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Entrepreneurial Clusters and the Co-agglomeration of Related Industries: Spinouts in Portuguese Plastics and Molds

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Entrepreneurial Clusters and the Co-agglomeration of Related Industries: Spinouts in Portuguese Plastics and Molds

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Entrepreneurial Clusters and the Co-agglomeration of Related Industries: Spinouts in Portuguese Plastics and Molds

ABSTRACT

This study examines how co-agglomeration (or collocation) of entrepreneurial firms in related industries influences cluster growth. Two types of effects are considered that may drive collocation: the inheritance of capabilities from local incumbents by spinout founders; and agglomeration benefits stemming from local access to supply-side spillovers. These effects are examined for the Portuguese molds and plastics industries. Results suggest that the transmission of capabilities from parent firms to spinouts locating in the same region is the foremost driver of collocation and performance for the molds and plastic injection industries. The presence of the plastics industry has a positive impact on the molds industry but not the inverse, implying that while collocation with molds is not a requirement for the plastics industry to flourish, collocation with plastics is important for the molds industry.

Keywords: Clusters; Spinouts; Regional development; Agglomeration Economies; Organizational Heritage.

J.E.L.: L26; M13; R30.

1. Introduction

The success of 'entrepreneurial clusters' has led policymakers towards extensive efforts to seed local entrepreneurship (Lerner 2009). In a recent review, Chatterji et al (2013) point to a variety of factors which are deemed to be spatial determinants of entrepreneurship; a particular important determinant of the 'supply of entrepreneurs' are industry linkages within cities or regions. Indeed, studies consistently find that the most powerful predictor of future entrepreneurship for a city or region is the presence and strength of incumbent firms in the same or in related industries (see, for instance, Figueiredo et al., 2002; 2009).

If firms in related (e.g. customer or supplier) industries are an important source of local entrepreneurs, than the collocation of related industries is likely to be driven by the creation of spinout firms. While the determinants and benefits of agglomeration of firms in the same industry have been extensively discussed in the literature (see, for instance, Porter, 2000; Klepper, 2010), the drivers and effects of collocation of related industries calls for more research. More than understanding what motivates companies to locate close to their peers in the same industry, we would like to understand the influence the location choice of one industry can have on the performance of a related industry that may drive collocation.

This paper aims to examine the factors influencing the enhanced performance resulting from location choice of industries driving them to collocate within a region. We aim to uncover 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. We look at two theoretical streams to 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 we test the predictions of both streams.

We focus on the case of the molds for plastic injection, and plastics industries (i.e. plastic injection molds 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 Marinha Grande region (hereafter referred as Marinha). This paper aims to clarify the mechanisms driving the Portuguese plastics industry to collocate in the region where the Portuguese industry of molds for plastic injection agglomerates. We expect to find linkages between these two related industries either in the form of spinouts and diversification phenomena (as predicted by heritage theories), and/or agglomeration benefits related to the transaction of goods, people and ideas, which influence the location choice of new firms. The molds industry in Portugal is agglomerated in Marinha and had itself roots in the glass industry, which had been located in the same region since the 18th century. The evolution of the Portuguese plastics industry trailed that of the molds industry. Hence, our main research question is: what mechanisms drive the collocation and performance of related industries in the same region where one of them agglomerates?

If agglomeration economies explain industry collocation, one would expect firms from related industries to collocate in the agglomerated region. Firms locating in the agglomerated region should perform better than firms located elsewhere, independently of their background. If heritage is the main force behind collocation, then spinouts will locate close to parent firms regardless of their region of origin. Spinouts from parent

firms in the same or a related industry perform better than other startups.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 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 paper is organized as follows. The following section discusses the theoretical approaches that motivate the paper (section 2). In section 3 we present a brief account of the evolution of the molds and plastics industries in Portugal. In section 4 the data and methodology are described. Then we present and discuss the empirical results (section 5). Finally, in section 6, 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 industries that are supplier or buyer industries of an agglomerated industry.

The collocation of related industries calls for an analysis of the drivers of agglomeration

for each individual industry but also raises the issue of possible cross-industry influence, that is, the possibility that clustering in an industry might be driven by the presence of other, related industry. Empirical research claims that the concentration of related industries contributes to firm entry (Glaeser and Kerr 2009) and survival (Neffke, Henning, and Boschma 2011), as well as industry and cluster growth (Delgado, Porter, and Stern 2012); therefore one 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.

Location choice of one industry close to a related industry could be driven by the benefits of agglomeration economies resulting from that proximity or it could be driven by an organizational reproduction process between these related industries. Therefore, two theoretical streams to explain the collocation of related industries process are considered: agglomeration economies and organizational heritage theories.

