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## **Entrepreneurial clusters and the co-agglomeration of related industries**

**Carla Costa**  
Utrecht University  
USE - Utrecht School of Economics  
c.costa@uu.nl

**Rui Baptista**  
IST - Technical University of Lisbon  
DEG  
rui.baptista@tecnico.ulisboa.pt

### **Abstract**

The success of clusters with collocated related industries raises questions on the mechanisms driving their performance. We look at two theoretical streams explaining collocation: agglomeration economies and heritage theories. Using the case of the molds for plastic injection and the plastics industries in Portugal, our results imply that heritage through the transmission of capabilities of parent firms in a related industry to spinoffs locating in the region is the foremost driver of performance. They also imply that collocating with a customer industry improves the performance of a clustered industry, although it may have no effect on the customer industry.

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## **ABSTRACT**

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**Keywords:** Cluster; Spinoffs; Entrepreneurship; Related industries; Co-agglomeration

## 1. Introduction

The motivations and dynamics driving related industries to locate in the one region with no natural advantages is a phenomenon that elicits questions that remain partly unanswered. Moreover such collocation of related industries appears not to be uncommon and calls for a broader discussion. More than understanding what motivates companies to locate close to their peers in the same industry, this paper aims to understand the cross-influences of the presence of one industry in the location choice of a related industry, and the influence they may have over each other's performance, in particular when agglomeration occurs.

We look at two theoretical streams that explain the collocation of related industries: agglomeration economies and organizational heritage theories. These theories propose different dynamics to explain why related industries would collocate and perform better and we test the predictions of both streams.

We focus on the case of the molds for plastic injection and the plastics injection industries (i.e. molds for plastic injection technology users) in Portugal and their supplier-customer relationship. A disproportionate number of plastics companies locate in the same region where their suppliers from the molds industry agglomerate: in the Marinha Grande region (hereafter referred as Marinha). The emergence of the Portuguese plastics and molds industry was simultaneous and their history is interconnected.

This empirical setting reflects an industry vertically disintegrated with networks of small companies, where scale economies are not prevalent and tacit knowledge is important – similar to Italian textiles and ceramic clusters in Emilia Romagna (Brusco, 1982; Porter,

1998)(Brusco, 1982; Porter, 1998). The role of organizational heritage was not investigated before in this type of small firm empirical setting. This study also contributes to the literature by broadening the analysis while looking, at the same time, at two related industries in the value chain to identify cross-influences in their performance.

Therefore, this paper aims to look for linkages between these two related industries, in the form of same or cross-industry spinoffs (as predicted by heritage theory), and/or agglomeration benefits related to the transaction of goods, people and ideas, influencing the performance of the firms in a cluster. Hence, our research question is: what mechanisms drive the performance of collocated related industries?

If agglomeration economies theory explains industry collocation, one would expect firms in an industry to perform better if they are located in a region where firms in a related industry are already clustered, since they benefit from agglomeration economies. Firms in both industries that are located in the cluster then should perform better, regardless of their ancestry (i.e. regardless of being spinoffs of successful companies in a related industry). If however heritage theory is the main force behind collocation, then suppliers locate close to producers because some of the suppliers are spinoffs of the producers (and vice-versa) and spinoffs do not venture geographically far when choosing where to locate. Under these circumstances, spinoffs should perform better than other types of entrants due to the quality they inherit from their parent companies, and not depending on their location.

The paper is organized as follows. We start section 1 with this brief introduction, followed by the theoretical discussion that motivates the paper (section 2). In section 3

the data and methodology are described. Then we present and discuss the empirical results (section 4). Finally, in section 5, we present the conclusions of the paper.

## **2. Theoretical Aspects**

The mechanisms driving industry location choice have interested researchers and policy makers alike, in an attempt to devise the drivers of industry agglomeration when natural advantages are not present. The high performance of companies in regions with strong agglomeration, as in the case of Silicon Valley, enhances the motivation to question why industries concentrate in specific regions and why related industries are often present in the same region. The concept of related industries, although commonly used in strategy literature, can have different meanings. In the context of this paper we refer to related industries as those that can be considered an important supplier or buyer industries of an agglomerated industry.

We will focus on two theoretical approaches that have attempted to explain the emergence and growth of industrial clusters, both basing their on arguments on firm performance-seeking behaviors: agglomeration economies and heritage theory. There is currently a tendency for these two theories to approximate opinions, to some extent, as agglomeration-based research recently follows views associated with the transformations of the industrial structure of regions (Buenstorf and Geissler, 2008; Martin and Sunley, 2011; Menzel and Fornahl, 2009) and acknowledging that entrepreneurship differs across space (Glaeser et al., 2010a; Glaeser et al., 2010b). On the other hand, heritage theory – based research admits that positive location externalities may improve spinoff

performance in a cluster (Golman and Klepper, 2013). Therefore, agglomeration externalities and heritage theory are not mutually exclusive. Nevertheless, they propose very distinct mechanisms for agglomeration and different drivers of firm performance in clusters. Buenstorf and Klepper (2009, 2010) and further studies by others (Boschma and Wenting, 2007; Heebels and Boschma, 2011; Kowalski, 2012) find that the spinoff process was key to clustering in several industries, and that agglomeration economies and proximity to markets, highlighted in the conventional account, played a minor role in the clustering of those industries. However, agglomeration economies supporters claim that although the role of spinoffs should not be neglected, the motivations for their location choice are linked to agglomeration economies (Glaeser et al., 2010b). This tension remains, therefore, unresolved and further empirical research is needed.

