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Clustered firms and solvency in the Spanish ceramics industry

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***Abstract*—There is a vast literature on the advantages of agglomeration due to positive externalities arising within industrial concentrations like clusters or industrial districts. Empirical studies strongly suggest these benefits when the focus is on innovation or transmission of knowledge. If this is the case, then it is reasonable to expect that cluster benefits should result in better financial performance and higher solvency for clustered firms soon or later. However, the limited empirical support for the link between clusters and economic performance provides contradictory results.**

This paper goes deeper into this matter and aims to measure the resulting effects on the solvency of firms in agglomeration economies. Empirical analysis has been applied to a sample of 609 firms in the Spanish ceramic tile cluster to test for statistically significant differences in the levels of solvency between clustered and isolated firms. Then we analyze whether firm size and phase of the economic cycle are relevant. Study results show significant differences between large and small clustered firms, suggesting that size does matter in terms of capturing the benefits of clustering from the perspective of solvency.

***Keywords*—industry clusters, firm solvency, firm size, economic cycle**

I. Introduction

This present work analyses solvency behaviour in clustered and isolated firms. We compare the differences in solvency in both groups and investigate whether size and economic cycle influence solvency behaviour. Two populations are compared: firms in the ceramics industry cluster in Castellon (Spain) and isolated firms.

The rest of the work is structured as follows: Section 2 presents a general view of the different theories supporting the benefits of clustered firms and the hypotheses to be tested on solvency. Section 3 presents the data, methodology and results of the empirical analysis. Finally, Section 4 presents the conclusions.

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II. Theory and Hypothesis

In the last twenty years there has been great interest in the theoretical and empirical study of clustered firms, focused mainly on indicating the advantages. Porter defines cluster as a geographical concentration of firms and institutions that are interconnected in a given field, generating a series of benefits for firms in the cluster that are not available to firms outside it [1].

There are various theoretical approaches to the advantages of clustered firms. Marshall [2] made the first study of the benefits, identifying an "external effect" in industrial agglomerations that explains the increase in productivity attributable to factors external to individual firms. Marshall attributes this "external effect" to the shared use of resources, like infrastructures, skilled human resources, specialist suppliers and knowledge spillovers [3].

From a strategic approach, Porter points out that clustered firms may improve competitiveness as a consequence of the pressure and challenges they are exposed to [1]. This increase in competitiveness will lead to greater productivity generated by improved access to resources, lower transaction costs, more skilled labour, greater information flow for members of the cluster and better conditions that provide a greater degree of innovation inside the cluster, as several studies show ([4], [5] and [6]).

Both knowledge-based theory and the resource-based view (RBV) offer a theoretical framework that has been widely used in empirical studies to examine the possible benefits of belonging to an industrial district. In this regard, Grant points out that knowledge can be regarded as the most important strategic resource firms can have [7]. Thus relations between the different agents in the cluster can create knowledge from the agents' own and complementary resources [8]. These knowledge-based resources are difficult to imitate as they are often based on causal ambiguity, especially when the resource is formed, at least in part, by tacit knowledge [9]. Although there is greater knowledge transfer within the cluster [10], it is not uniformly transferred to the different agents in the cluster; transfer depends on the firm's absorption ability and its ability to use external knowledge [11]. This flow of knowledge is public for clustered firms, but private for isolated agents.

The central tenet of the resource-based view (RBV) is based on the idea that the combination of tangible and intangible resources creates competitive advantages for firms [12]. Application of RBV to the business cluster concept suggests that in addition to the firm's resources and capacities, strategic resources shared in the cluster are also important [13] In this regard, Maskell and Malmberg point out

that these shared resources can be valuable, difficult to imitate and replace, leading to a source of competitive advantage [14].

According to the different theories of the firm, the positive effects of belonging to a cluster materialise in raised performance levels compared to other firms in the same industry but not in the cluster. Nevertheless, some authors note that clustering can have a negative effect on firm performance. Hendry et al. show that social networks and firms on the periphery of the cluster may lead to a drain on internal knowledge due to frequent changes in communication and the risk of employee rotation [15]. Weber argues that heightened competition for scarce resources within a cluster may displace firms towards the periphery in search of cheaper resources [16].

