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Drivers of Spin-off Performance in Industry Clusters: Embodied Knowledge or Embedded Firms?

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Abstract
Numerous studies attest to the distinctive performance of intra-industry spin-offs located in agglomerated regions. Both superior hires and regional embeddedness have been suggested as factors contributing to this pattern. We employ linked employer-employee data to assess their relevance in the empirical context of the Portuguese plastic molds industry. We find that the longevity of entrants is associated with the number and quality of early employees hired from within the Early hires account for about 10% of the estimated spin-off premium in performance; they also help explain the longer lives of entrants located in the industry clusters industry, consistent with the importance of embodied knowledge flows. Our findings do not suggest that entrants’ centrality in the regional industry network is associated with their longevity.
Drivers of Spin-off Performance in Industry Clusters: Embodied Knowledge or Embedded Firms?

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Keywords: Spin-offs, agglomeration, labor mobility, social networks, centrality.

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1. Introduction

Knowledge and skills acquired in prior employment are crucial determinants of entrepreneurial performance (Parker, 2004). Successful entrepreneurs who started up after leaving jobs at incumbent firms are legend, and their ventures played important roles in the evolution of various industries and regions. Witness for example the proverbial “Fairchildren”: large numbers of ventures were organized by employees leaving Fairchild Semiconductors, Silicon Valley’s first prominent semiconductor firm. These spin-offs were key to the subsequent ascent of Silicon Valley as the undisputed center of the global high-tech industry (Kenney and von Burg, 1999; Moore and Davis, 2004). As is equally well known, Fairchild Semiconductors itself was formed in 1958 by a group of leading employees who had quit their jobs at its predecessor firm, Shockley Semiconductors. And while the Fairchild story may be the most spectacular case of employee or spin-off entrepreneurship, many similar stories could be told.

Accounting for the performance premium of spin-offs has proven to be elusive (cf. Klepper, 2009, for a review of theories and evidence). Exactly why spin-offs are prominent in the evolution of regional industry clusters, and how spin-off dynamics relate to regional characteristics has been particularly contentious. According to the “heritage theory” of industrial agglomeration (Klepper, 2007; 2016; Buenstorf and Klepper, 2009, 2010) spin-off dynamics may trigger and sustain the geographic concentration of industries even when and where traditional Marshallian economies of agglomeration are absent. As critics have been quick to point out, however, finding that only spin-offs but not other de novo entrants in clusters outperform more isolated entrants does not prove that agglomeration economies are irrelevant. It might rather indicate that spin-offs are better positioned than other entrants to benefit from agglomeration, a possibility acknowledged by Klepper (2007; cf. also Golman and Klepper, 2016, as well as Boschma, 2015, for an insightful discussion).

Spin-offs’ embeddedness in localized social networks is one of the factors that might plausibly underlie their superior ability to benefit from agglomeration (Hervas-Oliver et al., 2017). Localized social networks have frequently been suggested to be important in the evolution of regional industry clusters, including the Akron tire cluster that was used as an early example of the heritage theory of industrial agglomeration (Sull, 2001). Boschma (2015) accordingly calls for studying the network positions of spin-offs, which we begin to do in the present paper.

Recent work moreover shows that spin-offs benefit from their founders’ industry experience when hiring their initial labor force (Carias and Klepper, 2010; Cheyre et al., 2014). The recruitment of employees may contribute to firms’ regional embeddedness, possibly enhancing their ability to absorb localized knowledge from external sources. At the same time, new hires add to the skills and capabilities available within the firm. These skills and capabilities presumably contribute to firm performance, which we also study below.

Disentangling the effects of spin-offs’ superior capabilities based on the prior experience of their founders and employees from those of embeddedness in relevant industry networks is challenging. It requires information on the backgrounds of founders and employees, as well as on their links to other relevant actors in the industry and the region. In this paper, we draw on a unique dataset allowing us to recover both types of information. Specifically, we use 24 years of linked employer-employee data covering the entire Portuguese labor market to study the performance of new entrants into the Portuguese plastic injection molds industry. Based on the linked employer-
employee data we can trace the backgrounds of entrepreneurs to identify spin-offs. We also identify early hires of all entrants and use within-industry labor mobility to reconstruct the network of linkages within the industry. We then analyze how founder backgrounds, locations, early hires and centrality in the regional industry network relate to the survival of entrants in the molds industry. To the best of our knowledge, our study is the first attempt to account for the role of employee mobility as well as network position in a study of spin-off performance.

