughout Spain. This has particular relevance as the ceramic sector is a sector that is situated far from the so-called high-intensity industries. In fact, ceramics has been defined as a medium to low technology in all literature on the subject.
- The latter refers to the importance of R&D&I in the ceramic sector compared to all the sectors in the Spanish economy.
- The productive position of the sector is good, both in absolute value and in comparison with the rest of Spain.

If we exclusively take the data from the ceramic tile sector:

Factor	1980	1990	1995	2000	2003
Production (mill. Metres)	128	225	400	621	624
Employees	15100	14700	16800	25000	25200
Productivity in metres	8476	15306	23809	24840	24760

Figure 7. Productivity evolution in metres

Factor	1980	1990	1995	2000	2003
Value(mill. euros)			1890	3301	3496
Production (mill. Metres)	128	225	400	621	624
Productivity by value/m			4,725	5,316	5,602

Figure 8. Evolution of the productivity value metre

Factor	1980	1990	1995	2000	2003
Value (mill. euros)			1890	3301	3496
Employees	15100	14700	16800	25000	25200
Productivity value/person			112500	132040	138730

Figure 9. Evolution of productivity value generated per employee

Looking at the figures we can segment the global period 1980-2005 in several periods:

- 1980 to 1990
- 1990 to 1995
- 1995 to 2000
- 2000 to 2005

Following this criteria, Fig 10 shows the following [5]: The average annual accumulative rate of variation in production, employment and productivity.

	1980 to 2002	1980 to 1990	1990 to 2002	1990 to 1996	1996 to 2002
Production AAARV	7.84	6.63	8.85	10.56	7.15
Employment AAARV	2.49	-0.25	4.77	3.16	6.38
Productivity AAARV	5.35	6.88	4.08	7.44	0.77

Figure 10.

The aforementioned authors indicate that for the period under consideration, 32% of the production growth can be explained by the evolution of employment and the remaining 68% by advancements in productivity. The part that is in accordance with the established economic results, and that explains two thirds of production growth, can be attributed to better technologies and a third to the work factor.

The period during the 80's shows a negative variation rate for employment which is due to the high growth rate in work productivity with respect to production. During the period 90-95 productivity continues to be high. However, from '96 onwards the increase in productivity contributed to only 11% of the production growth.

All of this information leads to the following conclusions:

- In spite of being traditionally categorised as a medium-low technology sector, its productivity results could indicate that it should be categorised in the medium-high-medium technology sector.
- Productivity has been increasing systematically and the cumulative data for the period 1980-2002 are 5.35% of the average rate of growth.
- The highest growth rate period (7.44%) was during the period 1990-1996
- Productivity has grown less than the 1996-2002 period, now being situated at an average rate of growth of 0.77%

Throughout the entire period under consideration 32% of production growth can be explained by the evolution of employment and the remaining 68% by advancements

in productivity. The part that is in accordance with the established economic results, and that explains two thirds of production growth, can be attributed to better technologies and a third to the work factor.

- The systematic improvement in productivity has been fundamentally sustained by improvements in technologies.
- Improvements in technologies have maintained competitiveness in the sector via productivity.

Given these findings, it appears necessary to verify what innovations have there been? What innovation model was applied in order to allow the district to maintain productivity-competitiveness figures above those of other industrial sectors and even put themselves in higher positions than the so-called medium technology companies?

2. EXPERIMENTAL

- The period studied is limited to 1980-2005:
  - This is the result of the express decision not to include the roller kiln as an innovation (little used before 1980) nor was the hydraulic press or the incorporation of gas as a substitute for coal and gas oil etc. included. Therefore, the reference date is from when homogenous and basic production passed over to a period of stable technological supply.
  - Another consequence is that these radical innovations (transformation to single firing of the firing process and the introduction of gas as fuel) only slightly preceded this (2-3 years) and it caused an external shock or technological break that required a response from the industry, the social environment and the institutions, which led to repercussion in competitiveness during the period studied. This section has been studied elsewhere[6].
- The period studied is broad enough to incorporate big changes in the international, national and local economy, changes in the technological situation, etc. Therefore, an analysis of the associated situational factors in the contingency theory of an organisation of ceramic tile businesses to verify that the alignment of production strategies have been more related to situational factors than with the organisation's[7].
- Additionally, it is difficult to obtain prior information and data that may help in analysis.
- Directly knowing the innovations in question.

All the aforementioned associated industrial sectors in the cluster were included when describing the district networks[8]: Ceramic tiles, frits, glazes and colours, machinery, raw materials, trims, chemical products, engineering, etc.