Moreover, the topic of collocation of related industries calls for an analysis of the drivers of agglomeration for each of the industries, but also raises the issue of the possible influence from the presence of the other related industry. Empirical research claims that the concentration of related industries contributes greatly to firm survival (Neffke et al., 2011), therefore we would expect to find effects of collocating with related agglomerated industries. However, research has mostly focused on single industry analysis and the present research aims to broaden the empirical approach to look at the mechanisms affecting both collocating industries.

### **2.1. Agglomeration Economies Theory**

Agglomeration economies theory explains the collocation of related industries, in particular supplier and customer industries, with the benefits firms accrue from the reduction of transportation costs of goods, people (labor market pooling), and ideas

(Marshall, 1890). Ellison et al. (2010) empirically test each of these claims regressing industry pairwise coagglomeration indices on measures of these three effects in manufacturing industries in the US. They find strong support for input-output dependencies and also for labor pooling benefits. Within this line of theory, the collocation of related industries is considered to be fueled by the economic benefits firms are able to extract from the reduction of the transportation costs mentioned. In particular, if there is a vertical relationship between the related industries in their value chain, there would be a reduction of transportation costs of products within the supplier-customer transactions. Firms that choose to locate close to related industries would therefore improve their performance compared to firms that would locate elsewhere.

Labor pooling agglomeration economies may derive from the reduction of uncertainty for the workers, who could move to a nearby company if demand decreases for their employer (in particular if those companies are in different industries but use the same types of workers), making them more willing to accept lower wages (Marshall, 1890). However, there may also be benefits associated with the higher probability of finding the best match between the employer and the talents and interests of the employee (Helsley and Strange, 1990), and to coping with worker skill uncertainty (Strange et al., 2006). In addition there may be matching benefits linked to the changes of worker preferences over time (Glaeser and Gottlieb, 2009). Nevertheless, as acknowledged by Glaeser and Gottlieb (2009), there is little empirical evidence to support claims related to the agglomeration benefits of labor market pooling, although it has been shown to have a positive effect on entry, if we refer to the presence of workers from related industries (Glaeser and Kerr, 2009). Ellison et al. (2010) found that input-output linkages are good

predictors of coagglomeration, but Glaeser and Kerr (2009) find only modest support for the effect of linkages to customers and suppliers on entry.

More recently, urban economists have focused on the role played by entrepreneurship in the industry agglomeration process. The motivation for this research is that regional performance in terms of employment growth has been consistently found to be highly correlated with the presence of a multitude of small firms, and therefore with entrepreneurship (see for example Acs and Armington, 2006; Feldman et al., 2005; Glaeser, 2007; Glaeser et al., 1992; Glaeser et al., 2012; Glaeser et al., 2010a; Rosenthal and Strange, 2010). Glaeser, Kerr, and Ponzetto (2010a) proposed a model to test several possible origins for this stylized fact and found empirical support to a source proposed by Chinitz (1961), who claimed that the supply of entrepreneurs differs across space. The authors also found some support to lower costs of entrepreneurship – since larger fixed costs deter entrepreneurship, while the presence of independent suppliers has the opposite effect (Glaeser and Kerr, 2009).

Glaeser, Rosenthal, and Strange (2010b) imply that agglomeration economies may be driving the entrepreneurship leading to clustering. In regions with a higher supply of entrepreneurs – because there are more small firms as proposed by Glaeser, Kerr, and Ponzetto (2010a) – those entrepreneurs tend to locate their ventures in the same region for several reasons, but possibly also because they are attracted by agglomerative spillovers like input sharing, labor pooling, and the opportunity to learn from their neighbors in the same or a related industry.

## **2.2. Heritage Theory**

Heritage theory focuses on the role played by spinoffs<sup>1</sup> and, more broadly, the transmission of capabilities from parent firms to startups. Buenstorf and Klepper (2009, 2010) propose that the clustering of entry is caused by the combination of entrants tending to locate close to their geographic roots and the uneven geographic distribution of potential entrants. They also tie the cluster's success to the entrants' pre-entry capabilities, which critically shape their performance (Helfat and Lieberman, 2002; Helfat and Peteraf, 2003; Phillips, 2002). The offspring of the better firms, although not decided by the involuntary spawning parent, will inherit more capabilities and therefore become superior performers. This sort of relationship has been studied in the management literature. A stream of research has focused on the relationship between the experiences of top managers and corporate performance (Hambrick and Mason, 1984; Hambrick et al., 1996; Michel and Hambrick, 1992; Murray, 1989). An important source of pre-entry capabilities is industry experience acquired by spinoff founders. Agarwal et al. (2004) and Klepper (2008) argue that the success of new organizations is fundamentally shaped by knowledge inherited from industry incumbents that was accumulated by their founders throughout their careers. Founders embody that knowledge themselves and complement it with the knowledge of the founding team, which often shares the same experience (Agarwal et al., 2013). Therefore, spinoffs stemming from the best founding or early firm in a region do better than those that do not. Like other new firms, spinoffs mostly locate where they originate, causing the spinoff dynamics to

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<sup>1</sup> The definition of "spinoffs" used here follows the one adopted by Garvin (1983), i.e. *de novo* firms with one or more founders that had worked previously in the same or a related industry.

reinforce the existing geographical differences in birth potential for new entrants, both in number and quality.