The abundant literature on the positive effects of business clusters has generated a stream of empirical works examining whether clustering is beneficial. According to the literature, clustered firms benefit from this agglomeration when compared with isolated firms. It seems reasonable therefore to see these benefits reflected in improved performance in clustered firms. The empirical works have used two types of performance measurements: financial measures (ROA, ROE, rotation, market value of shares) and non financial (degree of innovation, survival). The results are not conclusive. Whereas various works ([13], [17], [18] and [19]) evidence heightened financial performance (economic profitability, rotation level of sales, added value) of the cluster over isolated firms, Ferreira et al. [20] and Kukallis [21] , among others, find no significant differences in financial performance between both groups. In fact, Kukallis finds that isolated firms are more profitable (ROA) when the industry is at the maturity stage of the industry's life cycle and is in a period of economic contraction [21]. Bell and Deng find evidence for a negative relation between clustering and performance [22]. The results show that the market value for shares in clustered firms is lower than for isolated firms.

Although, as seen above, an important body of empirical works analyse performance in clustered firms compared with isolated firms, there are no studies analysing the solvency behaviour of the two groups. Solvency can be understood as the firm's risk in the future of not being able to meet its short or long term obligations. Solvency can therefore be understood as a measure of the firm's risk. When cluster density increases (as is the case in the ceramic industry in Castellon) there is greater competition for resources, which can force firms to take riskier decisions to continue competing and more costly resources increase their level of risk (thereby reducing solvency). Several works ([23], [24] and [25]) show a negative relation between survival rate and the size of the cluster. Shaver and Flyer find a negative relation between survival rate and clustering [26]. These results are in keeping with the idea that heightened competition in clusters forces firms to take more costly resources and riskier actions to remain competitive, which has a negative impact on their degree of solvency. Therefore, we posit:

Hypothesis 1: Clustered firms have lower solvency than isolated firms.

Shaver and Flyer note that firms in a cluster are heterogeneous and benefit from economies of agglomeration in different ways [26]. Not all firms benefit in the same way from the externalities generated by the cluster. In their analysis of clustered firms from the social capital or network approach, Molina et al claim that firms establish their own particular networks with different sets of participants and therefore present very different opportunities and restrictions so that significant differences can be observed between them [27]. According to the above authors, major companies usually direct internal relations in the cluster which gives them a strategic position enabling them to respond more quickly than other local actors to the demands of external markets.

Larger firms have better access to cheaper financial resources, a greater degree of innovation and more highly skilled workers. These determinants mean that most of the benefits of clustering accumulate in the largest firms [28]. It is to be expected that larger clustered firm have higher levels of solvency as they accumulate most of the benefits of economies of agglomeration. Therefore we posit:

Hypothesis 2: Larger clustered firms have a higher level of solvency than isolated firms.

As explained above, firms belonging to a district have a relative advantage over competitors operating outside the district. This benefit is mainly the high degree of strategic understanding of their competitors and the effect of sharing the value chain to a large extent. Clustering enables firms to benefit from a series of elements such as geographical proximity, dealing with the same suppliers, using human resources with similar origin, cultural values and training, assistance from nearby financial institutions, thereby favouring mutual understanding of business characteristics among firms in the same district. This situation facilitates the generation of operational, financial and knowledge synergies that can be used to strengthen firm core and size making them more able therefore to cope in times of crisis. Therefore, it can be assumed that district helps to mitigate the negative effects associated with periods of economic crisis. This positive relationship is highlighted in various financial studies [29] and [30], although other researchers like Kukalis question that relationship when the industry cycle is also taken into account [21]. Therefore:

Hypothesis 3: The stage in the economic cycle (expansion or recession) is a key factor when discriminating, on the basis of solvency, between clustered firms (district) and isolated firms (external to the district).

III. Empirical Analysis

A. *Data and Methodology*

The three hypotheses were tested using the annual accounts from Spanish firms in the ceramic paving and cladding industry from 2007 to 2010. This period has been divided into two sub-periods to test the third hypothesis: 2007 and 2008 (expansion) and 2009 and 2010 (crisis). The start of the crisis is located in the accounts for 2009 because at the

start of that year Spanish government debt lost the highest credit rating (AAA).

In addition to test the third (and the second) hypotheses, firms are classified by size using European Union criteria (see Table 1).

TABLE I. EUROPEAN UNION FIRM CRITERIA FOR CLASSIFYING FIRMS BY SIZE

	n: Employees (**)	**V: Turnover (million euros) (*)**	**B: General balance (million euros) (*)**
Small-sized enterprises	50 >n >=10	10 >= V >2	10 >= B >2
Medium-sized enterprises	250 >n >=50	50 >= V >10	43 >= B >10
Large enterprises	n >= 250	V >50	B >43

(*) Together with the number of employees one of these two conditions must be met
(**) Firms with fewer than 10 employees have not been considered (known as micro-entrerprises)

Solvency has been measured using Altman's [31] model for non-listed firms (Equation 1):

$$Z = 0.717\ X_1 + 0.847\ X_2 + 3.107\ X_3 + 0.420\ X_4 + 0.998\ X_5 \quad (1)$$

where X_1 is Working Capital / Assets; X_2 is undistributed Profits /Assets; X_3 is Profit before interest and tax / Assets; X_4 is Assets/ Liabilities and X_5 is Sales/Assets.