The industrial population refers to the group of businesses in the Castellón cluster and is associated with:

- Availability of published data.

- The sample is always aggregate and specific businesses are not mentioned.
- All phases of production have been considered.
- Non-production processes have been considered: Commercialisation, Brand, Dissemination, Image, Logistics, Management, Control, etc.
- All the agents from the Innovation System were included: Businesses, University, Research Centres, Consultants and Engineers, Chamber of Commerce, Qualicer, the Association of Technical Ceramics, Management Associations etc.

Qualitative Research was used for gathering data in this field, and more precisely, the "focussed interview"[9]. The interview itself is structured around questions from the researcher and answers from the informant which lead to a flow of information that provides content to the interview. There is no prior script, even though it is based on questions the researcher had "in mind".

To be more precise about the technique, it is a mixture dominated by the "semi-structured interview"[10] given that, despite having instructions of a general nature in order to provide the greatest freedom possible to the interviewee, the end goal is very clearly defined: to determine what innovations there are.

This methodology was chosen because:

- The interviewees were mainly the responsible agent for innovation or were directly involved in it.
- The previous point gave rise to the need to research the reasons, original causes and precise processes etc
- Other specialists that have coexisted with the aforementioned and with innovations can confirm the aforementioned, verify deviations etc. Definitively, they can provide a less "passionate" point of view.

It has been proved that all the sectors in the cluster were represented:

A total of 25 experts were interviewed from the different sectors previously cited: Ceramic Tiles: 5, Glazes, frits and colours: 4, Machinery: 4, Raw materials: 2, Trims: 1, Engineering: 1, University and Research centres: 3, other organisations from the innovation system: 5.

- The specialists were directly involved in innovation, in other words, they participated directly in the management, dissemination or use of innovation.
- Business people who introduced these innovations
- A questionnaire was drawn up with common but basic script to assist in having a structured conversation on the subject:
  - Define specific innovation that the specialist is familiar with.
  - Define the moment in history of its introduction.

- Indicate the origin of it and the origin of the origin, and so on until the entire trail is found.
- Indicate access method and the contact and introduction process etc.
- Indicate the reasons for introduction.
- Point out difficulties of all kinds, during the process.
- Verify the immediate benefits in each case
- Verify the subsequent benefits for the cluster as a whole

The following information sources were used:

- Statistics from: INE, IVE (the Spanish and Valencian Statistics Institute)
- Business associations: ASCER, ANFFECC, ASEBEC
- QUALICER (World Congress on Ceramic Tile Quality)
- Research centres: Universitat Jaume I, OCIT (the unit investigating technological innovation) Universitat Jaume I, ITC (Institute of Ceramic Technology), ICV-CSIC, Ingenio
- Scientific publications: Doctoral theses from Universitat Jaume I, Ceramic Information magazine, Ceramic Techniques magazine, Ediceram magazine, Report from the Spanish Society of Ceramics and Glass, The Ceramic World Review magazine, Industrial Economy magazine, Spanish Commercial Information magazine, sources from the University of Valencia library, Valencian Polytechnic University and Universitat Jaume I.
- CDTI (centre for industrial technological development)
- Spanish Ceramic and Glass Society
- Association of Ceramic Technicians
- Data from typical consultancy fields developed in the cluster over 15 years of the author's professional activity.
- The Mercantile Registry
- Aggregate publications: Economic 3, KPMG reports, Deloitte reports, DBK reports.

3. RESULTS

YEAR	PRODUCT/PROCESS	INNOVATIONS
1980	Stoneware	Rubber plates late 70's
1981		Oil plates early 80's. Magnetised.
1982	Fast double firing	Car pre-dryer
1983	Porous	Continuous listels
1984	Porous	Porous single firing Crushed frits
1985		Start of tile commercialisation using own networks
1986		Design incorporated in glaze sales. New method of commercialising glazes.
1987		Pellets. New frit fusion furnaces
1988		Line-guided vehicles
1989	Porcelain material	Cogeneration
1990		Lustre glazes. Start of load picking
1991		Waste reuse
1992		Continuous clay mill
1993		
1994		Glass-ceramic glazes
1995		Listels without substrate
1996		Decoration roller Laser guided vehicles
1997		
1998		Anti-bacterial , self-cleaning glazes
1999		Metallised glazes
2000	Glazed porcelain tile	Inkjet decoration Interchangeable die blades
2001		
2002		
2003		Domotics
2004		Large dies for porcelain tile
2005		

Figure 11. Main innovations defined and their time location

Fig. 11 contains all the innovations identified by the work group, from this point on another subsequent list was drawn up that includes innovations considered "influential". The concept covers the following:

- Obvious transformations produced in the form of work and the organisation of work.
- Obvious transformations in the structure of the facilities.
- Entailing obvious transformations in the material employed, whether they be raw materials or semi-processed products
- Entailing obvious interactions with different aspects (processes, systems, materials, etc.)