Moreover, new entrepreneurs tend not to venture far from their geographic origins (as found by, for instance, Dahl and Sorenson, 2009; Figueiredo et al., 2002; Michelacci and Silva, 2007). The location of new firms is heavily influenced by the local social ties of founders (Davidsson and Honig, 2003). Beckman (2006) finds evidence for a positive effect of entrepreneurial social capital on new venture performance. Regionally bounded knowledge helps entrepreneurs assemble the assets and recruit the personnel that they need to succeed in their ventures (Delgado *et al.*, 2010). For instance, new firms may wish to hire local employees since entrepreneurs have greater knowledge about local prospective hires based on their prior work experience (Carias and Klepper, 2010). Stuart and Sorenson (2003), and Michelacci and Silva (2007) suggest that there are so many local entrepreneurs because locals can better exploit the financial opportunities available in the region where they were located. Dahl and Sorenson (2009; 2012) argue that the lack of social capital limits an entrepreneur's ability to found a firm in a region in which (s)he does not have connections. This spinoff home location dynamic process leads to a build-up of superior firms in a region. Such a process does not strictly require the existence of advantages associated with agglomeration, but simply a preference of founders to locate near their previous employer.

The views of agglomeration economies and heritage theories are not mutually exclusive but are clearly based on different mechanisms whose effects on collocation we would like to clarify.

### **3. Data and Empirical Methodology**

Motivated by the theoretical discussion from section 2, our research question is: what mechanisms drive the collocation of related industries in the same region where one of them agglomerates? The methodological approach to address this question is based on an econometric analysis of detailed data on firms, founders, and workers in the Portuguese molds and plastics industries covering the period from 1986 to 2009.

The empirical analysis focuses on the relationship between the molds and the plastics injection industries in Portugal, and their supplier-customer link. Inside their value-chain, the plastics industry is the industry with the strongest vertical relationship with the agglomerated molds industry in the Portuguese territory. The majority of other important inputs (like steel) are imported. In addition, although the plastics industry is not agglomerated, a large number of companies collocate in the molds cluster.

#### **3.1. Data**

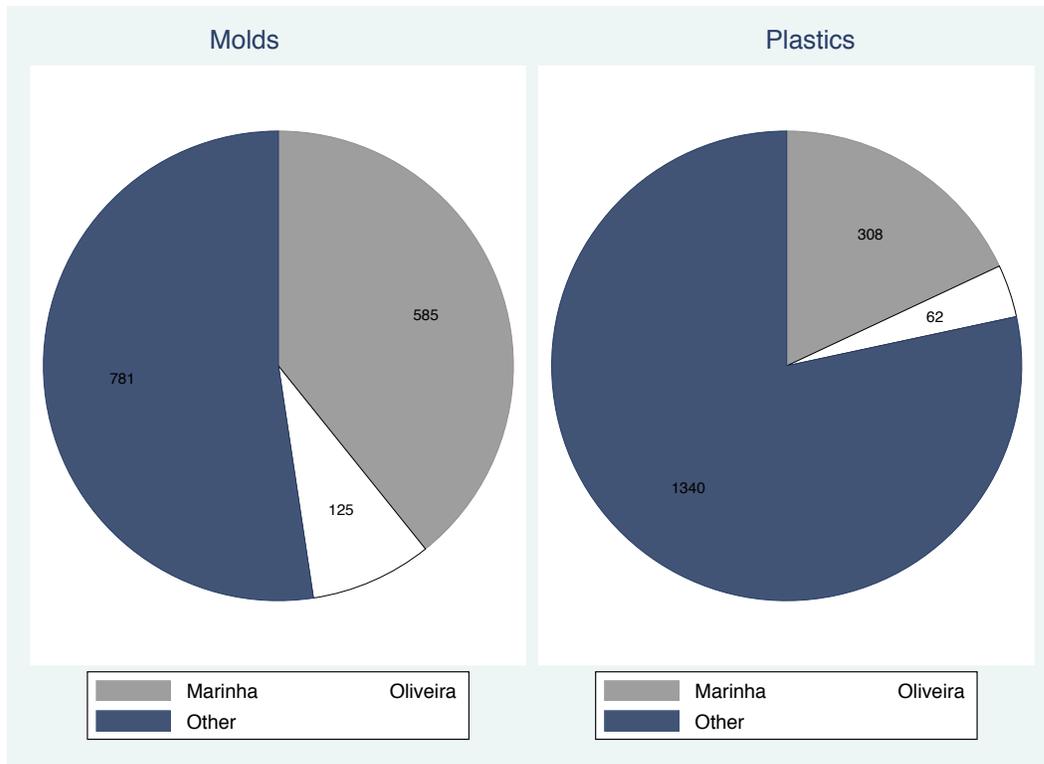
The paper uses a dataset extracted from "Quadros de Pessoal" (QP) micro-data. QP is a Portuguese longitudinal matched employer-employee database with extensive information on firms, workers and business owners for the period 1986-2009. QP data is updated annually by the Portuguese Ministry of Social Security and covers all firms and establishments in the Portuguese economy (with at least one wage-earner). Submission by firms is mandatory. The dataset includes detail on firms, such as size (number of employees) and location, as well as information on individuals covering age, education, employment, and professional careers. In our dataset we use longitudinal data for founders and firms in the molds and plastics industries from all Portuguese counties in

continental Portugal.