The Portuguese plastic molds industry is ideally suited for the purposes of our study. It is one of the country’s showcase industries. Portuguese molds makers, which are heavily concentrated in two clusters in Marinha Grande and Oliveira de Azeméis, are among the global industry leaders. They attained their position mostly because they were quick to embrace innovation. In addition, prior work on the industry has demonstrated the relevance of spin-off entry for its evolution (Costa and Baptista, 2012).

We find that firm longevity in the Portuguese molds industry is systematically associated with the number and quality of early employees hired from within the industry, consistent with the importance of embodied knowledge flows. Early hires account for about 10% of the estimated spin-off premium in performance; they also help explain the longer lives of firms located in the industry clusters. In contrast, our findings do not suggest that the extent to which entrants are embedded in the regional industry network, which we measure by betweenness centrality or alternatively by eigenvector centrality (Jackson, 2008), is systematically associated with their performance.

The remainder of the paper is structured as follows. We provide the theoretical background for our analysis and derive testable hypotheses in Section 2. Section 3 discusses the empirical context of our study, and Section 4 introduces our data and methods. Results are presented in Section 5. Section 6 concludes.

2. Theoretical Background: Spin-offs, Labor Mobility and Agglomeration

Entrepreneurial ventures are crucial drivers of innovation, employment and economic development. However, all entrepreneurial ventures are not created equal. Founding teams and early hires bring diverse experiences, skills and knowledge bases to new firms. A large stream of prior research has shown that these differences in pre-entry experience are systematically related to differences in post-entry activities and the performance of entrepreneurial ventures (cf. Helfat and Lieberman, 2002, and Peltoniemi, 2011, for surveys).

Among the different types of entrepreneurial or de novo ventures, (intra-industry) spin-offs have received substantial scholarly attention – i.e. new firms organized by (teams of) entrepreneurs who previously worked at other firms in the same industry.¹ In a variety of industries, spin-offs have been prominent in both numbers and performance. Spin-offs account for a sizeable fraction of all de novo entrants in high-tech industries such as semiconductors (Kenney and von Burg, 1999; Fontana and Malerba, 2010), disk drives (Agarwal et al., 2004), lasers (Sleeper, 1998), or biotechnology (Powell et

¹ Our terminology follows Klepper (2001; 2009) and Helfat and Lieberman (2002). Other authors prefer the terms “spin-out” (e.g., Agarwal et al., 2004) or “spawn” (e.g., Chatterji, 2009) when referring to what we will denote as spin-offs.
al., 2012). They tend to outperform other entrepreneurial entrants (e.g., Klepper, 2007; Wenting, 2008; Dahl and Sorenson, 2013), with their success often matching that of de novo entrants diversifying from related markets (Klepper, 2002). Performance differentials within the group of spin-offs moreover reflect differences in parent firm quality (Franco and Filson, 2006; Wenting, 2008; Buenstorf and Klepper, 2009; Klepper, 2010).

The superior performance of spin-offs suggests that they benefit from a richer endowment of capabilities at entry. It has therefore been suggested that incumbents serve as involuntary “training grounds” for aspiring entrepreneurs (Klepper, 2001), allowing future spin-off founders to acquire useful knowledge that they can then transfer from the parent firm to their new venture (Phillips, 2002; Agarwal et al., 2004). There is only limited evidence as to exactly what types of knowledge are relevant in this process of employee learning. However, prior findings suggest that in addition to technology-related knowledge (Agarwal et al., 2004; Klepper and Sleeper, 2005), also knowledge related to the market (Buenstorf, 2007) and the institutional environment of the industry (Chatterji, 2009) contribute to spin-off performance.