YEAR	PRODUCT/PROCESS	INNOVATIONS
1980	Stoneware	Transformations in the press plates
1981		
1983	Wall tile	Continuous listels
1984	Wall tile	Porous single firing
1985		Crushed frits
1986		Start of tile commercialisation using own networks
1987		Design incorporated in glaze sales. New method of commercialising glazes. Pellets New frit fusion furnaces
1988		Line-guided vehicles
1989	Porcelain material	Cogeneration
1990		Picking
1992		Continuous clay mill
1996		Decoration roller.
2000	Glazed porcelain tile	

Figure 12. Summary of innovations defined as "influential" by the team

- Late 70's, early 80's:
  - Appearance of single-fired stoneware and the transformation of press dies

- Early to mid-80's:
  - Appearance of the porous single-fired material
  - New glazes (crushed frits, glaze pellets)
  - Commercialisation of glazes through incorporated design
  - New frit fusion furnaces
  - First attempt to control the tile distribution channel

- Late 80's:
  - Line-guided vehicles
  - Cogeneration
  - Appearance of porcelain material

- Early 90's:
  - Load picking
  - Continuous clay mill

- Mid-90's:
  - Decoration rollers

- Late 90's:
  - Appearance of glazed porcelain tile

The 80's present a clear opportunity for the introduction of innovations. Subsequently, there is a convergence of the influential factors:

- The oil crisis in the late 70's (1979)
- The increase in internal demand in the late 80's due to the construction industry.
- This would stimulate the introduction of innovations centred on:
  - Energy saving
  - Productivity increase
  - New supply of products

The 90's present a different situation:

- Stability in energy fuel prices
- Strong increase in demand both internally and externally and the beginning of competition in target markets.
- This stimulated the introduction of innovations centred on:
  - Increased productivity
  - Incremental improvement in previously developed product innovations

The question should be asked, " what triggered these innovations?"

Let's look at some possible causes:

