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Agglomeration vs. Organizational Heritage: The Molds Cluster in Portugal

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Abstract

This paper examines the mechanisms that drove regional clustering of the molds industry in Portugal. Two alternative theories aiming to explain the clustering process are considered: agglomeration theory and organizational reproduction/heritage theory. Based on data for 1986 to 2008 on entrants in the molds industry, their location and performance, we find mixed support for both theories. In part this may reflect the period examined, that is well after the molds industry became geographically concentrated. All our findings, though, point to the importance of a firm?s heritage in the rate at which spawning occurs and also in entrants? location and performance.

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ABSTRACT

This paper examines the mechanisms that drove regional clustering of the molds industry in Portugal. Two alternative theories aiming to explain the clustering process are considered: agglomeration theory and organizational reproduction/heritage theory. Based on data for 1986 to 2008 on entrants in the molds industry, their location and performance, we find mixed support for both theories. In part this may reflect the period examined, that is well after the molds industry became geographically concentrated. All our findings, though, point to the importance of a firm's heritage in the rate at which spawning occurs and also in entrants' location and performance.

Keywords: Clusters; Entrepreneurship; Agglomeration; Spinoffs.

1. INTRODUCTION

Extreme industry clusters are rare (Ellison and Glaeser 1997) and call out for explanation, particularly when there is no obvious regional natural advantage underlying the clustering. While new firms may be attracted into a region as a result of advantages pertaining to previous geographical agglomeration of related firms in that region, geographical concentration may simply result from a preference for their home region by founders who previously worked for related firms in that region.

Research about extreme industry clusters (see, for instance, Saxenian, 1994, Lécuyer, 2006) lay out theories that resonate with modern theories of geography such as those advanced by Porter (1991) and Krugman (1992). Once firms in an industry begin to congregate in a specific region, labor pooling, technological spillovers, and a rich supplier industry stimulate further growth and entry. The evidence compiled about clusters is broadly consistent with the importance of such agglomeration economies (Baptista and P Swann 1998; Rosenthal and Strange 2004).

More recent analyses have focused on the role played by spinoffs and, more broadly, on organizational competence and heredity. Klepper (2007, 2008) proposes a theory in which a firm's pre-entry experience critically shapes its performance and its performance in turn influences the rate at which its employees leave to form spinoffs. Subsequently, better firms reproduce at a higher rate (through spinoffs) and their offspring become superior performers. Since new entrepreneurs and spinoffs tend not to venture far from their geographic origins (Figueiredo, Guimarães, and Woodward 2002; Dahl and Sorenson 2011), 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 benefits or externalities associated with agglomeration.

This study examines the location choice of entrants in the Portuguese molds industry. This industry is strongly agglomerated in Marinha Grande and Oliveira de Azeméis, outside the main metropolitan centers of Lisbon and Porto. Agglomeration occurred historically since the first few firms chose to locate there, in a process similar to that experienced in the US by the automotive industry in Detroit and the semiconductor industry in Silicon Valley (Klepper 2010).

We examine the founders' paths before they create molds companies. In particular, we look at the industry and location where they had previous working experience. If organizational reproduction theories are driving industry agglomeration, then entrepreneurs with a previous experience in the molds or a related industry should have a higher probability of spawning new molds companies. If agglomeration theories describe the main drivers of the agglomeration process better, founders will move to the agglomerated region regardless of their region of origin, attracted by the potential benefits of the agglomeration process, and firms located in the agglomerated region will perform better than firms located elsewhere.

In order to provide a more encompassing definition of spinoffs, we use different concepts of industry relatedness. Firms founded by individuals coming from related industries possess relevant pre-entry knowledge resulting from working in an industry related to molds. We capture relatedness associated with industries belonging to the value chain of the molds industry and also relatedness associated with human capital by using an adaptation of the index of skill relatedness developed by Neffke & Henning (2009).

The study follows all firms entering in the Portuguese molds industry over a period of 22 years. We estimate models of the probability to spawn a molds company as a function of the region and industry of origin of the entrepreneur, controlling for economic cycles. We also analyze the probability a molds entrant will locate in its' home region and the performance of

entrants according to their heritage. Results show support for both theories when we consider the likelihood of firms spawning entrants and the location of entrants whereas the analysis of firm performance supports only the organizational reproduction theory. The main contribution of this paper is showing that companies in the same industry, but also other companies from related industries (including those within the industry's value-chain and skill-related industries), can fuel the spinoff process that drives agglomeration through an organizational reproduction dynamic.

The paper is organized as follows. A brief background section presents the theoretical discussion that motivates the paper. The following section discusses the molds industry in Portugal. Then data and methodology are described. The next section presents and discusses the empirical results and in the final section we present concluding remarks.

2. THEORETICAL ASPECTS

The mechanisms that drive the creation and agglomeration of industries in a region have drawn the interest of scholars and policy makers throughout the world. In particular, the success of Silicon Valley motivated questions about what explains the clustering of industries in a specific region. Industry agglomeration is nowadays recognized as a prevailing characteristic associated with industrial growth and there have been several attempts to explain this phenomenon.

Three factors are commonly invoked to explain the clustering. First, some regions may have natural advantages for firms in particular industries, causing entrants to cluster there. Second, production externalities in which firms benefit from proximity to other firms may induce entrants to cluster. Supply-related factors drive companies to locate near their

competitors, suppliers, and customers: pooling of the labor market, supply of specialized inputs, and technological spillovers. Benefits associated with proximity to firms engaged in similar activities are called localization or intra-industry agglomeration economies (Marshall 1920; Henderson 2003) whereas those related to the diversity or overall level of economic activity in a region are called urbanization or inter-industry agglomeration economies (Jacobs 1969; Glaeser et al. 1992). Third, pecuniary economies related to transportation costs as featured in new economic geography models (Krugman 1991) may cause entrants to cluster near consumers and suppliers to their industry. LaFountain (2005) used data on land rents and regional industry activity to sort out the separate influence of each factor in the location of activity in various industries.