Taking into account the opportunity cost of giving up their current jobs, spin-off founders, in particularly those who leave successful firms, are a highly select group of entrepreneurs. The decision to start a firm in the industry that one worked in before, rather than to enter a (subjectively) new one, may also reflect self-selection in that more successful and ambitious entrepreneurs enter into markets that are more closely related to those served by their parents (Dahl and Sorenson, 2014). Empirically these dynamics of self-selection into spin-off entrepreneurship are difficult to disentangle from employee learning. Both predict that spin-off founders are superior to the founders of other de novo firms, which adds to the capabilities of their fledgling ventures. Furthermore, both learning and selection may help account for the direct relationship between parent and spin-off performance.

As the majority of entrepreneurs start their ventures close to where they previously worked (Figueiredo et al., 2002), the spin-off process is a powerful driver of regional industry agglomeration. If more successful firms have more (Klepper and Sleeper, 2005), and more successful, spin-offs, then regions that happen to host early successful entrants into an industry may experience virtuous circles of spin-off entrepreneurship and spin-off success, where each spin-off generation creates a new set of potential spin-off parents. These success-breeds-success dynamics of spin-off-based cluster evolution underlie what has become known as the “heritage theory” of industrial agglomeration (Klepper, 2007; Buenstorf and Klepper, 2009, 2010). According to this view, entrants located in industry clusters outperform more isolated competitors not because they benefit from Marshallian agglomeration economies based on knowledge spillovers, labor pooling and specialized suppliers, but because their capabilities are inherently superior. Indeed, it could be shown in various empirical contexts that only spin-offs, but not other entrepreneurial entrants located in the same industry clusters, outperformed more isolated competitors (ibid.; Boschma and Wenting, 2007; Wenting, 2008; Heebels and Boschma, 2011).

These considerations about how the backgrounds of entrepreneurial ventures relate to their performance inform the first hypothesis to be tested in the subsequent empirical analysis:

H1a: Spin-offs outperform other de novo entrants.

H1b: Controlling for spin-off background decreases the performance differential between de novo entrants located in industry agglomerations and de novo entrants located outside of agglomerations.
Founders are not the only source of capabilities that entrepreneurial ventures can draw upon. Early employees will also bring relevant knowledge to the firm, particularly if they have work experience in other firms active in the same industry (Braginsky, 2015). The performance of entrepreneurial entrants may be related to the number and quality of early hires in various ways. First, the larger the number of early employees, the larger the overall capability stock of the firm would be expected to be (all else equal). The number of early employees obviously cannot be considered to be exogenous, as it reflects strategic decisions made by entrepreneurs. However, theoretical work (e.g., Klepper, 1996) suggests that better firms enter at larger sizes. Larger numbers of early employees are accordingly expected to be related to stronger performance of entrepreneurial firms. Second, in analogy to the arguments about spin-off founders, we also expect the background of early hires to matter. Firms that hire employees from industry incumbents, particularly successful ones, should be able to tap into the useful knowledge that these employees have acquired before, allowing them to outperform competitors that do not have similarly experienced employees. Prior work moreover suggests that spin-off founders are better able to select and attract capable first-round employees than entrepreneurs who lack industry experience (Carías and Klepper, 2010; Cheyre et al., 2014). The quality of early hires may thus be a relevant factor underlying spin-off performance. In addition, thick labor markets are among the advantages that regional industry agglomerations may provide to firms located there, which is expected to show in their performance. We accordingly predict the following relationships:

**H2a:** De novo entrants that hire larger numbers of early employees with industry experience outperform de novo entrants with smaller numbers of such hires.

**H2b:** Controlling for the number of early hires with industry experience decreases the performance differential between spin-offs and other de novo entrants.

**H2c:** Controlling for the number of early hires with industry experience decreases the performance differential between de novo entrants located in industry agglomerations and de novo entrants located outside of agglomerations.