The number of molds companies that entered the industry in the period of analysis for was 1,146, including spinoffs from the same industry, spinoffs from the plastics industry, new molds establishments created by companies in other industries, and *de novo* entrants. The sample of the plastics industry entrants in the period of analysis includes 1,170 companies, including the mentioned types of entrants. Average entry by year in the plastics industry is 49 companies, while the average for the molds industry is 45 companies per year. The total number of companies in the market in both industries rose up until 2005, when there were 914 companies in the plastics industry and 681 in the molds industry.

The molds industry agglomerates in Marinha Grande and Oliveira de Azeméis regions. The plastics industry is less concentrated but also has a high proportion of companies in Marinha Grande region. Figure 1 shows that 21.64% of the plastics companies are located in the molds cluster (Marinha Grande and Oliveira de Azeméis), while the remaining companies are scattered in other 140 *concelhos* (14.39% are located in Lisbon and Porto). 47.62% of the molds companies are located in Marinha Grande and Oliveira de Azeméis regions (39.23% in Marinha Grande region).

**Figure 1 - Location of the Molds and Plastics Companies**



The plastics industry had a close relationship with their local molds suppliers during the emergence of the industry. However, from the mid 1950s the molds industry started exporting intensely, and soon the local plastics customers represented only a small part of their market. The molds industry consistently exported about 80% to 90% of its production. However, for the plastics industry, the local molds suppliers continued to be important, as Portuguese plastics firms bought about half of their molds from domestic suppliers.

### **3.1.1. Main Variables**

For the present analysis, we identify companies in the plastics industry as companies that

may mainly use plastic injection technology to produce plastic products. Molds companies are producing molds for plastic injection.

For each entrant in the molds and plastics industries from 1987-2009<sup>2</sup>, we identify the founder(s). Then we look for each founder's occupations in the previous five years of available data. Among the molds and plastics entrants we identified:

- *Same-industry* spinoffs: new entrants founded by at least one person with a prior job in the same industry, with no known dependence from the parent company;
- *Cross-industry* spinoffs: new entrants founded by at least one person with a prior job in the related industry (molds or plastics), with no known dependence from the parent company;
- *Diversifiers*: defined as new establishments created by companies in all other industries<sup>3</sup>;
- *De novo entrants*: new entrants whose founders did not have a prior job in the same or a related industry (with jobs in other industries or with no known prior jobs).

To assess the level of industry agglomeration across regions in the country we used the location quotient. The location quotient is the ratio of two shares: the employment share of a particular industry in a region and the employment share of that industry in the country and it has long been applied to estimate the strength of regional economic activities (see for example Isserman, 1977). Building on the dartboard approach

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<sup>2</sup> Entrants in 1986 were not included since we had no way to observe their professional backgrounds in prior years.

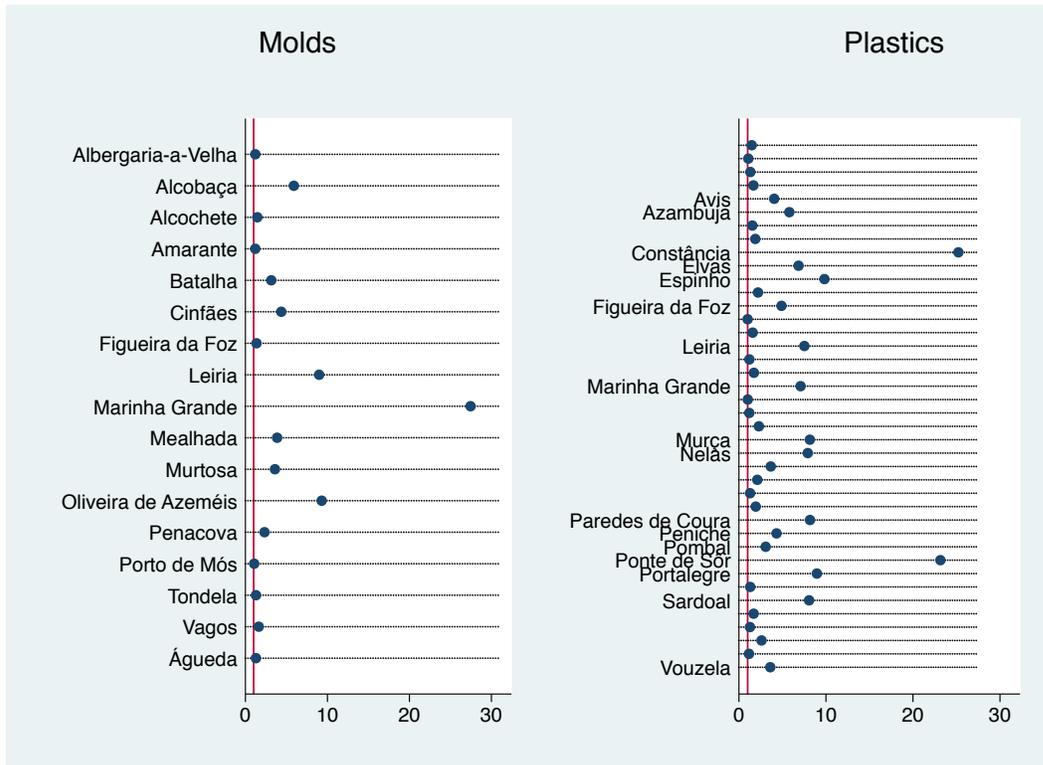
<sup>3</sup> Including 3 molds companies that created new plastics establishments.