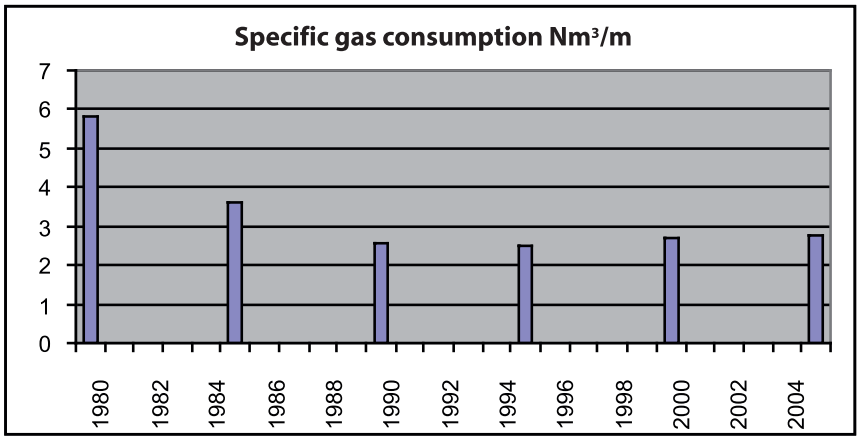

Figure 13. Evolution of energy consumption in the tile sector

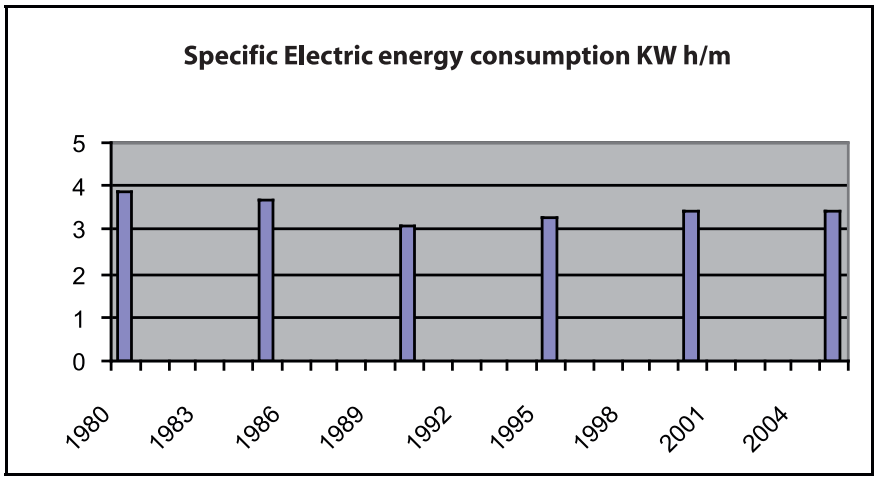

Figure 14. Evolution of electric energy consumption

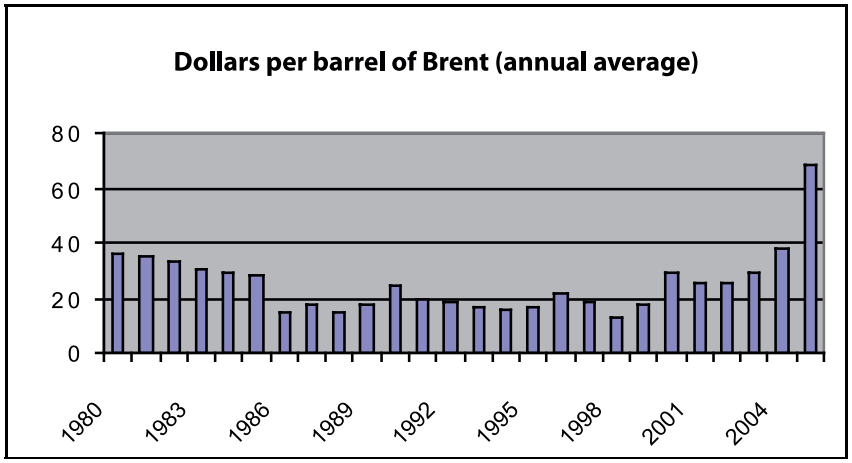

Figure 15. Evolution of the average oil price

From these graphs it can be deduced that the ceramic tile production sector has responded rapidly to ups and downs of energy prices during the 1970-2000 period. Specific consumption has decreased by 50% through the introduction of innovation in the processes. There was a slight recovery in energy consumption from the year 2000 with the introduction of the new "porcelain" product which requires firing conditions that use more energy. The same can be said for power and lighting consumption savings.

In both cases the innovations have been centred on processes (porous single-fired material, successive roller kilns with optimized energy consumption, continuous clay mills, pre-dryer before firing, etc).

The evolution of energy prices from 2004-2006 has not yet produced any innovation that has maintained specific consumption, except for the continuous improvement of operative conditions.

Following the observation of a possible correlation, the decrease in specific consumption is brought about fundamentally at the start of the 80`s. That is to say, 5-8 years after the rise in energy prices were triggered. The innovations are basically *associated technology or processes via systems.*

Moving on now to the evolution of demand and its possible correlation with supply, here is a presentation of construction data from the national market.