In addition to hiring more capable employees, there are other ways in which spin-off founders may leverage their industry experience. Familiarity with the industry is also helpful in acquiring capital, both because spin-off founders know better whom to address for funding and because their experience provides a quality signal in the capital market (Sorenson and Audia, 2000; Dahl and Sorenson, 2014). Industry experience may moreover be crucial to access relevant knowledge that is present in the industry. Again, not only spin-off entrepreneurs alone are relevant, but also employees contribute to the extent to which a firm is embedded in the industry network (Granovetter, 1985, 2017; Powell et al., 2012). Prior evidence shows that labor mobility and social networks linking past collaborators provide important channels of innovation-related knowledge flows (Almeida and Kogut, 1999; Breschi and Lissoni, 2009). Firms that are more strongly embedded in the network of labor flows within an industry may accordingly have better access to relevant knowledge and therefore outperform less strongly embedded competitors.

Based on the above considerations, within-industry labor mobility can be expected to exert a twofold effect on the performance of entrants. It adds to the firm’s capability endowment, but also contributes to its embeddedness in the industry. Conceptually, these two effects can be distinguished in the following way. On the one hand, a labor flow from firm A to firm B increases B’s
capability base at the expense of A’s capability base. B’s gain therefore corresponds to A’s loss. On the other hand, the labor flow also establishes a direct contact between A and B, thus providing a potential channel for future knowledge flows. This effect is independent of the direction of flow. After the move, both the moving employee can contact her former co-workers and the former co-workers can contact her. So while A loses some of its capability base, at the same time it increases its embeddedness in the industry network. Regarding embeddedness, both A and B may gain from the labor flow between them.

Spin-offs are by default part of the industry network created by labor mobility, because at least one tie exists between the spin-off founder and her parent firm (unless the parent firm has exited from the industry). Embeddedness in the industry network may therefore provide another element in the account for spin-off performance. Prior evidence also shows that social networks tend to be highly localized. For a variety of reasons, employees are more likely to switch jobs within rather than across regions, and spin-off entrepreneurs mostly locate close to their parent firm (see above). A firm’s position in the network established by labor mobility will thus be strongly related to its regional embeddedness, which in turn may condition its ability to benefit from agglomeration. Indeed, a long tradition in economic geography has highlighted the importance of localized social ties in accounting for the high degree of spatial concentration in many traditional industries, a phenomenon epitomized by industrial districts found in Italy and elsewhere (e.g., Becattini, 1990; Hervas-Oliver et al., 2017; Morrison and Boschma, 2017). We operationalize the extent of (“structural”; cf. Granovetter, 2017) embeddedness by how centrally an entrant is located in the regional network.

These considerations about the network effects of labor mobility provide the theoretical foundation of our final hypothesis:

**H3a:** De novo entrants in industry agglomerations that are more strongly embedded in the regional industry network outperform less strongly embedded de novo entrants.

**H3b:** Controlling for the extent of embeddedness in the regional industry network decreases the performance differential between spin-offs and other de novo entrants.

**H3c:** Controlling for the extent of embeddedness in the regional industry network decreases the performance differential between de novo entrants located in industry agglomerations and de novo entrants located outside of agglomerations.

Adopting longevity as a measure of firm performance, we will attempt to separate the roles of spin-off heritage, agglomeration, labor mobility, and embeddedness in the regional industry network in the subsequent empirical analysis. In line with the above considerations, the objective is to understand better how capabilities stemming from embodied knowledge flows based on the mobility of entrepreneurs and early employees, joint with embeddedness in the industry network, condition the performance of entrepreneurial firms. To set the stage, we will present the empirical context of our analysis, the Portuguese plastic molds industry, in the next section.

Plastic parts are ubiquitous in day-to-day life. They are key components of many assembled goods and find use as inputs in a variety of industries. Plastic goods are produced using injection processes with molds. Each new variety of plastic good requires a custom new mold to be designed and constructed, which may then be employed to manufacture production runs of possibly thousands or even millions of identical plastic components. Technological requirements for molds have become increasingly demanding over time. Present-day precision molds are characterized by tolerances in the range of only a few microns; their production uses a variety of different materials as well as sophisticated optical and information technologies (Henriques, 2008). Complex precision molds may require production periods extending for several months (Silva, 1996; Sopas, 2001).