developed by Ellison and Glaeser (1997), which removes the effect of agglomeration driven by random independent location decisions, Guimarães et al. (2009) developed significance tests for the location quotient.

As generally considered in the literature, we weighted the shares of the industries using the number of employees, in order to attribute more importance to the location decision of larger plants. Researchers usually assume that if the quotient is above one, then the industry is concentrated in the region. Using the significance tests introduced by Guimarães et al. (2009) we can verify if the location quotients show evidence of geographic concentration in excess of what would be expected to happen randomly.

We used the data in QP from 1986 to 2009 to estimate significant location quotients for the molds and the plastics industries, and also a joint location quotient for both. Results show that the molds industry is concentrated in fewer counties, while the plastics industry has a strong presence in a large number of counties. The average location quotient across counties for the molds industry is 0.58 and 1.26 for the plastics industry. As expected, the highest location quotient for the molds industry was for Marinha (27.46), as shown in Figure 2. Nearby counties like Leiria, Alcobaça, and Batalha also rank high. Oliveira de Azeméis is another county acknowledged as having a strong presence of large molds companies, further north.

**Figure 2 – Counties with Significant Concentration in the Molds and Plastics Industries (1986-2009)<sup>a</sup>**



<sup>a</sup> Names of low location quotient counties were omitted to improve the graph's readability

The highest location quotient for the plastics industry was for the counties of Constância (25.22) and Ponte de Sôr (23.16), while for Marinha (7.09) and nearby Leiria (7.52) concentration is still high and well above average. However, if we used weights for number of companies instead of employment the concentration level for Marinha and Leiria in the plastics industry would rank higher (6<sup>th</sup> and 4<sup>th</sup>, respectively), suggesting that these regions have a large number of small companies.

Considering that the average employment in the molds industry for the period was 8,599 employees per year, while it was 18,233 employees in the plastics industry, the joint location quotient is, not surprisingly, dominated by the regions where the plastics

industry has a stronger presence. Therefore, the joint location quotient for the molds and plastics industries is higher for Constância (17.18), followed by Ponte de Sôr (15.60), Marinha (13.58), and Leiria (7.94).

We used the location quotient estimates to proxy for agglomeration of these industries across counties in Portugal. We used the value of the quotient when the estimate was significant and replaced it by zero when the test failed to confirm localization above what we would expect to find randomly.

### **3.2. Empirical Analysis**

One main prediction emerges from the agglomeration economies theoretical approach discussed in Section 2. If agglomeration theories better describe the main drivers of industry collocation, then:

- firms from related industries collocating in the cluster<sup>4</sup> will perform better than firms located elsewhere, independently of their background.

Likewise, two main predictions emerge from the heritage theory approach. If heritage better describes the main drivers of the industry collocation process, then:

- spinoffs originating from the same industry and cross-industry spinoffs from a related industry perform better than other startups; spinoffs originating from the same or a related industry from better quality parents perform better.

We would also expect to find, according to heritage theory, that incumbents from an agglomerated industry (and a related industry) spawn more entrants in that industry than

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<sup>4</sup> The cluster refers to the presence of the agglomerated industry and the related industry.

incumbents in other industries, independently of the region where they are located. The analysis will explore this prediction, although it does not contribute to determining which mechanism is driving collocation and enhancing the performance of collocating industries.

The empirical study is divided in two parts: the first part concerns the survival of companies in both related industries and the way it is influenced by the background of the entrepreneurs and the worker density in the region; the second part looks at another measure of firm performance by analyzing the factors influencing the likelihood the molds and plastics entrants will become top one-third sellers in their third year of activity.

These approaches examine the determinants of the performance of entrants, according to their origin, using survival analysis and sales ranking analysis. We look at the effect on survival of the background of entrants in the plastics and molds industries (in particular if they are cross-industry spinoffs). The analysis controls for the backgrounds of entrants (i.e. the career paths of founders) and also the extent of activity in the entrants' region in the related industry and its own. We therefore test whether survival of firms that enter plastics and molds is more influenced by the background of founders (i.e. whether they are spinoffs from related industries and the performance of parent companies) or by the concentration of molds producers in the region and the concentration of plastics producers in the region. If backgrounds play a greater role, heritage theory is supported; if region plays a greater role, agglomeration theory is supported. We also look at cross-influences between the two industries.