There is a long tradition in regional and urban economics of modeling industry agglomerations as the result of Marshallian externalities involving labor pooling, knowledge spillovers and specialized inputs. The microfoundations of these externalities are reviewed in Duranton and Puga (2004). Beginning with Krugman (1991), and Krugman and A. J. Venables (1995), a stream of literature known as the New Economic Geography has emerged to model agglomeration. In these models, pecuniary externalities arising from increasing returns at the firm level, coupled with market size effects, lead to geographical concentration. Both types of models imply that under certain circumstances producers and their specialized suppliers agglomerate in a limited number of regions. The extent of agglomeration in any one region is limited by various forces, including transport costs, more intense price competition among more closely located firms, decreasing returns to scale as some inputs are increased relative to those that are fixed, and congestion costs.

According to Buenstorf and Klepper (2009), the "conventional account" of agglomeration externalities explaining industry clustering incorporates many of the ideas inherent in the Marshallian and New Economic Geography traditions, but it is not a single theory nor is it

couched within an equilibrium framework. An alternative but not mutually exclusive view is that the clustering of entry is caused by the combination of entrants tending to locate close to their geographic roots and the uneven regional distribution of potential entrants (Buenstorf and Klepper, 2010). Prior studies have shown that entrants commonly locate close to where their founders previously worked and/or were born (Figueiredo et al., 2002; Michelacci and Silva 2007; Dahl and Sorenson, 2011). It has also long been recognized that for any given industry, regions differ in terms of the sources of entrants, or, in Carlton's (1979) terms, their birth potential. Entrants need basic organizational knowledge to compete in an industry. Such knowledge may be especially important in innovative industries in which R&D and marketing may ultimately distinguish the performance of firms. For any industry, an important source for such knowledge may be firms in older, related industries or firms in the industry itself (Klepper and Simons 2000; Klepper 2007; Buenstorf and Klepper 2009; Klepper 2010). In many industries, pre-existing firms in older, related industries account for a substantial share of entrants. Thus, similar to natural advantages, regions may have more entrants into an industry that has a greater stock of pre-existing firms in older, related industries.

Incumbent firms in an industry can also be an important source of entrants in the form of employees leaving to found their own firms in the same industry. Following Klepper (2007), we call these firms spinoffs. Similar to localization economies attracting or encouraging the formation of alike firms in a region, regions with more firms in an industry will naturally spawn more spinoff entrants. Analogously, regions with a larger overall firm population will spawn more entrants into a wide range of industries. Finally, parallel to the new economic geography models, both suppliers and demanders may themselves be candidates to vertically integrate backward or forward into an industry.

A stream of research in organizational ecology focuses on the transfer of routines and experience from a founder's previous employer to his or her new firm (Phillips 2002), in a process of organizational reproduction or heredity. The argument that the blueprints of a parent firm are passed on to new organizations through their founders is the cornerstone of a number of works by, among others, Carroll (1984). Klepper (2001; 2002) has found traction for these ideas in the context of spinoffs. A central argument of this research is that the success of new organizations is fundamentally shaped by the pre-entry experiences of their founders. New organizations inherit knowledge from industry incumbents that was accumulated by their founders throughout their own careers (Agarwal et al. 2004). This sort of relationship has been studied in the management literature.

Buenstorf and Klepper (2009) propose a view, called heritage theory, which features the inheritance of organizational competence as the principal force underlying industry clustering. According to this view, clustering of an industry in a region begins with one firm (for instance, Oldsmobile in the case of the automotive industry in Detroit, Goodrich in the case of the tire industry in Akron) and its initial influence attracting other regional producers, similar to the conventional agglomeration economics account. However, the subsequent growth of the regional cluster is attributed to an endogenous process in which incumbent firms involuntarily spawn spinoffs. Better firms are predicted to spawn more and better spinoffs, which can explain the build-up of successful firms around the early entrants.

The key idea proposed by Klepper (2007) and Buenstorf and Klepper (2009) is that a region's birth potential is shaped by an endogenous process that gives rise to a build-up over time of superior firms around successful early entrants. As they try to enhance their own performance through technological innovation and improved organizational processes, successful industry incumbents inadvertently function as training grounds for their employees, allowing them to acquire the skills needed to start ventures of their own. This is

part of a broader process in which firms differ in their competence. Through employee learning these differences are transferred to spinoffs. Employees are better and acquire more useful knowledge as prospective spinoff founders by working in superior incumbent firms. This increases the likelihood of spinoff formation from these firms as well as the performance of the ensuing spinoffs. Like other new firms, spinoffs mostly locate where they originate, thus reinforcing the existing geographical differences in birth potential.

There is, to a certain extent, a tendency for the views on agglomeration externalities and organizational heritage to share arguments, as research pursues approaches associated with the changing industrial structure of regions (Martin and Sunley, 2006; Menzel and Fornahl, 2009; Buenstorf and Geissler, 2008). While the conventional account of agglomeration externalities and the heritage theory are not mutually exclusive, they each have distinctive implications regarding the geographical origin and performance of firms that can be used to assess the importance of their featured mechanisms.

This paper broadens the analysis of Buenstorf and Klepper (2009) by looking at the role played by related industries in the agglomeration process, and by testing and comparing arguments from the two theoretical perspectives described. We focus on the Portuguese molds industry. As pointed out above, agglomeration occurred historically in this industry, in a process similar to that experienced in the US by the automotive industry in Detroit, the semiconductor industry in Silicon Valley (Klepper 2010), and the tire industry in Akron (Buenstorf and Klepper 2009).

In order to understand the agglomeration process and the relationship with related industries, we investigate where the founders of molds entrants came from, geographically and industry wise. Organizational heritage/reproduction theories predict that the closer a firm's background is to the molds industry then the greater the likelihood of spawning a

molds entrant and the better the performance of the entrant. Furthermore, to the extent that firms in agglomerated regions perform better, this should be entirely due to a "superior" background of their founders. Regarding where entrants locate, recent work by Klepper and Carias (2010) finds that firms whose founders previously worked in the same industry would be more likely to enter in their home region in order to hire old colleagues about whom they have distinctive knowledge.