Agglomeration economies theories explain 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) explain industry coagglomeration with economic benefits from supplier and customer reduction in transportation costs, labor market pooling, and intellectual spillovers. Regressing industry pairwise coagglomeration indices on measures of these three effects, they find positive and significant correlations with input-output dependencies and labor pooling benefits.

Within this line of reasoning, the collocation of related industries is 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 relationship. Also, Glaeser and Kerr (2009) find that the presence of related industries, to the extent that they induce labor pooling by hiring the same type of workers, has a significant effect on entry. Delgado *et al.* (2012) also mention benefits related to access to key inputs, better interactions with customers, and facilitation of experimentation and innovation. Therefore, these authors would expect that firms that chose to locate close to related industries would improve their performance compared to firms that would locate elsewhere.

Chinitz (1961) argues that entrants are attracted to areas with many independent small suppliers, and Glaeser and Kerr (2009) find empirical support for that claim. They also find that entry in a region tends to be even more influenced by the presence of related industries that hire the same sort of workers.

Heritage theory focuses on the role played by spinouts and, more broadly, the transmission of capabilities from parent firms to startups. Buenstorf and Klepper (2009) propose that a firm's pre-entry capabilities critically shape its performance. The offspring of the better firms inherit more capabilities and therefore become superior performers. Since new entrepreneurs tend not to venture far from their geographic origins (Michelacci and Silva 2007; Dahl and Sorenson 2009; Figueiredo, Guimarães, and Woodward 2002), this dynamic process leads to a build-up of superior firms in a region. Such a process does not strictly require the existence of any advantages associated with agglomeration,

but simply a preference of founders to locate near their previous employer.

Often the spinouts created in a new industry originate from parent companies that are incumbents in an older, predecessor industry, which is related to the new industry. This is the case of, for instance, glass, glass molding, and plastic injection molding in Portugal; bicycles, carriages, and automobiles in the United States (Detroit) (Klepper 2007), and radio and television receivers in the United States (Klepper and Simons 2000). This is due to the benefits that startups in the new industry accrue from inheriting important pre-entry knowledge (i.e. capabilities and routines) from their parent firms. Such pre-entry knowledge is transmitted between firms by founders and/or employees of the new firms that previously worked in the parent firms or through diversification of the parent firm into the new industry. Such a process provides new firms with a significant competitive advantage (Helfat and Lieberman 2002; Phillips 2002).

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. Taking into consideration these two theoretical approaches, the aim of this study is to understand the cross-effects that the presence of one industry may have in the location choice of a related industry.

3. The Evolution of the Molds and Plastic Industries in Portugal

Molds are metal parts used in plastic injection equipment to define the shape of plastic components that can then be used as inputs in several industries like electronics, automotive, electric appliances, and many others. Molds are technologically complex

products, often with tolerances of only a few microns (for precision molds), and usually each mold is unique, made to order under the specifications of the customer. Each mold can then be used to inject millions of identical plastic components.

The emergence of both the molds and plastics industries is deeply rooted in the Marinha region, which in earlier times had also been the birthplace of the glass industry in the country (Callapez 2000). In fact, the glass industry agglomerated in the region since 1769, when Portuguese King José I, with the support of his prime minister Marquee of Pombal, invited an English industrialist, William Stephens, to restart the glass factory, then named "Real Fábrica de Vidros" (Royal Glass Factory) in Marinha (Barosa 1993). By the mid-1920s, one young toolmaker working at "Real Fábrica", Aires Roque, asked the manager's permission to create a glass molds workshop. Together with a skilled lathe operator, António Santos, he produced the first die-cast mold for glass in Marinha, using chromium steel (Henriques, Silva, and Laranjeira 1991).

Latter on, and in parallel with the development of the plastics industry, the plastic injection molds industry gave the first steps in a workshop named after Aires Roque, but eventually managed by his half-brother Aníbal Abrantes, who started experimenting with molds for Bakelite[1] in 1936 (Beira *et al.* 2004; Callapez 2000). The molds industry settles in Marinha region, by influence of the glass industry, because the early glass molds technology could also be applied in the plastics molds industry. This technological closeness in an early stage of the plastics industry (when Bakelite was the most popular plastic material) drove the natural evolution from glass molds to plastic molds (Callapez

[1] Bakelite was the first chemically synthetic plastic. It was invented in 1907 by Leo H. Backeland, an industrial PhD chemist who emigrated from Belgium to the US (Meikle 1995).

2000).

In 1946, at the time thermoplastics were introduced in the market, Aníbal Abrantes started in Marinha the first Portuguese company (A.H.A.) to produce steel molds for plastic injection (Gomes 1998). Rapidly the company attracted more clients as more plastics companies emerged nearby, in Leiria and in the North region (Gomes 1998). Benefiting from the economic growth that followed the end of WWII the company and the molds and plastics industries prospered. A.H.A. innovated by creating news forms of work organization that allowed splitting the production process into specific tasks, and thus became a training center for many young workers. Around 1957 this very successful company became one of the first to export to the US, a trend that generalized and soon turned the US into the Portuguese molds industry's focal market (Beira *et al.* 2004). A large number of young workers got trained in specialized areas of mold manufacturing, many of whom later left to start their own companies taking some of their colleagues with them after a long on-job learning and training periods (Beltrão 1987; Matos 1985).