As the previous model has only been used to obtain a homogeneous measure of solvency for firms, this present study uses the coefficient values estimated by Altman [31]

TABLE II. SOLVENCY LEVEL: CLUSTERED FIRMS VS NON-CLUSTERED FIRMS GENERAL ANALYSIS. PERIOD: 2007 TO 2010.

	District	**No district**
n	449	160
Mean	2.208720	3.207022
Levene Statistic	33.654	
F-statistic	22.440	
Welch Statistic	9.739	

n: number of items in the population
mean: mean of Altman's Z-score value for firms in the population
(**) Significance level below 1%
(*) Significance level between 1 and 5%
Levene statistic H_0: variances between the two populations (district and non district) are equal
F statistic (only when H_0 from the Levene statistic is not rejected). H_0: averages for the two populations (district and non district) are equal.
Welch statistic (only when H_0 from the Levene statistic is rejected). H_0: measures for the two populations (district and non district) are equal.

To test the hypotheses we have looked for statistically significant differences between levels of solvency in clustered firms and in isolated firms. In a prior step, homocedasticity was tested between the two populations (cluster vs. no cluster) by calculating the Levene test statistic. When this homocedasticity condition is fulfilled, equality of means is tested using Snedecor's F test used in the factor analysis of variance (ANOVA). When the condition of homocedasticity is not met, equality of means is tested using Welch's t-test.

B. *Results*

Table 2 shows the results for the first hypothesis. As can be seen in this table, variances for the two populations (cluster and non cluster) are different from a statistical perspective. Therefore, the Welch statistic was used to test equality of means. The results show statistically significant differences in the levels of solvency between clustered and isolated firms. Nevertheless these differences are expressed in greater levels of solvency in non-clustered firms compared to clustered firms. These results suggest that clustering is a negative factor for solvency and support Bell and Deng's [22] conclusion that clustering involves greater levels of risk [22].

To test the second hypothesis the firms in both populations are classified according to size. For each size (large, medium and small-sized enterprises) we looked for differences in statistically significant means between solvency levels in clustered and non-clustered firms. Table 3 presents the results.

TABLE III. SOLVENCY LEVEL: CLUSTERED FIRMS VS. NON-CLUSTERED FIRMS ANALYSIS BY FIRM SIZE PERIOD 2007 TO 2010.

	Small-sized enterprises		**Medium-sized enterprises**		**Large enterprises**	
	District	***No district***	***District***	***No district***	***District***	***No district***
n	117	112	263	40	69	8
Mean	2.505	3.596	2.106	2.557	2.095	0.999
Levene Statistic	11.681		2.331		1.300	
F-statistic	2.96		4.837		11.437	
Welch Statistic	5.746		3.972		23.773	

n: number of items in the population
Mean: Mean of Altman's Z-score value for firms in the population
(**) Significance level below 1%
(*) Significance level between 1 and 5%
Levene statistic H0: averages for the two populations (district and non district) are equal.
F statistic (only when H0 from the Levene statistic is rejected). H0: means for the two populations (district and non district) are equal.
Welch statistic (only when H0 from the Levene statistic is rejected). H0: means for the two populations (district and non district) are equal.

As can be seen in Table 3 statistically significant differences were detected in the levels of solvency for the 3 sizes of enterprises analysed. Nevertheless, solvency levels in small and medium-sized enterprises are greater for firms outside the district than for firms in the district, whereas in the case of large enterprises the situation is exactly the opposite. These results qualify those obtained from the testing of the first hypothesis in the sense that, belonging to the district can be a positive factor for the solvency of firms but it will depend on their size. These results are in keeping with Appold's [28] finding that most of the benefits of clustering accumulate in large enterprises.

As already noted, to test the third hypothesis we divided the time period into two sub-periods: 2007 and 2008 corresponding to a period of economic expansion; and 2009 and 2010 corresponding to a period of recession or crisis. The

results from the testing of the third hypothesis are summarised in Tables 4 and 5.