Agglomeration theories predict that firms will be drawn to agglomerated regions and that, all else equal, entry should be greater in agglomerated regions due to the greater profitability of operating in such regions. Thus, firms should be less likely to enter in their home region the further the region is from where molds firms are concentrated. Furthermore, given the background of firms, they should be more likely to spawn entrants into the molds industry the closer they are to where molds firms are concentrated. Finally, all else equal (i.e., controlling for the backgrounds of firms and home region location), firms located closer to where molds firms concentrate will perform better. Note that these predictions of the modern theories hinge on congestion costs and other factors not undermining the advantages of locating in agglomerated regions. To the extent they offset any such advantages, then none of the predictions should hold as agglomerated regions will be no more profitable to locate in than other regions.

3. THE CASE OF THE MOLDS CLUSTER IN PORTUGAL

The Portuguese molds industry is recognized by the US International Trade Commission as “one of the world’s principal producers of precision molds for the plastics industry” (USITC 2002), traditionally exporting almost its entire production (Beira et al. 2004). This industry is innovative and technologically advanced (Beira et al. 2004). Extensive historical

reports and qualitative studies have focused on this industry in an attempt to explain the success of an industry that stands out in the country's economy.

The industry's history in Portugal has roots in the late 1920s, when one group of three men (Aires Roque, his half-brother Aníbal Abrantes, and António Santos) started a small workshop in Marinha. The glass industry (mainly involving artisanal production processes) was agglomerated in that region and provided an increasing demand for the glass molds they produced.

The three men from Marinha moved to Oliveira for nine months in 1927 in order to work in glass molds. The following year these men separated: the brothers returned to Marinha and their colleague stayed. Oliveira had another cluster of the glass industry that gained more relevance after 1926, when Centro Vidreiro do Norte de Portugal was created: a project that joined several glass firms and soon became "training centre" for a new generation of molds workers. This centre, due to its unusual larger scale, became the place where many future entrepreneurs took their first steps in molds manufacture and where a network of personal contacts among workers was often started.

The plastics industry emerged in the 1930s also in the Marinha region and started to order a different type of very simple molds, that at the time used similar mechanical principles to the glass molds. Soon, the workshop named after Aires Roque, but eventually lead by his half-brother Aníbal Abrantes, started experimenting with molds for plastic pressing, at the time for products made of Bakelite (Beira et al. 2004). Aníbal Abrantes' enthusiastic experiments were seen as a way to escape a demand crisis in the glass molds market, but curiously this was the origin of the brothers' disagreement that took them to separate paths (Gomes 2005).

In 1946 Aníbal Abrantes started in Marinha the first Portuguese company to produce the more resistant steel molds for plastic injection, named after himself. This was a very important company for the industry because it played a similar role to Centro Vidreiro in what refers to worker training, but also because it innovated in the work organization. While in the rest of the world molds were produced with artisanal processes, this company introduced division of labor that allowed for worker specialization along the production process (Vieira 2007). This allowed training a large number of young workers, many of whom later left to start their own companies. It also opened the way for the creation of a large number of small companies, specialized in different parts of the production process, a pattern we can still find today (Vieira 2007).

In both molds agglomeration regions we can trace the origin of the majority of companies to a very small group of mother companies. Employees and owners left those few companies where they learned about the technology and the production process and got commercial connections that would help them create a new company. The movement of people was common within the industry and it became a tradition to maintain an agreeable atmosphere among old and new entrepreneurs. It was documented that historically the industry grew from this repeated process of intra-industry spinoffs (Gomes 2005).

The trajectories followed by relevant people in the industry show that employees left older companies to create spinoffs in the early times of the industry. The movement of these key pioneers is historically reported as the driver of entrepreneurship and competitiveness of the industry both in Marinha and Oliveira regions (Beira 2007). It was very common for people who worked together or did training together to establish long-term relationships that at some point in time would lead to the creation of new molds companies. Several people became entrepreneurs in more than one company in this industry and even in related industries.

Although in its inception the industry relied on local customers, as early as 1957 the exports to the US market became regular, pioneered by Abílio Abrantes. He arranged a contract with an intermediary, Tony Jongenelen, who had contacts both with European and US plastics producers (many were friends that fled to the US after WW II), taking advantage of the high quality and low price of the Portuguese molds. The intervention of this and other foreign intermediaries contributed to a generalized boom of exports, mainly to the US market in the beginning, and transformed the Portuguese molds industry into an international player, exporting nearly the entire production (Gomes 2005).

Nowadays nearly half the companies in the industry are still located in two agglomeration regions: Marinha and Oliveira, away from the main urban centers. These regions concentrate 47% of the molds companies existing between 1986 and 2008 (39% in Marinha region and 8% in Oliveira), while the remaining entrants scattered over 72 other *concelhos*[1]. Oliveira has fewer companies but they tend to be larger (with an average of 21 employees compared to 6 for Marinha) and focus on the market segment of large sized molds.

In general, the molds companies are small. A company with 100 workers is considered large (Henriques 2008). They produce on demand and are intensely customer driven. These companies rely on specialized workers in a small production scale. Their dependency on the use of assisted and adaptable technologies, forces the companies to maintain a relatively small size because of the high demand for flexibility and lower business risk (Henriques 2008). The modern plant requires a heavy reliance on advanced software and machinery increasingly based in information technologies. Besides being technologically advanced, the Portuguese industry was also a pioneer innovating in business strategies and approaches to

[1] *Concelho* is the Portuguese administrative division for a region with a city council. Currently there are 278 *concelhos* in continental Portugal, with an average area of 320 km^2.

the market – e.g. introduction of labor division, low dependency on local customers, close relationships with key customers (Beira et al. 2004).

The industry is mainly composed of family-owned firms, which often employ several generations of the owner's family. A high percentage of workers belonging to the same family provide the companies with high flexibility in the decision process, due to flat hierarchies, sharing a common technical language in a climate of trust. The owners of companies in mold making are normally former technicians, who founded their own company taking advantage the "boom era" of plastic products and consumer goods in the 60s and 70s.

One interesting aspect of this particular industry is the fact that common practice reveals a tendency not to mix different types of molds and tools in the same production unit. The need for different knowledge relating to design engineering and a tendency to focus on anchor clients are the main reasons for this situation. Then, diversification is not viable as a business strategy inside the same company. Entrepreneurs that aim for growth often create several separate companies, usually specialized in different areas. In addition, the appearance of spinoffs from the same or related industries is common. Molds manufacture involves specific knowledge and great experience, and is a training field for skilled workers that gain the level of expertise required by the industry by means of long on-job learning and training periods. This particular characteristic shows that spinoffs from the same industry are common because of the creation of new firms by workers that leave the company taking their tacit knowledge with them.