Portugal is one of the world’s centers of the molds industry. The Portuguese molds industry is considered to be technologically advanced and innovative. It exports about 80-90% of its output. The industry is highly agglomerated. Two rural regions located between Porto and Lisbon account for about half of all producers active between 1986 and 2009: Marinha Grande (in Leiria region) and Oliveira de Azeméis (in Aveiro region). With 39% of all 1986-2009 producers, Marinha Grande is the larger cluster. It comprises three administrative districts (concelhos) covering a total area of 1,160 km² and also has a co-located plastics industry (Costa, 2013) (Oliveira: 8% of all companies and 161 km²). Both clusters have been likened to Italian industrial districts, as they comprise networks of small, specialized firms that subcontract intensively (Mota and Castro, 2004) while being vertically disintegrated to access external capabilities (Loasby, 1998).

The origins of the Portuguese plastic molds industry can be traced back to glass production, which was historically centered in the same two regions that today host most of the molds producers. The first plastic molds producer, A.H.A., was organized in Marinha Grande in 1946. A.H.A. had its roots in a workshop manufacturing molds for the regional glass industry. As a center of networking, training of employees, and organizational innovation (increased specialization and division of labor in molds manufacturing; Vieira, 2007; Neto, 2014), it was an important driver of the industry’s subsequent evolution. Worker training and specialization also provided the foundation of a substantial spin-off process. According to a 1992 survey, 83% of the then existing molds producers in Marinha Grande were owned by prior production workers (Melo, 1995). Spin-off dynamics were similarly prominent in the evolution of the Oliveira cluster (Beira et al, 2007).

Export activities of the Portuguese plastic molds producers have been documented since 1954 (1957 for exports to the U.S.). Over time the share of exports increased until almost the entire production was sold internationally (Gomes, 2005). Helped by low costs and Portugal’s EU membership in 1986, the industry experienced an export boom from the 1970s to the early 1990s. Parallel to the rise in exports, the number of new entrants into the industry soared. Entry concentrated in the two industry clusters, with 57% of the 1986-2009 entrants locating in Marinha Grande, 9% in Oliveira de Azeméis, and the remainder scattered across 99 other concelhos. While smaller in overall size than Marinha Grande, the Oliveira cluster concentrates on the market segment for larger molds. With 21 versus 11 employees on average, Oliveira firms also tend to be larger than Marinha firms. In the second half of the 1990s the industry experienced a large increase in the number of firms (cf. Figure 1), which was driven by a growth of the external demand from the EU countries and the penetration of the
automotive market. This market segment grew from 20% of sales in 1994 to 72% by 2008 and has since remained the most important market segment (CEFAMOL, 2010).

**Figure 1 – Evolution of the Number of Companies by Region**

4. Data and Methods

Our empirical analysis of the Portuguese molds industry is based on *Quadros de Pessoal*, a linked employer-employee dataset for Portugal that has found widespread use in prior research (e.g. Cabral and Mata, 2003; Figueiredo et al 2002; Geroski et al, 2010). We use all years from 1986 and 2009 but restrict our focus to firms entering in the 5-digit industry class of ‘Manufacture of metal molds’, a total of 1,066 observations. Most of these firms are small (mean size across the industry is 17.4 employees in this period).

Spin-offs are identified as follows. We look at the backgrounds of the new entrants’ founder(s) and classify a firm as a spin-off if at least one founder had worked in a molds company in the previous five years. In total, 39% of the 627 entrants for which background information could be attained are spin-offs, which attests to the relevance of this type of entrepreneurial venture in the Portuguese molds industry.

Based on the above conjecture that not only founders but also early hires are crucial for the capability base of entrepreneurial ventures, we further derive from the *Quadros de Pessoal* dataset all third-year employees of the 1986 to 2009 entrants. We identify whether they previously worked at molds firms or outside the industry. Specifically, an employee is coded as coming from a molds firm if she is listed as an employee of such a firm in at least one of the five years prior to her

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2 Code 25734 considering the Portuguese economic codes classification (CAE Revision 3). For early entrants we use the corresponding prior industry classes.