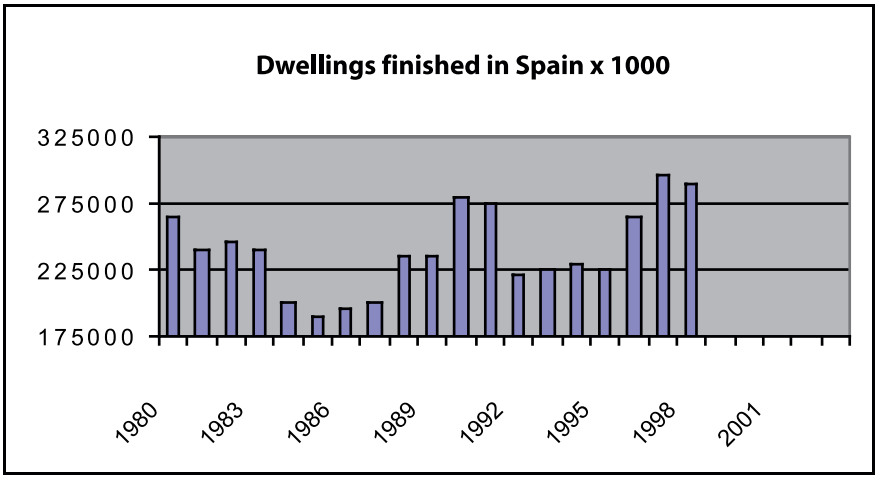

Figure 16. Evolution of finished housing in Spain

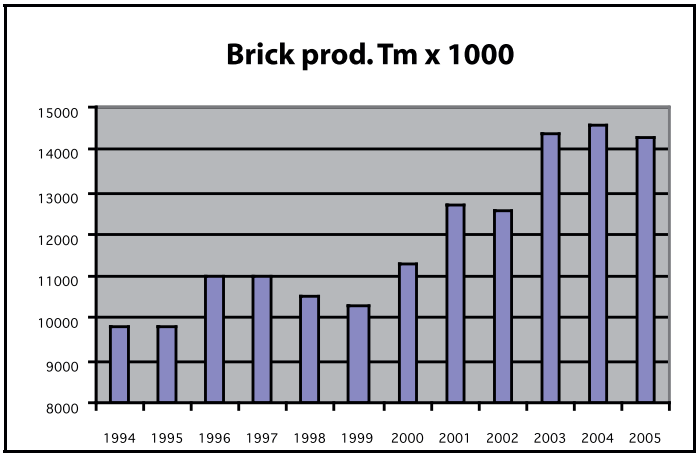

Figure 17. Evolution of tile production

There are no data presented corresponding to the years 2002-2006. In any case, it is obvious that this period was one of the highest in terms of construction quantity. With the aim of finding a possible correlation between demand (housing) and supply (production) and bearing in mind the production data, sales and building, we can see that the correlation coefficient housing/metres is 0.51 for the period presented in the graph. However, the correlation coefficient between total sales and exports is greater than 0.99 and total sales and national sales are more than 0.97. This indicates that demand makes product supply grow and, subsequently, the production capacity.

In order to corroborate the aforementioned, Fig. 17 shows the production data for building bricks[11] (product destined almost exclusively for the domestic market). Carrying out the same comparison one can see that the correlation coefficient with respect to ceramic tile production goes from 0.66 to 0.75, 0.82 and 0.88, making the same assumptions. Therefore, the spectacular increase in production over the years 95-2000 is due to previous demand in the 90's (in the case of the national market). This

is seen favourably as being years of relatively low stock exchange index and greater investment in building capital.

Other possible favourable demand factors could be, for example, the changes in the economic cycle on a worldwide scale (variation of the stock exchange index in Fig 18 and the S&P index in Fig. 19). No correlation is noted in the production or sales curves. There is a better correlation with the evolution curve for the euro/dollar exchange rate (Fig 20), especially for exports to the U.S. and countries that use the dollar. No correlation is noted for currency price in the Eurozone. (Fig. 21)