4. DATA AND METHODOLOGY

In this section we describe the data on the molds industry and methods that we used to analyze the agglomeration dynamics. Our empirical approach is divided in two parts, one concerning the entry and location decision and the second concerning firm performance.

4.1 Data

We use longitudinal data from the Portuguese economy ranging from 1986 to 2008. The data source is "Quadros de Pessoal" (QP) Micro Data set, based on mandatory information submitted yearly by firms. The longitudinal employer-employee dataset includes extensive information on the mobility of firms and business owners. Using data comprising an extensive sample of companies from all industries and regions for a period of 23 years, we identify the path of workers that become entrepreneurs by starting a company in the molds industry. The use of these linkages allows to evaluate the influence of the entrepreneur's background on the probability a company will spawn a molds spinoff, the probability an entrant will locate in its home region, and the determinants of entrants' performance.

For each entrant in the molds industry[2] we identified the firm's founder(s). Then we looked for the last job we could identify for each founder, in the same or previous five years of available data. The task of tracing the background of entrants faced several limitations. For a large number of firms it was not possible to identify the entrepreneurs. In the case of firms with corporate shareholders they may not list any employee as the "employer." In most other cases there is probably an issue of misreporting. For the entrepreneurs we manage to identify it's not always possible to find their previous job. The total number of molds companies that entered the industry in the period of analysis for which we could identify the entrepreneurs

[2] Entrants were defined empirically as companies with entry declared or assumed between 1987 and 2008 that were not located in the same industry and region and hiring the majority of the workers from a company that exited the dataset in the same or previous period.

and their previous jobs was 576 companies, or 54% of the total number of companies – (with 778 entrepreneurs).

All the firms in the data are considered potential spawners (even the molds entrants because they can spawn later on), except for the ones located outside of continental Portugal. In all the models we used information about the entrepreneur's background regarding his/her prior location and industry. Regarding location we focused mainly on two categories of interest, which may overlap: home region and agglomerated region. Home region was defined as the *concelho* where at least one of the entrepreneurs was working prior to creating the company. The agglomerated region is the region where the molds industry clustered, which includes two different locations in the center and north of Portugal: Marinha and Oliveira.

The industry background categories were defined using the similar criterion of having at least one entrepreneur whose previous job was in the same industry (molds) or in related industries. We aim to identify the backgrounds where the entrepreneur could have gained specific knowledge that could be applied in creating and developing a successful molds company. Relevant knowledge for this purpose is likely to be of a specific nature and very closely related to the molds industry. This would naturally include the molds industry itself but also key supply industries, with knowledge about inputs and technologies, and major client industries, with knowledge about the products and the market. Specific knowledge from industries in the molds value-chain could have a strong impact on the future performance of the molds entrant. For example, in the Portuguese molds industry production often involves subcontracting specific tasks to other types of companies that perform tasks like design, metal polishing, milling, etc. Workers from companies in these and other supply areas that work with molds companies can acquire technical knowledge that would be advantageous for the entrant. In addition, workers from customer industries may gain

knowledge about applications and requirements for the molds as well as valuable contacts in the molds market that would also be advantageous.

Another way to identify related industries is by looking at their human capital closeness. If two particular industries draw from a similar pool of human resources it's likely that they are related and that they require similar skills in order to succeed. If that is the case, then the knowledge acquired in one industry is likely to have a high impact in the performance of a company in the other skill-related industry. Neffke and Henning (2009) argue that if two industries have a high flow of workers between them it is likely that they are using similar skills in their production process and are therefore closely related industries. We use an adaptation of their skill-relatedness index to identify relevant backgrounds for molds entrepreneurs.

It should be noted that the data available does not cover the formative era of the industry, which began in the 1930s. Data ranging from that period would be ideal for our purposes but QP data are only available since 1986. We believe that we can learn from the dynamics observed in the period from 1986 to 2008, but it is important to acknowledge this time frame. Using our data we were able to provide descriptive statistics concerning the industry's evolution during the period of analysis. The industry is still growing in this phase (Figure 1), if we measure its size by the number of companies in the market. The average size of the companies is rather small (less than 25 employees). The most commonly chosen location by the entrants was the Marinha region, followed by Oliveira.

FIGURE 1

We can determine the origin of 576 molds companies, both in terms of location and industry where the entrepreneurs were working previously. The majority of firms have entrepreneurs with experience in the same industry (57%) but there is also a high incidence of

entrants with experience in related industries, in particular from the molds value-chain (24%). Also, 73% of the entrants decided to locate in the home region of founders.

4.2. Methodology

In the first set of empirical models, using pooled panel data, we look at which companies are more likely to spawn new entrants in the molds industry. The second set of Logit models looks at the determinants of entry in the home region between 1987 and 2008 using cross-section data. Acknowledging that firms tend to locate in their home region, we test if this tendency is stronger in the agglomerated region. Finally, in the survival analysis we use the Cox proportional hazard model to estimate the factors influencing the performance of the entrants, again in cross-section data. We aim to test if there are differences in survival for the firms that were related to the organizational reproduction process and the firms benefiting from proximity to others, which may have been influenced by conventional agglomeration mechanisms.

The sample for entry models has one observation per entrant, each with information about the background of one or several entrepreneurs. The sample for the spawning models has one observation per year for each company in the period of analysis. Each company has as many observations as years of data reported in QP, depending on how many years it survived during the period of analysis and how many years it reported data (some companies have periods with missing reports). Nevertheless, when a company spawns more than one molds entrants in one year, we keep one observation per each entrant in that year. The total number of companies included in the sample as potential spawners is 803,491. On average there are

6.25 observations per company[3]. In cases where firms had more than one owner-employee that came from different firms we considered all of them as spawners. For the hazard models the sample include one observation for each entrant for which we had information on background (again, 576 molds companies).