Regarding the plastics industry, in Portugal its origins can be traced back to the 1930s, not long after the industrialized pioneer countries started producing the first synthetic plastic products (e.g. US, Germany, UK). However, for example, in the US the industry was far more developed and organized, mainly populated with large companies – by 1925 they started publishing the first trade journal named *Plastics*, although their first "National Plastics Exposition" was organized much later in New York in 1946 (Meikle 1995). The first company to produce plastic products in the country was 'SIPE,' created in 1935 to produce electrical material made out of Bakelite. An electro technical engineering professor at the most prominent engineering school in the country (IST)

founded the company (Callapez 2000).

The company was located in the outskirts of Lisbon, not far from the university. Curiously, though, the professor had been waiting for nine years before he was allowed by authorities to start the company, who were enforcing policies limiting industrial growth. 'SIPE' imported the raw materials from England and used large electric molding press machines to mold the electric products. This company had a large impact over the country's protected market because it offered high quality electric products at much lower prices than its porcelain competitors (Callapez 2000).

In the following year the firm 'Nobre & Silva' also started to produce Bakelite products. The company was created in 1927 in Leiria (Marinha region), but initially produced espadrilles with rubber soles (Callapez 2000). The founders of the company were two bank employees that took advantage of county regulation – commanding the population to refrain from walking barefoot – in order to produce and sell low cost espadrilles (Callapez 2000).

In 1936 the company acquired an hydraulic press machine and started producing Bakelite lids for perfume bottles (Beltrão 1985; Callapez 2000; Gomes 1998). The mold for this lid was made by a local blacksmith workshop owned by José Marques, known as 'Wooden Eye' (Beltrão 1985; Callapez 2000). Other products followed, such as Bakelite corks and ashtrays and later products made with other plastics, including extruded and injected thermoplastics (Callapez 2000). 'Nobre & Silva' soon became a client of the Marinha region's molds manufacturers and started to order a different type of very simple molds for plastic pressing.

Possibly driven by the demand of the first few plastics companies in the country but also by the potential this new industry represented, other glass and glass molds companies started to experiment with very simple molds for plastic pressing, which at the time used similar mechanical principles to the glass molds (Callapez 2000). These experiments were a breakthrough in the inception of the plastic injection molding industry in the country, which soon outgrew the plastics industry itself.

Soon other small, family-owned plastics companies joined the market to produce toys, plastic flowers, corks, slippers and lids. The use of such plastic products became widespread and in the 1940s a new set of plants for plastic products emerged to produce products like belts, personal hygiene products, and vanity goods (Callapez 2000).

By then, the first fully automatic injection molding machine named ISOMA was developed in Germany and manufactured by the firm "Franz Braun AG" starting from 1933 and exported to other 28 countries in the following 10 years (the first machine imported in the US was bought in 1935 by the Index Machinery Corporation of Cincinnati)[2]. This equipment automatically molded and ejected a finished plastic product at 'every stroke of the machine' (Meikle 1995), thus allowing for a much less expensive production process.

Examples of other early plastics entrants in Marinha region are prolific. In 1946 'Baquelite Liz' was created in Leiria to produce Bakelite wine glasses, toys, combs, kitchenware, and office supplies. In the same year 'Matérias Plásticas' was created, and in 1955 'Plásticos Santo António', both in Leiria. Together with 'Nobre & Silva', these

[2] For more information on the ISOMA machines see for example Maschinenhandel Borowski (http://www.mhborowski.de/Glossar/Spritzgiessmaschinenbau-der-DDR_-7.html).

companies were considered the largest in the country in this industry (Callapez 2000).

After WWII plastics products proliferated with the post-war expansion both in Europe and the US (Meikle 1995), while in Portugal the industry also developed at a faster pace (Callapez 2000). Companies started using plastic injection equipment, and demand was boosted by the lower classes, driven by examples of imported plastic products that were substitutes for more expensive products. By 1947 the industry had 34 registered companies operating in the country, in a policy framework that did not favor industrial development (Callapez 2000).

From 1958 to 1970 the number of plastics companies in the Portuguese plastics industry grew at a 23% rate, reaching 383 companies registered with the mandatory national industry association by that time. During the 1970s and 1980 the industry's growth continued, once the industrial development limitations were no longer enforced (after 1974). In parallel, by 1979 in the US the annual volume of plastic production exceeded that of steel for the first time (Meikle 1995).