TABLE IV. SOLVENCY LEVEL: CLUSTERED FIRMS VS. NON-CLUSTERED FIRMS ANALYSIS BY FIRM SIZE PERIOD 2007 AND 2008 (ECONOMIC CYCLE: EXPANSION)

	Small-sized enterprises		**Medium-sized enterprises**		**Large enterprises**	
	District	***No district***	***District***	***No district***	***District***	***No district***
n	46	59	152	23	41	4
Mean	2.635	3.550	2.194	2.704	2.115	1.113
Levene Statistic	5.182		0.606		1.923	
F-statistic	2.073		3.832		5.660	
Welch Statistic	2.568		3.959		37.779	

n: number of items in the population
Mean: Mean of Altman's Z-score value for firms in the population
(**) Significance level below 1%
(*) Significance level between 1 and 5%
Levene statistic H0: averages for the two populations (district and non district) are equal.
F statistic (only when H0 from the Levene statistic is rejected). H0: means for the two populations (district and non district) are equal.
Welch statistic (only when H0 from the Levene statistic is rejected). H0: means for the two populations (district and non district) are equal.

As can be seen in Table 4 in period of expansion the results do not vary with respect to those obtained in the testing of the second of the hypothesis: there are significant differences in all firm sizes, but with a different sign in relation to whether the firms are, either large, or medium or small. However, as Table 5 shows, in the results for medium-sized firms during a period of crisis: there are no statistically significant differences in solvency levels between clustered and non-clustered firms.

TABLE V. SOLVENCY LEVEL: CLUSTERED FIRMS VS. NON-CLUSTERED FIRMS ANALYSIS BY FIRM SIZE PERIOD 2009 AND 2010 (ECONOMIC CYCLE: RECESSION)

	Small-sized enterprises		**Medium-sized enterprises**		**Large enterprises**	
	District	***No district***	***District***	***No district***	***District***	***No district***
n	71	53	111	17	28	4
Mean	2.430	3.648	1.986	2.357	2.066	0.885
Levene Statistic	5.182		0.606		1.923	
F-statistic	2.073		3.832		5.660	
Welch Statistic	2.568		3.959		37.779	

n: number of items in the population
mean: Mean of Altman's Z-score value for firms in the population
(**) Significance level below 1%
(*) Significance level between 1 and 5%
Levene statistic H0: means for the two populations (district and non district) are equal.
F statistic (only when H0 from the Levene statistic is rejected). H0: means for the two populations (district and non district) are equal.
Welch statistic (only when H0 from the Levene statistic is rejected). H0: means for the two populations (district and non district) are equal.

A priori this variation may be motivated by improved solvency levels in clustered firms, or by worse solvency levels in isolated firms or by a combination of both. To discover the reason, in the two groups of firms, we tested for statistically significant differences in means between the levels of solvency during the periods of expansion and recession. In both groups (cluster and non cluster) the tests show no statistically significant differences. That is, the levels of solvency do not vary appreciably between the two periods. If this is joined to the fact that before the crisis there are differences between cluster and no cluster whereas during the crisis those differences disappear, the conclusion must be that (significant) differences from before the crisis were not excessively large; thus, a (non significant) improvement in clustered firm solvency joined to a worsening (non significant) in the levels of solvency of non clustered firms makes those differences disappear.

IV. Final Considerations

A priori, clustering could be interpreted as a positive factor although the results of various studies focused mainly on analysing profitability and innovation are not conclusive on this point. This present study analyses whether clustering has a positive effect from the perspective of business solvency, an aspect which, to date, has not be dealt with in the literature.

Specifically, for firms in the Spanish ceramic paving and cladding industry, we have tested for statistically significant differences between solvency levels (measured through Altman's Z-socre) in clustered firms (based in the Castellon district) and in non-clustered firms. Generally, solvency levels are higher in non-clustered firms. However, these results must be qualified after separate analysis of firm size.

Specifically it has been seen that in small and medium-sized enterprises, non-clustered firms have lower solvency levels than clustered firms. However, the result for large enterprises is the opposite: solvency is greater in clustered firms, a result in keeping with some works in the literature where large enterprises are found to obtain the most benefits from clustering.

Finally, we have analysed whether results vary in relation to the economic cycle in the different sizes of firms. In a period of expansion, the results are identical to those noted in the above paragraph. However, during a crisis the results vary only for medium-sized enterprises in which no statistically significant differences in solvency levels have been found between clustered and non-clustered firms. The tests suggest that the disappearance of differences in medium-sized firms during a period of crisis obeys the relative proximity of solvency levels in clustered and non-clustered firms. These results reinforce the conclusion that size is a relevant factor when benefiting from the advantages of clustering.

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