4.2.1 Variables

The variables of interest are related to the backgrounds of the entrepreneurs, both in terms of location and industry, and their effects on entry and survival. In the entry models the dependent variable is a dummy for locating in the home region. We classify companies as entering their home region when they locate in the same *concelho* where at least one of their entrepreneurs had a previous job. The dependent variable in the Logit spawning models is a dummy for whether that company was the last job of an entrepreneur prior to establishing the entrant in the molds industry. Independent variables include a dummy for companies belonging to the molds industry.

Based on information gathered about the main customers and suppliers of the Portuguese molds industry, we also identified a set of industries that can be considered as working in the molds value-chain. Such industries are identified in Table 1. The molds industry has produced a large diversity of products for different customer industries. Among the main plastic products that were made using Portuguese molds are toys, construction ware, electric material, domestic appliances, kitchenware, electronics, packaging, and automotive products (Beira et al. 2004). The main suppliers/subcontractors from within the country were technically similar industries that were hired to perform specific services or tasks involved in the manufacturing process.

TABLE 1

[3] Standard deviation of 5.67.

Related industries were identified using an adaptation of the Skill-relatedness Index proposed by Neffke and Henning (2009), based on cross-industry labor flows. The skill-relatedness index aims to capture industry relatedness, as defined by Teece et al. (1994), through the use of human resources. It's a measure of inter-industry similarity, based on the human capital industries employ. The underlying assumption is that industries that require similar human capital use similar skills and therefore work in strategically related areas.

Our relatedness index was computed for the molds industry from 1995 to 2002 (using a 5 digit CAE level). Contrary to Neffke and Henning (2009), we did not exclude the managers. The reason for this was that on average these are medium and small companies where most managers are performing industry-specific tasks and have a high proportion of industry-specific knowledge and skills (Henriques 2008). The estimated index of skill-relatedness compares the actual flow of workers between each pair of industries and regions with the estimated flow expected to occur given the characteristics of the industry in each region. The skill-related index is given by:

$$SR_{ixjy} = \frac{F^{obs}_{ixjy}}{Fx_{ixjy}}$$ Where:

SR_{ixjy} – Skill-relatedness index for industry *i* in region *x* and industry *j* in region *y*

F^{obs}_{ixjy} – Observed flow of workers between industry *i* in region *x* and industry *j* in region *y*

F_{ixjy} – Predicted flow of workers between industry *i* in region *x* and industry *j* in region *y*, based on industry and region-specific variables

We focused on the molds industry, therefore either *i* or *j* must be the molds industry, since we care about the flow of workers to and from the molds industry. When this ratio is over 1 and the estimates are significant we conclude that the industry-region is skill-related to the

molds industry. We then create a dummy variable that identifies the pairs of industry and regions that were considered skill-related. We introduced an additional variable in the estimation of the predicted labor flows that accounts for the density of industry workers in the region. This additional variable aims to account for regional differences in terms of worker density that we expect to influence the predicted flows of workers across industries and regions.

The model estimated is:

$$E(F_{ixjy} \mid v_{ix}, w_{jy}, \varepsilon_{ixjy}) = [1 - \pi_o(\gamma + \delta_i emp_i + \delta_j emp_j)].$$
$$f(\alpha + \beta_{1i} \log(emp_i) + \beta_{2i} \log(wage_i) + \beta_{3ix} workerden_{ix} + \beta_{4j} \log(emp_j) + \beta_{5j} \log(wage_j) + \beta_{6jy} workerden_{jy}))$$

where:

F_{ixjy}	Flow of workers from industry *i* in region *x* to industry *j* in region *y*
v_{ix} , w_{jy}	Industry-level variables for industry *i* in region *x* and industry *j* in region *y*
π_o	Probability that a flow can in principle take place as a function of the vectors v_{ix} and w_{jy}
emp_i	Sum of employment in industry of origin *i* from 1995 to 2002
emp_j	Sum of employment in industry of origin *j* from 1995 to 2002
$wage_i$	Average wage in industry of origin *i* from 1995 to 2002
$wage_j$	Average wage in industry of origin *j* from 1995 to 2002
$workden_{ix}$	Density of workers in industry of origin *i* from 1995 to 2002 in region *x*
$workden_{jy}$	Density of workers in industry of origin *j* from 1995 to 2002 in region *y*

TABLE 2

The results from estimation, shown in Table 2, seem plausible and conform to our expectations with the exception of the coefficient estimate of the wage of the origination industry, which was expected to be negative. The flows of workers across industries are influenced by the size of their employment and their wages, which is reflected in the positive and significant coefficient estimates. The pairs of industries and regions identified as significantly skill-related to the molds industry are listed in Table 3.

TABLE 3

Organizational reproduction theory predicts that the role potentially played by related industries – both value-chain industries and skill-related industries – is important in fueling entry in the molds industry. Entrepreneurs coming from companies in the same or related industries should have the opportunity to learn about the technology and the business and thus inherit some level of competence from the related company (Klepper 2010).

4.2.2. Entry and Location Decision

We looked at two relevant aspects in what refers entry and location decision: the likelihood a firm will spawn a molds entrant and the likelihood an entrant will locate in its home region. We introduce the specifications for each model below. We use robust standard errors to correct for serial correlation and clustered standard errors in the spawning analysis. Our first step in the analysis looks at the likelihood a firm will spawn a molds entrant. In the Logit models we estimated the probability of spawning given the firm's specific background, controlling for economic growth cycles with year dummies.

$$P(Spin_{it} = 1 \mid x_{it}) = \Lambda[\beta_1 \log(pemp_{it}) + \beta_2 molds + \beta_3 vc + \beta_4 rel + \beta_5 moldsr1_{it} + \beta_6 moldsr2_{it} + \beta_7 moldsmr_{it} + \beta_8 vcmr_{it} + \beta_{9t} year_t]$$

The variables are:

$Spin_{it}$	Dummy for creation of molds spinoffs by company *i* in year *t*
$pemp_{it}$	Size of company *i*, measured by the number of employees in year *t*
$molds_i$	Dummy for company in the molds industry
vc_{it}	Dummy for company in an industry from the value chain of molds in year *t*
rel_t	Dummy for company in a skill-related industry and region in year *t*
$moldsr1_{it}$	Dummy for company in the Marinha region (Marinha, Leiria, and Alcobaça) in year *t*
$moldsr2_{it}$	Dummy for company in the Oliveira region (Oliveira) in year *t*
$moldmr_t$	Dummy for company in molds industry located in the molds agglomerated region in year *t*
$vcmr_t$	Dummy for company in an industry from the value chain of molds located in the molds agglomerated region in year *t*
$year_t$	Year dummies from1986 to 2008

Model 1 isolates the effects of industry background of the entrepreneurs. In model 2 we identify only the effects related to background in terms of previous location. Model 3 adds the interaction between location and industry.