4. Data and Empirical Methodology

Motivated by the theoretical discussion from section 2, our research question is: what mechanisms drive the collocation and performance of related industries in the same region? 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 1986-2009.

4.1. 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 details on firms, like 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 1,066, including spinouts from the same industry, the plastics industry and other industries, new molds establishments created by companies in other industries, and de novo entrants (see Figure 1). The sample of the plastics industry entrants in the period of analysis includes 1,710 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 sample and 681 in the molds industry.

molds industry agglomerates in Marinha and Oliveira de Azeméis[3] regions. The plastics industry is less concentrated but also has a high proportion of companies in Marinha region.Figure 2 shows that 21.64% of the plastics companies are located in the molds

[3] Hereafter referred as Oliveira.

agglomerated region (Marinha and Oliveira), while the remaining companies are scattered in other 140 counties (14.39% are located in Lisbon and Porto). We see also that 47.62% of the molds companies are located in the Marinha and Oliveira regions (39.23% only in Marinha region).

Figure 1 - Entry and Number of Companies in the Molds and Plastics Industries

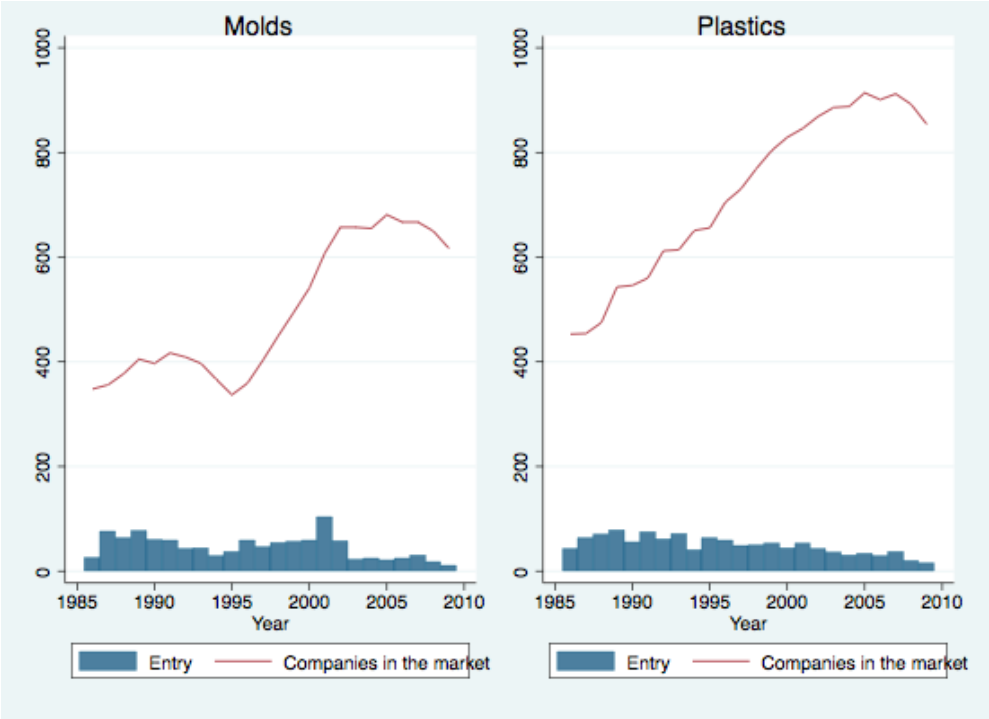
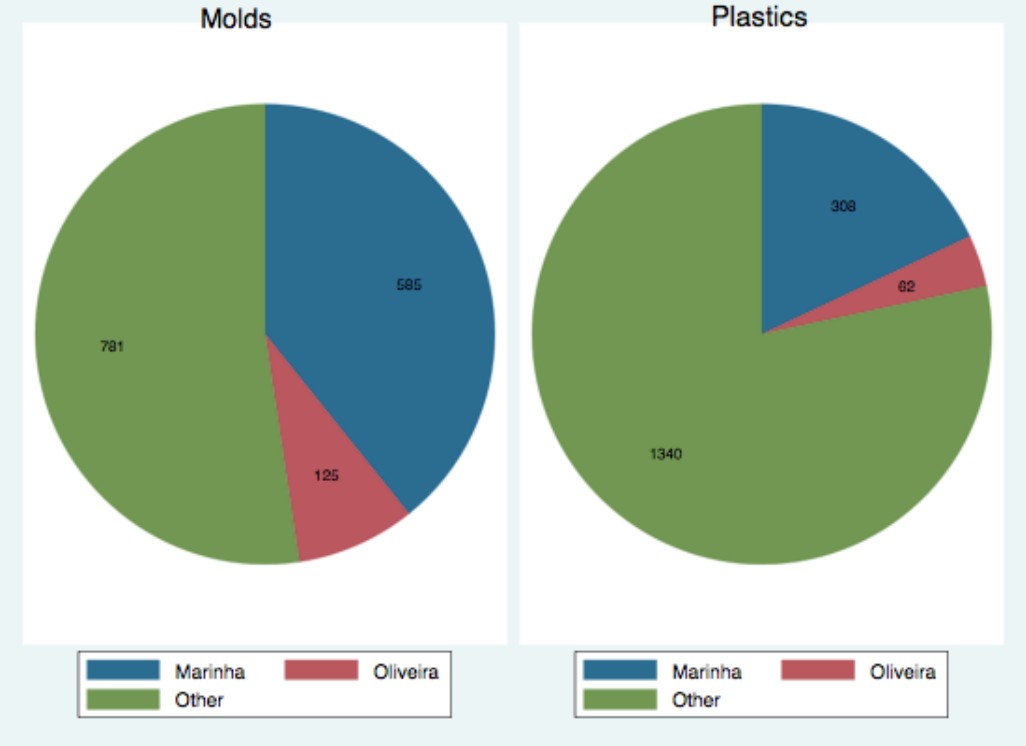