In the second part we do a similar performance analysis by looking at the likelihood entrants will become top one-third sellers in their third year of activity.

## 4. Results

This section presents the empirical estimation results. Estimations for the survival analysis present hazard ratios (Table 1). The estimations of the sales ranking Logit model (in Table 2) present the marginal effects of the explanatory variables, again as recommended by Wiersema and Bowen (2009). For a discrete explanatory variable, the marginal effect is the change in the dependent variable when the explanatory variable is incremented by one unit.

Model I analyses the probability of survival and Model II looks at sales ranking. If spinoffs or startups originating in related industries are more likely to survive and have higher sales, then the prediction of the heritage theory is supported. If molds companies located in the cluster are more likely to survive and sell more, regardless of their industry of origin, then the prediction of the agglomeration economies account is supported.

Entrants are classified as *same-industry* spinoff (with experience in the same industry), *cross-industry* spinoffs (with experience in the other industry: plastics or molds), *diversifiers* (new establishments in molds or plastics from companies that are not in those industries), *de novo entrants* (entrants with identified background that is not in a related industry), and entrants with unknown backgrounds (omitted baseline category).

### 4.1. Survival

The goal is to examine the probability of firm survival in plastics and molds as a function of the firm's background (i.e. whether it is a same or cross-industry spinoff, and diversifiers) and of the density (location quotient) of the region where it locates. If related backgrounds play a greater role, heritage theory is supported; if region plays a greater

role, agglomeration theory is supported. The analysis includes a control for the quality of the parent company, thus examining whether factors conditioning survival operate immediately at the birth of entrants, reflecting that they influence the innate ability of entrants to compete. It also controls for the entrant's initial size. We use mixed Frailty models<sup>5</sup>.

Table 1 displays the results of the frailty survival models using a Gompertz distribution with Gamma heterogeneity. These models account for firm heterogeneity so we would expect to obtain more accurate results. Looking at entrants in both plastics and molds (column 1), there are significant effects from entrant background, both from the same industry and cross-industry. However, agglomeration also has a significant positive, though weaker, effect on survival, in particular when looking at the joint molds and plastics location density. When only molds entrants are examined (column 3) a similar pattern emerges, with positive and significant effects from background of the entrepreneur on survival (i.e. same industry, but even stronger impact from cross-industry spinoffs coming from plastics, that are less likely to exit), lending support to both heritage and agglomeration accounts. Survival of molds spinoffs seems to be most positively affected by entrepreneur background in the plastics industry (lower hazard ratios from cross-industry spinoffs than for same industry spinoffs). However, collocation with their customers in the plastics industry also has a positive, although weaker, effect on survival.

Findings are quite different for the plastics entrants (column 2), since there are only significant effects for same industry background. An entrepreneur background in the

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<sup>5</sup> Results from a Cox proportional hazards model are, however, similar.

molds industry does not have a significant influence on plastics entrants' survival. Furthermore, there are no significant effects of locating in *concelhos* where the molds industry agglomerates or even where both industries agglomerate, so results are very much against the agglomeration economies account.

*De novo* entrants seem to perform surprisingly well in the plastics industry. Indeed, *de novo* plastics entrants survive longer than entrants with a background in the same industry. This trend however, does not apply in the case of the molds entrants. This would suggest that prior industry knowledge has a much stronger impact on firm survival in the molds industry than in the plastics industry. This conclusion is also consistent with the lower intensity of spawning in the plastics industry observed in Model I. Both results would suggest that the nature of knowledge in these industries is not comparable and that the heritage mechanisms would not play a very important role in the plastics industry.

However we must note that this *de novo* categorization may not correspond entirely to the classification usually found in the literature. Our sample of entrants with unknown background may contain entrants who are also *de novo* entrants (or other types of entrants) but we were unable to confirm that in the data.

**Table 1 – Model II: Estimates of the Survival Frailty Model, Gompertz distribution (Gamma heterogeneity) – hazard ratio<sup>b</sup>**

VARIABLES	(1) Molds and Plastics		(2) Plastics		(3) Molds	
	Size at entry (ln)	0.947* (0.028)	0.947* (0.029)	0.912* (0.043)	0.910** (0.043)	1.006 (0.042)
Size of spinoff's parent (ln)	0.988 (0.042)	0.984 (0.042)	0.984 (0.074)	0.978 (0.074)	1.000 (0.053)	0.999 (0.053)
Same industry spinoffs	0.587*** (0.091)	0.585*** (0.091)	0.609* (0.166)	0.612* (0.167)	0.492*** (0.099)	0.496*** (0.099)
Cross-industry spinoffs	0.588** (0.151)	0.588** (0.151)	0.593 (0.207)	0.594 (0.209)	0.396** (0.152)	0.406** (0.154)
Diversifiers	6.094*** (0.674)	6.194*** (0.687)	7.694*** (1.816)	7.780*** (1.854)	4.767*** (0.577)	4.767*** (0.576)
“De novo”	0.618*** (0.049)	0.620*** (0.050)	0.544*** (0.075)	0.546*** (0.075)	0.656*** (0.071)	0.662*** (0.071)
Location Quotient Molds & Plastics	0.979*** (0.007)		0.979 (0.013)		0.967*** (0.008)	
Location Quotient Molds		0.992** (0.003)		0.992 (0.007)		
Location Quotient Plastics						0.946*** (0.013)
Constant	0.087*** (0.006)	0.085*** (0.006)	0.073*** (0.008)	0.071*** (0.007)	0.108*** (0.010)	0.108*** (0.010)
Observations	2,307	2,307	1,157	1,168	1,182	1,182
Log-likelihood	-2,745.1	-2,747.3	-1,312.3	-1,319.8	-1,435.5	-1,435.7
Lh ratio test $\theta=0$	0.000	0.000	0.000	0.000	0.000	0.000