Then we look at the likelihood of entrants to locate in the entrepreneur's home region. The general Logit specification is:

$$P(Home_i = 1 \mid x_i) = \Lambda[\beta_1 surv_i + \beta_2 molds_i + \beta_3 vc_i + \beta_4 rel_i + \beta_5 moldsreg_i + \beta_6 moldsmr_i + \beta_7 vcmr_i)$$

The variables used in the Logit models are described below:

home	Dummy for entry in a *concelho* where at least one entrepreneur had a previous job
surv	Longevity of the entrant given by the number of years it survives
molds	Dummy for company with at least one entrepreneur with a previous job in the molds industry
vc	Dummy for company with at least one entrepreneur with a previous job in an industry from the value chain of molds
rel	Dummy for company with at least one entrepreneur with a previous job in a skill-related industry and region
moldsreg	Dummy for company with at least one entrepreneur with a previous job in the molds agglomerated region (Marinha and Oliveira)
moldsr1	Dummy for company with at least one entrepreneur with a previous job in the Marinha region (Marinha, Leiria, and Alcobaça)
moldsr2	Dummy for company with at least one entrepreneur with a previous job in the Oliveira Molds region (Oliveira)
moldsmr	Dummy for company with at least one entrepreneur with a previous job in the molds industry located in the molds agglomerated region (*molds* x *moldsreg*)
vcmr	Dummy for company with at least one entrepreneur with a previous job an industry from the value chain located in the molds agglomerated region (*vc* x *moldsreg*)

In addition to the variables of interest, related to the entrant's background in terms of location and industry, we control for the longevity of entrants, as a proxy for their quality. Model 1 restricts the analysis to the entrepreneur's background in terms of industry and locating inside the molds agglomerated region. Model 2 adds interactions between industry and location. On the second step we use Logit models to assess the likelihood of spawning molds entrants, in order to determine which companies are more likely to fuel the agglomeration process. For our panel data sample we pooled all observations of all

companies, therefore the database had one observation per year reported by each company in the period of analysis. We control for the characteristics of the spawner, using its size in terms of the number of employees as a proxy for the quality of the potential spawner.

4.2.3 Company performance

We analyze survival over the period of 23 years as a performance measure for the molds entrants. In the performances analysis we aim to identify which factors influence the quality of the spinoffs. The specification for the Cox proportional hazard model is:

$$\lambda(t \mid x;\theta) = \exp(\beta_1 agg + \beta_2 home + \beta_3 molds + \beta_4 vc + \beta_5 rel + \beta_6 moldsmr + \beta_7 vcmr + \beta_8 hmolds + \beta_9 hvc)$$

The variables are:

agg	Dummy for company located in the molds agglomerated region (Marinha and Oliveira)
home	Dummy for company with at least one entrepreneur with a previous job in the same *concelho* where it entered
molds	Dummy for company with at least one entrepreneur with a previous job in the molds industry
vc	Dummy for company with at least one entrepreneur with a previous job in an industry from the value chain of molds
rel	Dummy for company with at least one entrepreneur with a previous job in a skill-related industry and region
moldsmr	Dummy for company with at least one entrepreneur with a previous job in the molds industry located in the agglomerated region (*molds* x *moldsreg*)
vcmr	Dummy for company with at least one entrepreneur with a previous job in a value chain industry located in the agglomerated region (*vc* x *moldsreg*)
hmolds	Dummy for company with at least one entrepreneur with a previous job in the molds industry located in the *concelho* of entry (*molds* x *home*)
hvc	Dummy for company with at least one entrepreneur with a previous job an industry from the value chain located in the *concelho* of entry (*vc* x *home*)

5. RESULTS

5.1. Entry and Location Decision

Table 4 presents the first set of results that analyze the rate at which firms spawned spinoffs. Results for the year dummies are omitted from the tables. The results show that firms in Marinha and Oliveira were more likely to spawn spinoffs even after controlling for the backgrounds of firms – i.e., whether the firm was in the molds industry, a value chain-industry, or a skill-related industry. As seen in Buenstorf and Klepper (2009), this result can be interpreted to support conventional agglomeration theories. The argument is that if all firms locate in their home region and all else equal firms are more profitable if they enter in an agglomerated region, then entry will be greater in the agglomerated region even after controlling for firm backgrounds (and thus controlling for differences across regions in the backgrounds of firms). Alternatively, it is also consistent with a self-reinforcing process governing spinoffs in a region, which could occur because it was easier to found a new firm in an agglomerated region. This could be due to many factors, including greater access to finance and greater access to hiring labor.

TABLE 4

In Table 5 we present coefficients from the Logit model on the probability of entry in the home region, as a function of the entrepreneur's background (industry and location), controlling for the quality of the entrant. Firms whose founder previously worked in the agglomerated regions, particularly the Marinha region, were more likely to enter in their home region (Marinha region or Oliveira region) than other firms. Also, firms whose founder previously worked in the molds industry or the value chain were also more likely to locate in their home region (this was not true for firms whose founders previously worked in skill-related industries). The coefficients for interactions between industry and location in the molds region are not significant, implying that all types of firms originated in the agglomerated regions were more likely to locate in their home (agglomerated) region. These

results are consistent with conventional agglomeration theories, which predict that agglomerated regions are attractive to locate in.

TABLE 5

5.2. Company Performance

Using a Cox proportional hazard model and controlling for entry in the molds region and in the home location, we find that the nature of the entrepreneur's previous job has significant effect on survival, as shown in Table 6. A hazard ratio estimate of less than 1 indicates that the respective variable lowers the hazard of exit while an estimate above 1 indicates the opposite.