Figure 2 - Location of Molds and Plastics Companies



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 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. Nevertheless, in recent years (from 2005 on), the growth of molds production has been closely associated with the increase in domestic demand.

4.1.1. Main Variables

For the present analysis, we identify companies in the plastics industry as companies that may use mainly plastic injection technology to produce plastic products (see the

Appendix for further detail on the empirical definition of molds and plastics industries).

For each entrant in the molds and plastics industries from 1987-2009[4], the founder(s) were then identified. Previous occupations of each founder in the previous five years of available data were identified. Among the molds and plastics entrants it was possible to distinguish between:

- Same-industry spinouts (sis), 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 spinouts (cis), 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 (div), defined as new establishments created by companies in all other industries (including 3 molds companies that created new plastics establishments);
- De novo entrants (dnv), 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).

In the scope of our analysis, related industries are supplier or buyer industries of an agglomerated industry. These industries are important elements of the value chain of the agglomerated industry. The analysis will focus on the linkage between the plastics injection industry and the molds industry in Portugal and their tendency to collocate.

[4] Entrants in 1986 where not included since we had no way to observe their professional backgrounds in prior years.

Other supplier industries play a less important role in this case in Portugal because the majority of important supplies (like steel) are imported.

To assess the level of industry agglomeration across regions the location quotient was used. The location quotient has long been applied to estimate the strength of regional economic activities (see for example Isserman 1977). Building on the dartboard approach developed by Ellison and Glaeser (1997) that removes agglomeration driven by random independent location decisions, Guimarães *et al.* (2009) develop significance tests for the location quotient.

The location quotient (L) 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, as shown below:

$$L_{jk} = \frac{w_{jk}}{x_j} \frac{w_k}{x}$$

Where:

j – region

k – industry

w_k – total employment in industry k

w_{jk} – employment in industry k and region j

x – total manufacturing employment in the economy

x_j – total manufacturing employment in region j

As generally considered in the literature, the shares of the industries were weighted 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) it can be can verified if the location quotients show evidence of geographic concentration in excess of what would be expected to happen randomly. The test statistic (*W*) is given by the expression:

$$W_{jk} = \frac{J \ log \ L_{jk}^{\ 2}}{J - 2 \ w_{jk}^{-1} + w_{k}^{-1}} \approx \chi_1^2$$

Where:

$J -$ total number of regions in the country (275 counties)

Data in QP from 1986 to 2009 were used 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 *concelhos*, while the plastics industry has a strong presence in a large number of *concelhos*. The average location quotient across *concelhos* 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). Nearby counties like Leiria, Alcobaça, and Batalha also rank high. Oliveira is another county acknowledged as having a strong presence of large molds companies, further north.

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^{th} and 4^{th}, 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).

Location quotient estimates were then used to proxy for agglomeration of these industries across *concelhos* in continental Portugal. The value of the quotient was used when the estimate was significant and replaced it by zero when the test failed to confirm localization above what one would expect to find randomly.

Table 1 defines the variables used in the empirical analysis.