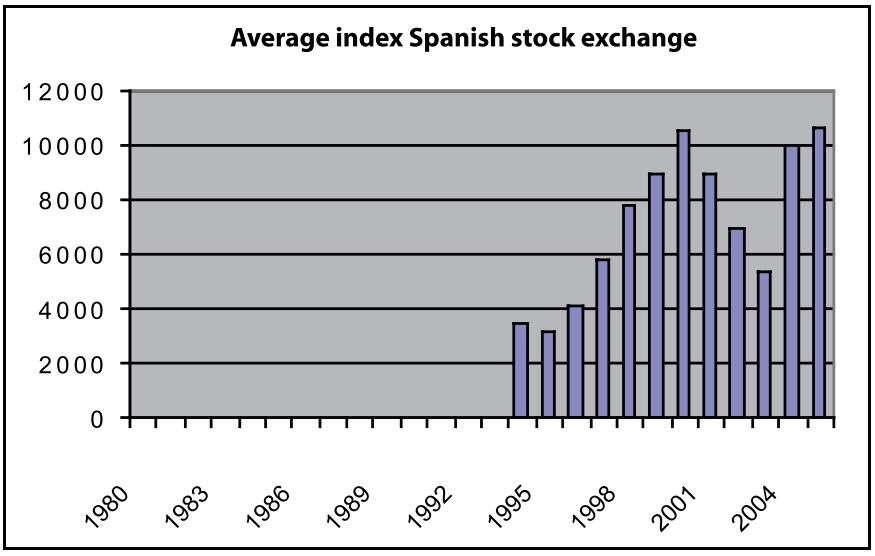

Figure 18. Evolution of the average stock exchange index

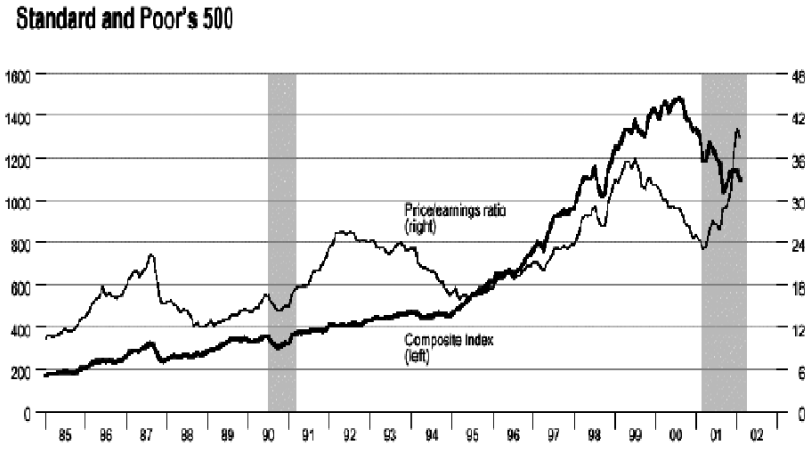

Figure 19. Index evolution in the US

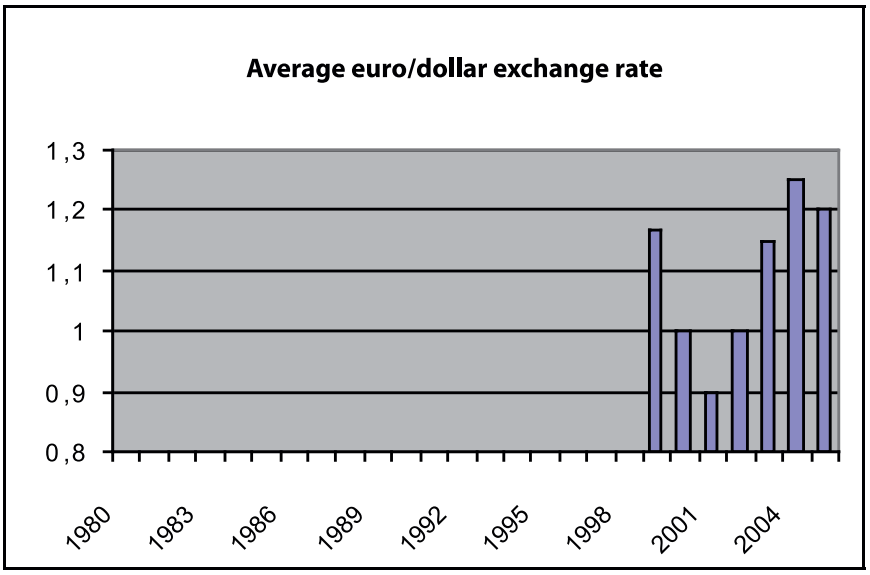

Figure 20. Evolution of the Euro/Dollar exchange rate

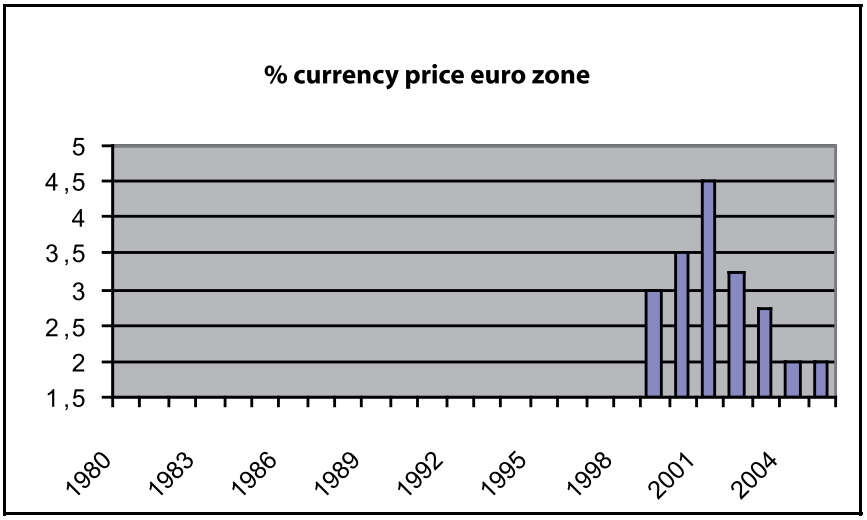

Figure 21. Currency price evolution in the Eurozone

	International	Spain
1980	Iran Revolution	Last UCD period and transition
1983	OPEC production restrictions	Industrial restructuring
1990	Gulf War	Last period of adjustment
1992	End of the USSR	Entry into the EU
2001	Attack on the Twin Towers	Period of expansion
2003	Iraq War	Construction expansion
2006	Iran, Iraq, uncertainty in Nigeria	Increase in inflation

Figure 22. Periods of international crisis

Considering these data and their coincidence with Fig. 11 and 12 innovations and its temporary appearance it seems that innovations clearly correspond with two specific factors:

- *Defensive factors:*
  - External origin: External influences on organisations:
    - Demand: Increase in demand means increase in supply and therefore innovations in processes, as is shown by continuous process automation.
    - Factors favouring demand: The economic situation and, more succinctly, the exchange between the dollar and our currency (be it the peseta or the euro). This is what gains competitiveness in the international markets.
  - Internal origin: The difficulties pertaining to influential cost factors as is the case for energy prices and their influence on the need for energy saving:
    - Exclusively via processes
    - Or even through processes that produce new products.