TABLE 6

The survival equation suggests that locating in the agglomerated region did not (significantly) enhance survival after controlling for the backgrounds of firms, which were important if the firm was a spinoff from the molds industry or a value chain firm (but being from a skill-related industry resulted in shorter survival). The result concerning coming from a skill-related industry suggest this background was not helpful even though it seemed to raise the probability of a firm spawning a spinoff. It also does not seem to have been helpful to locate in a firm's home region.

We should note that finding that locating in an agglomerated region did not lower the hazard is not consistent with conventional agglomeration theories. Conventional theory claims that agglomeration economies can increase entry in a region even if no firms are drawn to locate in agglomerated regions (because the costs of locating away from home are prohibitive). Buenstorf and Klepper (2009) stresses that if this effect is present and leads to more entry in the agglomerated region, it also implies that firms in the agglomerated region

should perform better. This is a strong implication, which is even more relevant if we consider other mechanisms that could cause entry to be greater in agglomerated regions, such as better support for new firm foundings (this is an agglomeration economy, but not a conventional one) or foundings spurring more founders via a sort of demonstration effect.

6. CONCLUSIONS

The Portuguese molds industry formed in Marinha and Oliveira, and its strong presence in the region is still growing over 40 years later. The industry's early history is well known and describes how the pioneers decided to go from making molds for glass to making them for plastics, well before plastic became a commodity product. In this new industry learning and experimenting were essential, so Centro Vidreiro and Aníbal Abrantes, pioneers in the molds manufacture, inadvertently became the training grounds for young workers that became entrepreneurs. This process of gaining valuable experience and then creating a molds competitor became common in the industry and was generally accepted without much dispute. Soon these two regions agglomerated the core of the new industry and were considered a success case in the country.

Such historic accounts point to an agglomeration process very similar to what was experienced in the US tire, automotive and semiconductor industries, where organizational reproduction was a major agglomeration driver. Nevertheless, conventional agglomeration economies could also be perceived as the force attracting entrepreneurs to the agglomerated region.

To challenge and compare conventional agglomeration theories and this modern approach to agglomeration, based on the concept of organizational reproduction and heredity, is a

complex matter (Buenstorf and Klepper 2009; 2010). Companies tend to locate in their home region and therefore if there is a larger population of firms of any type in one location, the entry of new firms might be fueled either by the organizational reproduction process of firms from related industries, or by the mere attraction to the home location of all types of firms. However, conventional agglomeration theories would predict that performance of the firms that entered the agglomeration region would be better than the ones that locate outside the region, while the organizational reproduction theory would sustain that only the firms in the agglomerated region with backgrounds in the same or a related industry would indeed perform better.

Results show that although entry in the home region is more likely for the firms located in the agglomerated region, this effect is not restricted to related industries. There is a generalized attraction to locating in the agglomerated region, consistent with conventional agglomeration theories. Moreover, spawning a molds entrant is more likely for firms located in the agglomeration region, even after controlling for industry. Again this effect is consistent with conventional agglomeration theories. Nevertheless such results do not imply that organizational reproduction effects are not occurring simultaneously with this generalized attraction for the industry inside the agglomerated region.

It's perhaps not surprising that the industry became attractive inside the agglomerated region. Contrary to other industries studied before, the molds industry is far beyond its formation era and a demonstration effect may be at play in this stage. The success of the industry was widely publicized in the period, in particular in the regional media (Gomes 2005), and Government support was channeled to the industry and support institutions. This attention, coupled with the success of some role model companies in the industry, would naturally increase the interest of entrepreneurs, particularly the ones in the vicinity.

Nonetheless, the analysis of company performance takes us deeper into the phenomenon. Results show that coming from the agglomerated region does not improve the prospects of survival, which contradicts the predictions of conventional agglomeration theories. However, having a background in a related industry (molds or value-chain) increases the likelihood of survival.

The overall results indicate that organizational reproduction fueled the agglomeration process and the success of the industry, by ensuring the reproduction of the best companies and the best knowledge in the industry. This dynamics improved the performance of the companies with the "right" genealogy but, after the early years of the industry formation, it also contributed to creating a demonstration effect that then generated further agglomeration. This additional entry could also be motivated by mechanisms other than agglomeration economies, therefore they do not prove the existence of conventional accounts. The entry of entrepreneurs from unrelated industries diluted the organizational reproduction effects on entry but the impacts on firm performance, driven by the superior quality of the entrepreneurs, continued to be noticeable.

Similarity to studied industries in the US in terms of technological advancement and intense export nature, along with historic reports about the role of spinoffs suggest that also in the molds industry, organizational reproduction was the main agglomeration driver in an early stage. On a later stage entry may be drawn to the agglomerated region by other effects, but results show that performance is only enhanced for the spinoffs of related companies in the agglomeration region. This conclusion implies that there is no evidence of conventional agglomeration theories that would account for the success of agglomerated industries. Conversely, results support the role played by organizational reproduction and heredity in the success of the industry.

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TABLES AND FIGURES

Table 1 - Value Chain Industries

Suppliers and subcontractors:
Basic industries of iron and steel, not specified
Aluminum production
Manufacture of basic iron and steel and of ferro-alloys
Casting of iron
Casting of other non-ferrous metals
Casting of light metals
Casting of non-ferrous metals
General mechanical engineering
Treatment and coating of metals
Manufacture of other fabricated miscellaneous metal products
Manufacture of other miscellaneous special purpose machinery
Manufacture of tools
Manufacture of machinery for plastics and rubber industries
Wholesale of metals and metal ores
Engineering activities and related technical consultancy
Customers:
Manufacture of footwear
Manufacture of parts of footwear
Manufacture of plastic packing goods
Manufacture of builders' ware of plastic
Manufacture of other plastic products
Manufacture of cutlery
Manufacture of electric domestic appliances
Manufacture of equipment for low-voltage electrical installations
Manufacture of lighting equipment and electric lamps
Manufacture of other electrical equipment
Manufacture of motor vehicles
Manufacture of motorcycles
Manufacture of bicycles and invalid carriages
Manufacture of electrical and electronic equipment for motor vehicles
Manufacture of other parts and accessories for motor vehicles
Manufacture of games and toys
Wholesale of machine tools