Table 1 - Variable definitions

Variable	Definition
spin	Dummy for creation of molds or plastics spinouts by company *i* in year *t* (DV)
pemp	Size of company *i*, measured by the number of employees in year *t*
plast	Dummy for company with at least one founder with a previous job in the plastics industry
molds	Dummy for company with at least one founder with a previous job in the molds industry
Ljmp_e	Location quotient for molds and plastics, weighted by employment
Ljmolds_e	Location quotient for molds, weighted by employment
Ljplast_e	Location quotient for plastics, weighted by employment

chosenloc	Dummy for *concelho* of location at entry (DV)
home	Dummy for entry in a *concelho* where at least one founder had a previous job
pemp_f	Size of the entrant measured by the number of employees in the first year
sis	Dummy for a spinout in the same industry as the previous job of at least one founder
cis	Dummy for a spinout in the other industry (molds or plastics) as the previous job of at least one founder
div	Dummy for new establishment created by companies in all other industries

4.2. Empirical Analysis

This work is divided in three main parts: the first part concerns the probability of firms generating spinouts in the related industry; the second part focuses on how company survival is influenced by spinouts and agglomeration externalities; and the third part concerns the influence of spinouts and agglomeration externalities on the likelihood the entrants in collocating industries will become top one-third sellers in their third year of activity. Additional models add to a descriptive characterization of the collocating industries by looking at the location decision of new firms and the factors associated with variations in sales. In order to test the predictions derived from both the agglomeration theory and the organizational heritage theory, three main types of models are estimated regarding:

I. the incidence of firms in molds and plastics industries cross-spawning entrants in those industries is analyzed. The aim is to examine the likelihood that a plastics entrant is spawned by a molds company and vice-versa, and the likelihood that entrants will locate in the agglomerated region. The analysis focuses on firm quality (measured by firm size in employees) bearing on the rate of spawning

startups, and also the role of location in affecting the spawning rate. If the incidence of spawning is greater for more successful firms independent of location, heritage predictions are supported;

II. the determinants of the performance of entrants, according to their origin, using survival analysis. The analysis focuses on the effect on survival of the background of entrants in the plastics and molds industries (in particular if they are cross-industry spinouts). 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 its own industry and in the related industry. In this way, a test of whether survival of firms that enter plastics and molds is more influenced by the background of founders (i.e. the type of entrants and the links to 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 is performed. If backgrounds play a greater role, heritage theory is supported; if region plays a greater role, agglomeration theory is supported;

III. performance determinants, but this time by analyzing the factors influencing the likelihood an entrant will become a top one-third seller in its third year of activity. The objective is to test whether the sales ranking of an entrant is influenced by the background of the entrepreneurs in the plastics and molds industries (supporting the heritage theory predictions), or by the concentration of molds producers and plastics producers in the region (supporting the predictions of agglomeration theory).

Additional estimations we performed but are not extensively reported here, such as:

IV. where spinouts of molds firms that enter plastics and spinouts of plastics firms that enter molds locate, given the geographic origin of the entrepreneurs. The goal here is to see whether there is company movement from all regions toward the agglomerated region or whether entrants are more likely to stay in the home region of founders;

5. Results

This section presents the empirical estimation results. The estimations of the cross-industry spinout Logit models (in Table 2) and for the sales ranking Logit model (in Table 4) present the marginal effects of the explanatory variables, 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. Estimations for the survival analysis present hazard ratios (Table 3). Table 5 presents the coefficients from the Conditional Logit model.

5.1. Probability of Spawning a Cross-industry Entrant

Model I addresses the effect of parent firm quality on the probability of generating startups measured by firm size and sales growth rate (however, the later does not have significant effects). Other possible measures of firm quality were tested but revealed low explanatory power. The effect of regional quality (i.e. industry density, as measured by the location quotient) is also addressed, while controlling for economic cycles with year dummies.

Table 2 – Model I: Estimates of the spawning Logit model - marginal effects†

VARIABLES	(1) Molds and Plastics entrants from all origins	(2) Cross-industry Plastics spinouts		(3) Cross-industry Molds spinouts	
Size in employees *(log(pemp))*	0.000294*** (0.000012)	0.004305*** (0.000811)	0.004281*** (0.000824)	0.003002*** (0.000708)	0.003079*** (0.000644)
Sales growth rate *(sgr)*	-2.35e-07 (2.14e-07)	-0.000055 (0.000142)	-0.000537 (0.000142)	-0.000652 (0.000514)	-0.000671 (0.000526)
Plastics Industry *(plast)*	0.000978*** (0.000053)				
Molds Industry *(molds)*	0.001405*** (0.000057)				
Location Quotient M & P *(Ljmp_e)*	0.000041*** (3.57e-06)				
Location Quotient Molds *(Ljmolds_e)*		0.000033 (0.000074)			0.000327*** (0.000064)
Location Quotient Plastics (*Ljplast_e*)			0.000315 (0.000318)	0.000101 (0.000112)	
Log p-likelihood	-11,940.995	-350.361	-349.891	-351.884	-334.773
Pseudo R^2	0.2767	0.0889	0.0901	0.0929	0.1371
Observations	4,775,473	8,901	8,901	13,000	13,000

† Cluster standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Year dummies omitted

Table reports results of Logit models of the probability of startup spawning (Model I). Column 1 looks at the probability of any firm in the Portuguese economy spawning a startup in either molds or plastics. Dummy variables equal one if the firm is in molds or plastics have positive effects, thus confirming that same or related industry spinouts are more likely to occur than startups coming from other industries. Both firm quality (as measured by size) and regional density in molds and plastics have positive effects on the probability of spawning, so startups are both more likely to come from better (larger) firms and to locate in regions that have greater agglomerations of molds and plastics. However the industry effects are much stronger than regional density effects.