<sup>b</sup> Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 4.2. Sales ranking

The estimates from Model II, the Logit model, in Table 2 show the marginal effects for the likelihood to become a top one-third seller by the third year in the market. Same-industry and cross-industry spinoffs, both from molds and plastics, are significantly more likely to become top sellers. For the molds industry, “de novo” entrants are much less likely to rank in the top-third sellers than spinoffs. Location does not have an impact on the likelihood a plastics entrant will become a top seller, but it has a significant, although very small, effect for molds entrants, in particular locating close to plastics companies.

**Table 2 – Model III: Estimates of the Logit models for top sales in the third year – marginal effects <sup>c</sup>**

VARIABLES	(1)		(2)		(3)	
	Molds and Plastics		Plastics entrants		Molds entrants	
Size at entry (ln)	0.132*** (0.009)	0.132*** (0.009)	0.135*** (0.013)	0.135*** (0.013)	0.134*** (0.012)	0.135*** (0.012)
Size of spinoff's parent	-0.002 (0.011)	-0.001 (0.011)	-0.004 (0.019)	-0.002 (0.019)	0.001 (0.013)	0.001 (0.013)
Same industry spinoffs	0.178*** (0.039)	0.180*** (0.039)	0.172*** (0.064)	0.170*** (0.064)	0.175*** (0.048)	0.169*** (0.048)
Cross-industry spinoffs	0.181*** (0.066)	0.181*** (0.066)	0.165* (0.092)	0.165* (0.092)	0.189** (0.096)	0.183* (0.096)
"De novo"	0.122*** (0.021)	0.121*** (0.021)	0.142** (0.029)	0.141*** (0.029)	0.099*** (0.032)	0.098*** (0.032)
Location Quotient Molds & Plastics	0.005*** (0.002)		0.005 (0.004)		0.005** (0.003)	
Location Quotient Molds		0.002* (0.001)		0.001 (0.002)		
Location Quotient Plastics						0.011** (0.004)
Observations	2,271	2,271	1,122	1,122	1,170	1,170
Log-pseudo likelihood	-1,177.21	-1,179.19	-613.70	-614.41	-566.31	-565.08
Pseudo R <sup>2</sup>	0.1678	0.1664	0.1398	0.1389	0.2122	0.2140
Wald test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

<sup>c</sup> Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Year dummies omitted

## 5. Discussion

Results unequivocally show that heritage through the transmission of capabilities from parent firms in the related industry to spinoffs locating in the same region is a very important driver of collocation of the molds and plastic injection industries, thus supporting the findings of Klepper (2010), and Buenstorf and Klepper (2009), even when we look mainly at a cluster's growth and sustainment stages. Cross-industry spinoffs between molds and plastics are more likely to occur for larger (i.e. better) parent firms, while spinoffs are more likely to locate in the same region as their parent company.

Location choice is not influenced by attraction to the cluster. Results on the performance of new firms in the molds and plastics industries show some support for heritage theory (in the case of molds), and evidence is only weakly supportive of the agglomeration economies theory.

It appears that the choice of the plastics entrants to locate in the molds cluster is driven by the fact that molds firms are more likely to spawn plastics firms and that entrepreneurs tend to locate in their home region, therefore collocating with their supplier industry. However, the performance of the plastics companies does not seem to improve with collocation with the suppliers from the molds industry. For molds entrants, collocation with plastics again arises from the higher likelihood that plastics companies will spawn molds spinoffs, and that those spinoffs tend to locate close to the parent firm. In the case of molds spinoffs, knowledge learned from the same industry, and even from the customer plastics industry, seems to positively influence firm performance (survival and sales). Collocation with plastics customers only marginally improves survival, but has a stronger impact on the likelihood to become a top one-third seller. We also find a positive and significant impact of parent quality (measured by its wage levels) on the sales volume of entrants in their third year in the market (in particular for plastics entrants).

Klepper's (2010) account of the geography of organizational knowledge is consistent with the collocation patterns between the molds and plastics industries, while agglomeration economies accounts do not seem to significantly explain collocation. This study contributes to the understanding of the process of causation associated with industry collocation patterns in industrial clusters, concluding for the prevalence of organizational heritage effects over agglomeration economies accounts.