- *Preventive or offensive factors:*
  - Opposition to external origin:
    - Favouring demand through a new offer of a differentiated product and the associated innovations: Fundamental innovations in the product
    - Favouring demand through competitive prices (costs) and therefore, innovations development, fundamentally for processes and the automation of them.
  - Opposition to internal origin:
    - To get ahead of the foreseeable influences as is the case with energy costs, transport costs, competition in outside local markets, etc. In order to attend this need, product differentiating innovations are being developed (design, characteristics and applications), process (basically costs, logistics and marketing) and more general aspects (brand and distribution channel).

The analysis of all these innovations shows:

- In most cases they are defensive
- The first companies to introduce them, in spite of being defensive, turn them into offensives. They gain time on the competition with them. They become a competitive advantage by being the first ones to introduce them.
- Fundamentally process-driven, both in quantity as in ground-breaking effects but not in substantial modification with the existing products. This is valid including when a new product is introduced.
- Products cannot be clearly considered as innovations.

- In practically all of them, a need first arose and then the innovation was developed.

We still need to resolve the following problem: Once the need to generate defensive innovation arises, given that its trigger is known, where does it originate? Who develops or generates it?

In order to answer the question, the dates and appearance of innovation for the same period have been analysed:

- Theses published by ITC personnel
- Other published studies for the UJI and other references in the district.
- Studies acknowledged in magazines of note in the experimental section.
- Studies presented in Qualicer
- The awards given by SECV
- R&D projects approved by the CDTI
- In total 1000 entries were analysed and correlated by date and subject.

The following conclusions were drawn:

- In each case innovation carried out in the cluster innovation appeared first and subsequently references to literature pertaining to associated studies.
- Publications obviously appear later.
- It could be assumed that the best seasonal approximation corresponds to the study phase. Even so, there were no studies in any of the cases before or simultaneous with innovation.
- Consequently, the conclusion can be made regarding innovations in the ceramic cluster: The direct origin of innovations is not in the studies carried out by the recognised centres indicated previously.
- Innovations originate in other more specific environments:
    - Technology suppliers: Here there is a clear prior patent or study phase or even a complete prior supply phase. This fact is easily proven through research into patents by going to www.espacenet.com.
    - Companies internal development, be it in collaboration with the knowledge centres or their own development.
- Furthermore, if we separate the innovations defined between the most ground-breaking (porous single firing, porcelain tile, decoration rollers, rotary mill, line-guided vehicles), all of these originate in internal development or technological supply from suppliers.
- Contribution from the Knowledge Centres does not correspond to the first level or step and it would have to be sought on a third level.

Therefore, the model implies the following:

- Wait until a technological supplier develops new innovations (normally it would be a foreign supplier)
- Seize the innovation as soon as possible in order to have the initial advantage.
- Technological centres study the innovation, publish it and propose improvements
- It is disseminated

The model implies that the innovation is:

- Passive in generation
- Active in incorporation and improvement
- Pro-active in the optimization loop

For this the following is required:

- Watching in the first phase
- Absorption capacity in the second phase
- Capacity for client-supplier relations in the third phase.

INNOVATION	DIRECT ORIGIN	ORIGIN
Transformations in the press plates	Die suppliers	Direct transfer of technology from other sectors.
Porous single firing	Internal, direct	Internal direct
Continuous porous single-fired listels	Suppliers of trims	Directly from the suppliers
Crushed frits	Glaze suppliers	
Tile commercialisation with own networks	Internal, direct	Direct. Transferred technology from similar sectors
Design incorporated in glaze	Glaze suppliers	Direct. Transferred technology from similar sectors
Pellets	Glaze suppliers	Direct. Transferred technology from similar sectors.
New frit fusion furnaces	External suppliers and internal knowledge	Direct. Transferred external technology
Line-guided vehicles	Machine supplier	Direct. Transferred technology from other sectors
Cogeneration	Supplier	Technology transfer
Picking	Internal, direct	Direct. Transferred technology from other distribution sectors
New colour production system	Direct from colour suppliers	Direct
Continuous clay mill	Machine supplier	Direct. Transferred technology from other sectors
Decoration roller.	Machine supplier	Direct. Transferred technology from other sectors

Figure 23. Given these premises we can view the specific breakdown of innovations in the current study

These apparently drastic and even de-mystifying conclusions can be included in the specific context of the sector. The bibliography[12] demonstrates 4 basic methods for technological progress:

- Systematic R&D Investment.
- Informal processes for the dissemination of knowledge.
- Exploitation of external knowledge through "learning by doing" and "learning by using".
- Adoption of innovations incorporated in equipment assets and intermediate inputs.