Table 2 - Zero inflated Negative Binomial estimates [4]

VARIABLES	*(1)*
Log of number of workers in origin industry and region (empi_o)	*0.10** (0.04)*
Log of number of workers in destination industry and region (empi_d)	*0.26*** (0.05)*
Log of average wage in origin industry and region (wage_o)	*0.79*** (0.14)*
Log of average wage in destination industry and region (wage_d)	*1.21*** (0.14)*
Worker density in origin industry and region (workden_o)	*0.11*** (0.01)*
Worker density in destination industry and region (workden_d)	*0.12*** (0.01)*
Constant	*-10.80*** (0.85)*
Observations	*186,974*

Table 3 - Pairs of region/industry significantly related to the molds industry [5]

Region	**Industry**
Marinha	21211 | Manufacture of corrugated paper and paperboard (includes containers)
Marinha	22220 | Printing
Marinha	25210 | Manufacture of plastic plates
Marinha	25220 | Manufacture of plastic packing goods
Marinha	25240 | Manufacture of other plastic products
Anadia	26220 | Manufacture of ceramic sanitary fixtures
Marinha	27510 | Casting of iron
Marinha	28752 | Manufacture of other fabricated miscellaneous metal products
Marinha	31202 | Manufacture of equipment for low-voltage electrical installations
Marinha	51610 | Wholesale of machine tools
Marinha	51650 | Wholesale of other machinery for use in industry trade and navigation
Marinha	51700 | Other wholesale
Marinha	55406 | Others beverages establishments with some form of entertainment
Marinha	60240 | Freight transport by road
Marinha	72200 | Software consultancy and supply
Marinha	72600 | Other computer related activities
Marinha	74120 | Accounting
Marinha	74202 | Engineering activities and related technical consultancy

[4] *significant at the 0.10 level; ** significant at the 0.05 level; ***significant at the 0.01 level (standard errors in parentheses)

[5] Note: CAE codes for Revision 2.

Table 4 - Coefficient estimates of the molds spinoff Logit model [6]

VARIABLES	**(1)**	**(2)**	**(3)**
Size (log(pemp))	*0.79*** (0.02)*	*0.79*** (0.03)*	*0.80*** (0.03)*
Molds industry (Molds)	*5.73*** (0.09)*	*4.59*** (0.15)*	*5.53*** (0.15)*
Value Chain industry (vc)	*1.98*** (0.11)*	*1.74*** (0.12)*	*1.82*** (0.14)*
Related Industry (Rel)	*1.18*** (0.22)*	*0.42** (0.19)*	*0.54*** (0.19)*
Marinha Region (Moldsr1)		*1.83*** (0.15)*	*2.62*** (0.14)*
Oliveira Region (Moldsr2)		*1.31*** (0.15)*	*2.10*** (0.18)*
*Agglomeration in Molds (Molds*Moldsreg)*			*-1.74*** (0.21)*
*Agglomeration in Value Chain (vc*Moldsreg)*			*-0.63*** (0.24)*
Constant	*-13.94*** (0.59)*	*-14.13*** (0.59)*	*-14.32*** (0.59)*
Observations	*4,609,984*	*4,609,984*	*4,609,984*

Table 5 - Likelihood of locating in the home region [7]

VARIABLES	*(1)*	*(2)*
Longevity of Entrant (surv)	*-0.03* (0.02)*	*-0.023 (0.02)*
Entrepreneur from Molds (molds)	*0.48** (0.23)*	*0.52* (0.32)*
Entrepreneur from Value-chain (vc)	*0.47* (0.25)*	*0.45 (0.32)*
Entrepreneur from Skill-related (rel)	*-0.03 (0.39)*	*-0.04 (0.40)*
Molds region (moldsreg)	*0.61*** (0.23)*	*0.65* (0.38)*
*Molds industry and molds region (molds*moldsreg)*		*-0.08 (0.47)*
*Value-chain and molds region (vc*moldsreg)*		*0.03 (0.50)*
Constant	*0.53** (0.21)*	*0.52** (0.23)*
Observations	*576*	*576*

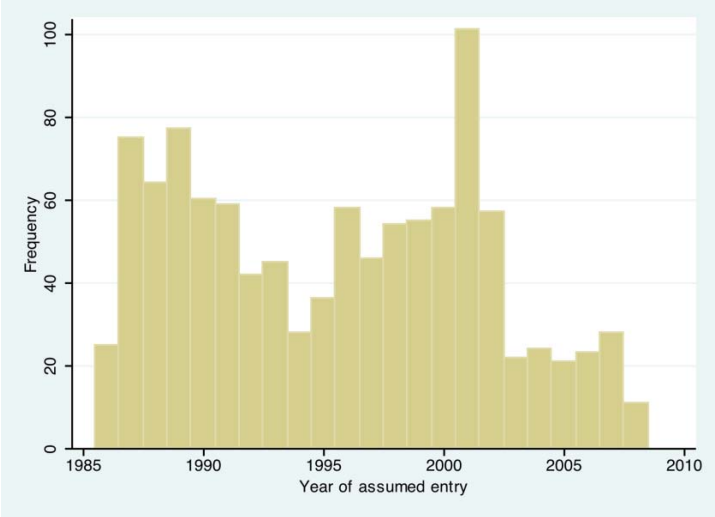
[6] *significant at the 0.10 level; ** significant at the 0.05 level; ***significant at the 0.01 level (cluster standard errors in parentheses); Year dummies ommited

[7] *significant at the 0.10 level; ** significant at the 0.05 level; ***significant at the 0.01 level (robust standard errors in parentheses)

Table 6 - Cox Proportional Hazard Estimates [8]

Cox Proportional Hazards Estimates (Hazard Ratio)	***(1)***
Agglomerated region (moldsrege)	*0.80 (0.12)*
Home region (home)	*1.27 (0.19)*
Molds industry (molds)	*0.56*** (0.08)*
Value-chain (vc)	*0.50*** (0.08)*
Skill-related industry (rel)	*1.52* (0.33)*
Number of observations	*576*

Figure 1 - Entry in the molds industry by year



[8] *significant at the 0.10 level; ** significant at the 0.05 level; ***significant at the 0.01 level (standard errors in parentheses)