The finding that collocation effects seem to have a positive, although weak, effect on the survival of molds but not plastics firms may be explained by the fact that for the plastics industry spawning is not prevalent. Golman and Klepper (2013) propose that positive location externalities may enhance spinoff performance in a cluster, while they would have a weaker impact on other types of firms that would not have the necessary inherited knowledge to benefit from them. This claim would be consistent with our results, showing that only in the molds industry, where spinoffs are prevalent and perform better, firms are able to benefit from collocation with plastics companies. On the other hand, our results do not support the impact of agglomeration economies on collocating industries. Ellison et al. (2010) claim that input-output linkages and labor pooling are good predictors of coagglomeration. We would suggest that these agglomeration economies may (or may not) induce collocation but they are not enhancing firm performance per se. Industry characteristics seem again, to play an important role in their ability to gain from collocation. In the case of the plastics industry, where tacit knowledge is not dominant, it appears unlikely that true clustering would occur, due to the absence of significant heritage effects.

## **6. Conclusions**

This research aims to contribute to the understanding of the mechanisms driving the performance of industries clustering in specific regions and their ability to benefit from collocating with related industries. The case of the molds industry in Portugal is an example of a successful cluster that emerged in the 1950s and is still prevalent today. Quantitative data are available from 1986 to 2009; therefore, there is an opportunity to

examine the cluster's growth and sustainment stages (while using an historical account to describe the cluster's emergence and early growth stages). This research also extends the analysis to more than one industry by including the cross-industry relationships with related industries (in particular with its main customers in the plastics industry, but also with other industries in the value-chain, and skill-related industries).

seems to be the origin of the entrepreneur. Such findings suggest that agglomeration economies effects, although significant, are not the main drivers of firm performance in the cluster, whether in the, growth, or sustainment stages of the cluster's development. Moreover, agglomeration economies seem to complement the effect of heritage in the late growth and sustainment stages of the cluster's life cycle, but there is no evidence that those effects would be able to cause agglomeration on their own. However, results point to significant effects attributed to agglomeration economies, which cannot be ignored.

Our results are concordant with the work by Boschma and Wenting (2007) who studied the automotive industry in Britain and concluded that there are complementarities between agglomeration economies and spinoff linkages driving the industry's agglomeration. In the early stage of the British automotive industry's development, during its first twelve years, the entrepreneur's prior experience in related industries seemed to be the best predictor of survival. When examining the whole 74 years of British automotive industry data, experience remained important but the spinoff effect became the strongest performance driver, but only if it was from a successful parent.

Broadening this view, this research also contemplated the phenomenon of industry collocation, or why a significant number of plastics companies chose to locate in the molds cluster and what effect that had in the molds industry itself. In the study of the

cross-industry effects driving collocation, again in a post-emergence stage, results point to even stronger effects of heritage and mild but significant effects of agglomeration economies. Molds spinoffs with entrepreneurs from the plastics or the molds industries seem to perform better, while collocating with their customer industry only has a weak positive effect. Moreover, the plastics companies did not seem to benefit from collocating with their suppliers. This results could be explained by the inability of firms that do not possess advantages associated with inherited tacit knowledge to benefit from the externalities associated with collocation. Again, the main factor driving performance for the industries seems to lie on the effect of industry background, associated with the tendency to locate home, as proposed by Buenstorf and Klepper (2009).

The present study has several limitations that have already been noted but should be restated. First, detailed data are not available for the formative era of the industry, which does not allow the use of econometric techniques to test the predictions of the two theories under consideration for the period 1946–1986.

Regarding the econometric study, tracing backgrounds of entrepreneurs is not always possible when dealing with the data, although a sizable and representative sample of molds startups entering over 24 years was assembled. Also, the unavailability of firm-specific data other than size imposed serious limits to the ability to control for firm heterogeneity in the Logit models (as size is not a critical variable accounting for quality in the Portuguese plastic injection molding industry). A final difficulty lay in the identification of industries related to molds. Identification of industries in the molds value-chain would benefit from additional analyses of input-output data that was not accessible, compelling us to resort to published lists of industries.

These findings have implications for both practitioners and policy makers. For practitioners, the findings seem to confirm that access to external capabilities can substitute for vertical integration in localized networks of firms. The findings are also informative for firm location choice, suggesting that firms may benefit from locating in the cluster.

For policy makers, the results suggest that industrial districts remain a valid model for regional growth, at least in industries where tacit knowledge plays a greater role than scale. However, results suggest that the main driver for successful cluster emergence and growth is linked to the spinoff process, implying that policies fostering spinoffs may be more effective than generalized entrant attraction incentives. Examples would be policies not allowing or enforcing non-compete clauses in labor contracts and promoting an entrepreneurship-supportive environment. This research also shows that not all types of industries can benefit from clustering. The benefits of clustering seem to be closely associated with industries where tacit knowledge is an important asset. The importance of tacit knowledge, however, appears to be associated with the fact that it enables spawning. Workers who embody significant tacit knowledge in an industry where that type of knowledge is critical are better candidates to create successful spinoffs than in other types of industries. Evidence from the plastics industry shows that this lower preponderance of tacit knowledge leads to lower rates of spawning and, therefore, to a lower ability to profit from collocating with a supplier. For policy makers this shows that the type of industries that can benefit from clustering is limited to industries where tacit knowledge is prevalent.

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