The ceramic sector is advancing in all markets, as indicated by the data in this current study. However, it is done in a way that pertains to a mature sector in a number of aspects. The following diagram demonstrates how this generally happens :

- First: Adoption of innovations incorporated in equipment assets and intermediary inputs (glazes)
- Afterwards: Exploitation of the former through "learning by doing" and "learning by using"
- Parallel to this: Exploiting the structure of the cluster through the dissemination of knowledge

The result of this makes the Sectoral Innovation System look like this:

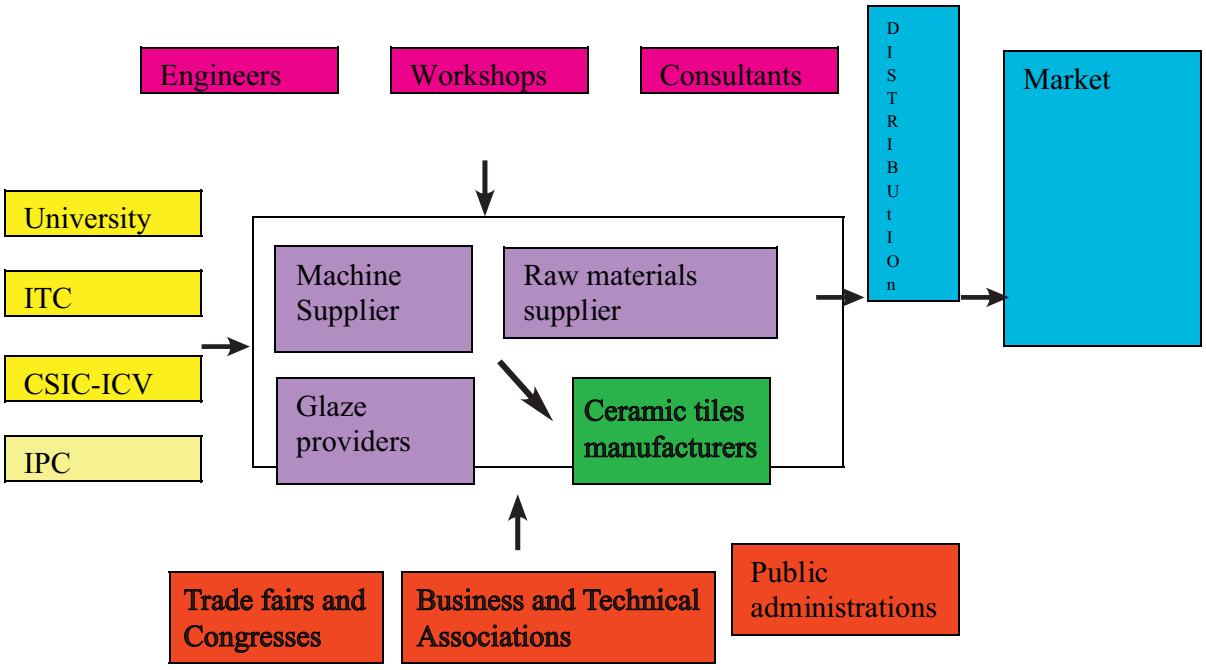

Figure 24.

The system, its configuration, configuration, development and functioning means that tile companies demonstrate better data than the rest of the industrial sectors in the Valencian region in terms of innovation.

In conclusion, a special mention must be given to the fact that the aforementioned is only possible thanks to the existence of the industrial cluster or district. This means that within it competitiveness can be improved compared to other type of business organisations. Amongst the advantages of the cluster or industrial district what stands out [13] is the aims distribution by Foster.[14] It is based on technological absorption capacity and is present in the established relationships in the cluster itself, basically, between machine and glaze suppliers and tile customers, as we have seen from this study. The rest, like other suppliers and consultants, universities and technology centres, congresses and magazines etc. configure a subsequent circle to the preceding one that is necessary to complete the structure of the innovation management system.

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