The marginal effect for firms in the molds industry (0.00141) is much larger than the marginal effect for firms in the plastics industry (0.00098), suggesting that molds firms are more involved in the creation of spinouts in both industries than the plastics companies. This result suggests that employees in the molds industry may have more access to tacit knowledge that would give them an advantage when creating their own company in the same or a related industry. Other possible reasons for this lower engagement in the spinout process may be associated with barriers to entry in the industry, considering that plastics firms tend to be larger than molds firms. In any case, this would suggest that the spinout prevalence associated with the heritage of knowledge embodied in the molds workers who become entrepreneurs in the same or a related industry seems to be weaker in the plastics industry.

When looking specifically at collocation, however, a different picture emerges. Column 2 reports results on the probability of molds firms spawning plastics spinouts, while column 3 reports results on the probability of plastics firms spawning molds spinouts. In both cases, firm quality, as measured by size, has a positive effect on the probability of spinout spawning, but regional density only has significant impact for the molds spinouts. Moreover, it refers to the molds location density, while the density of the plastics industry is not significant. These results suggest that, while heritage theory helps to explain the collocation of the two industries (better firms generate more spinouts, which locate near their parents), agglomeration economies do not seem to explain collocation, as cross-industry spinouts are not more likely in more agglomerated regions when parent firm quality is controlled for. Findings point to same industry location density effects for the molds spinouts but no significant effects for cross-industry influence.

5.2. Entrant Performance

Model II analyses the probability of survival and Model III looks at sales ranking. If spinouts 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 agglomerated region 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 spinout (with experience in the same industry), cross-industry spinouts (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).

5.2.1. 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 spinout, 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 but results are similar to the Cox proportional hazards estimation. The frailty models account for firm heterogeneity, so we would expect to obtain more accurate results.

Table 3 displays the results of mixed Frailty survival models. 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 spinouts coming from plastics, that are less likely to exit), lending support to both heritage and agglomeration accounts. Survival of molds spinouts seems to be most positively affected by entrepreneur background in the plastics industry (lower hazard ratios from cross-industry spinouts than for same industry spinouts). 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 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.

We also performed estimations for the same specifications using Cox proportional hazards survival models. Nevertheless results are very similar to the mixed frailty models results.

In order to analyze different proxies for parent quality we tested a number of alternative variables. One example is a model using the base wage residuals as proxy for parent quality, using the Cox proportional hazards model. The rationale for this proxy is that firm quality may be assessed through the precision level of the molds it produces or uses. The level of precision a molds company is able to apply in its products would be a good indicator of its quality, and precision levels should be positively related to workers' skills and, therefore, wage levels. The evolution of plastics and molds industries led to a market

segmentation with different levels of knowledge that can be revealed by the level of precision used.

Table 3 – Model II: Estimates of the Survival Frailty Model, Gompertz distribution (Gamma heterogeneity) – hazard ratio†

VARIABLES	(1) Molds and Plastics		(2) Plastics		(3) Molds	
Size at entry *(log(pemp_f))*	0.947*	0.947*	0.912*	0.910**	1.006	1.010
	(0.028)	(0.029)	(0.043)	(0.043)	(0.042)	(0.042)
Size spinout's parent *(parent)*	0.988	0.984	0.984	0.978	1.000	0.999
	(0.042)	(0.042)	(0.074)	(0.074)	(0.053)	(0.053)
Same industry spinouts *(sis)*	0.587***	0.585***	0.609*	0.612*	0.492***	0.496***
	(0.091)	(0.091)	(0.166)	(0.167)	(0.099)	(0.099)
Cross-industry spinouts *(cis)*	0.588**	0.588**	0.593	0.594	0.396**	0.406**
	(0.151)	(0.151)	(0.207)	(0.209)	(0.152)	(0.154)
Diversifiers *(div)*	6.094***	6.194***	7.694***	7.780***	4.767***	4.767***
	(0.674)	(0.687)	(1.816)	(1.854)	(0.577)	(0.576)
"*De novo*" *(dnv)*	0.618***	0.620***	0.544***	0.546***	0.656***	0.662***
	(0.049)	(0.050)	(0.075)	(0.075)	(0.071)	(0.071)
LQ M & P *(Ljmp_e)*	0.979***		0.979		0.967***	
	(0.007)		(0.013)		(0.008)	
LQ Molds *(Ljmolds_e)*		0.992**		0.992		
		(0.003)		(0.007)		
LQ Plast *(Ljplast_e)*						0.946***
						(0.013)
Constant	0.087***	0.085***	0.073***	0.071***	0.108***	0.108***
	(0.006)	(0.006)	(0.008)	(0.007)	(0.010)	(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 θ=0	0.000	0.000	0.000	0.000	0.000	0.000

† Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

More qualified companies would be able to produce or use more precise molds. Such high quality firms hire better and more qualified workers, with higher education levels and higher wages. By comparing wage levels across molds and plastics companies, it

should be possible to identify the top wage payers. "Best parents" would be the firms with higher wage levels. The coefficients for this parent quality proxy (or any of the remaining alternatives used from the available data) are not significant in the survival models, however. In addition, results of survival models using this variable do not change significantly from the analysis using firm size.

5.2.2. Sales ranking

The estimates from Model III, the Logit model, in Table 4 show the marginal effects for the likelihood to become a top one-third seller by the third year in the market. Again we tested a specification with wage levels as proxy for parent quality. In this case both specifications present very similar results, with no significant effects for parent quality. Same-industry and cross-industry spinouts, 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 spinouts. 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 4 – Model III: Estimates of the Logit models for top sales in the third year – marginal effects†

VARIABLES	(1) Molds and Plastics		(2) Plastics entrants		(3) Molds entrants	
Size at entry	0.132***	0.132***	0.135***	0.135***	0.134***	0.135***

(log(pemp_f))	(0.009)	(0.009)	(0.013)	(0.013)	(0.012)	(0.012)
Size spinout's parent *(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 spinouts *(sis)*	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 spinouts *(cis)*	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*" *(dnv)*	0.122*** (0.021)	0.121*** (0.021)	0.142** (0.029)	0.141*** (0.029)	0.099*** (0.032)	0.098*** (0.032)
LQ M & P *(Ljmp_e)*	0.005*** (0.002)		0.005 (0.004)		0.005** (0.003)	
LQ Molds *(Ljmolds_e)*		0.002* (0.001)		0.001 (0.002)		
LQ Plast *(Ljplast_e)*						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^2	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

† Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Year dummies omitted

5.3. Descriptive Results

In this section we present estimations that help describe the collocation of the molds and plastics industries but do not aim to contribute to the objective of identifying the mechanisms driving collocation.

5.3.1. Location Choice of Entrants

The alternative-specific conditional Logit (McFadden's choice) model was used to examine the location choice of entrants (Model IV). This model allows analyzing a multiple choice frame including both attributes for the choice (locations to choose from) and characteristics of the firm.

Table 5 reports the effects of home region and regional agglomeration on location choice. Column 1 provides results for all entrants in molds and plastics, while column 2 looks at entrants in plastics and column 3 looks at entrants in molds. In all cases, new entrants are significantly more likely to locate in the home region of one of the founders, i.e. the same region as a parent firm. Regional agglomeration as measured by the location quotient has a much smaller effect for the joint sample, which is no longer significant when one considers spinouts of each industry separately. These results support the heritage theory's contention that spinouts locate primarily near their parent firms [thus confirming the results of Figueiredo *et al.* (2002), among others]. The agglomeration economies do not seem to play an important role, as cross-industry spinouts do not seem to choose to locate in a region based on industry density.

Table 5 – Model IV: Estimates of the spinout alternative-specific location choice conditional Logit model – odds ratio†

VARIABLES	(1) Molds and Plastics entrants	(2) Plastics entrants	(3) Molds entrants
Home *concelho (home)*	64.639*** (5.531)	67.936*** (8.056)	55.349*** (7.136)
Location Quotient for Molds and Plastics (*Ljmp_e*)	0.934*** (0.015)		
Location Quotient for Molds (*Ljmolds_e)*		1.007 (0.023)	
Location Quotient for Plastics (*Ljplast_e*)			0.874*** (0.022)
Observations	634,425	308,000	326,425
Cases	2,307	1,120	1,187
Log pseudolikelihood	-7,296.190	-3,830.475	-3,258.342
Wald test	0.0000	0.0000	0.0000

† Robust cluster errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. Conclusions

Results unequivocally show that heritage through the transmission of capabilities from parent firms in the related industry to spinouts 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 spinouts between molds and plastics are more likely to occur for larger (i.e. better) parent firms, while spinouts are more likely to locate in the same region as their parent company. Location choice is not influenced by attraction to the agglomerated region. 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 agglomerated region 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 spinouts, and that those spinouts tend to locate close to the parent firm. In the case of molds spinouts, 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 (Golman and Klepper 2013) propose that positive location externalities may enhance spinout 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 spinouts 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.

In summary, results point to even stronger effects of heritage and mild but significant effects of agglomeration economies. Molds spinouts 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).

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 agglomerated region.

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 spinout process, implying that policies fostering spinouts 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 spinouts that 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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