3 The omitted entrants without background information are mostly short-term survivors.
employment at the new entrant. Among the molds-experienced workers, we further identify those who worked at firms that had survived for at least seven years at the time the respective entrant was organized. We use this information to proxy for quality differences in the hires made by new entrants. While long-term survival admittedly is a crude proxy of quality, it is available for all firms, and is more suitable in our context than alternative measures such as sales or market share (Neto, 2014). Out of the total 4,867 third-year employees of entrants into the molds industry, 1,978 (41%) have prior molds industry experience, and 1,639 (34%) come from long-term survivors. These large numbers of hires from other molds firms indicate that, in line with our theoretical considerations, within-industry labor mobility may be a relevant channel of knowledge transfer across firms.

We also use labor mobility to construct networks of firms in the Portuguese molds industry. Specifically, for each year, we define all molds firms active in that year (irrespective of age or size) as a node in the industry network. Two individual firms are linked by a (undirected) tie whenever there was at least one mobility event in the prior five years involving a job move from one of the firms to the other. As we are interested in the existence of communication channels between the two firms based on two individuals having previously worked together, we do not distinguish transitions into spin-off entrepreneurship from regular job moves in constructing the industry network. Networks were constructed using the Gephi software package. Figure 3 depicts for selected years how the industry network evolved over time. It shows that the Marinha and Oliveira networks are clearly separated in all years. There is very little evidence of direct labor mobility between both clusters. To the extent the clusters are linked, these links are mediated by employees moving to and from firms located outside the two clusters.

Reflecting the strongly localized nature of industry networks indicated in Figure 3, we also constructed regional industry networks for the Marinha and Oliveira clusters and focus on the positions of firms in these regional networks in our econometric analysis. Specifically, as our primary measure of how embedded an individual firm is in the regional industry network we adopt betweenness centrality, which is defined as the share of all shortest paths between all other firms that go through the focal firm, divided by the total number of possible pairs in the respective network (excluding the focal firm; cf. Wasserman and Faust, 1994). If no labor flows from or to other cluster firms are observed (possibly reflecting poor reporting of marginal firms), we set the betweenness centrality of the respective firm to zero. The betweenness centrality of entrants located outside of the clusters is also set to zero.

Betweenness centrality is a useful measure of embeddedness in the industry network on theoretical grounds, as it accounts for the ease of which potentially sensitive information can be acquired by a firm based on personal contacts of its members (and their personal contacts). Conceptually, even a firm whose members all have an industry background can have a very low value of betweenness centrality, if all members come from firms that are peripheral in the network. Betweenness centrality further has the advantage of being defined for all ties, irrespective of whether they are part of the network’s principal component (ibid.) Our measures of betweenness centrality are calculated based on firms’ network positions in their second post-entry year. Accordingly, they reflect both the links of their founders and those established through the mobility of early employees. As noted above, spin-

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4 We also assessed the quality (proxied by age) of the parents of spinoffs, but decided to remove it from our analysis because it was highly collinear with the spin-off dummy.

5 Very similar results were obtained when the position in the unified industry network across all firm locations was alternatively employed as measure of a firm’s embeddedness.
offs are advantaged in the construction of the centrality measure since they are linked to their founders’ prior employers. This is reflected in our data, as spin-offs have an average betweenness centrality of 0.0004046 versus 0.0000377 for non-spin-off entrants.

Eigenvector centrality is adopted as an alternative measure of embeddedness. In contrast to betweenness centrality, eigenvector centrality takes into account the “prestige” of a firm’s direct contacts in the industry network; i.e. the focal firm’s own eigenvector centrality is proportional to the sum of its neighbors’ eigenvector centrality values (Jackson, 2008, ch. 2). This captures the idea that the value of being connected to others depends on how well they are connected themselves. Having a large number of contacts will not be very valuable if these contacts are relatively isolated in the network.

Figure 3 - Labor Mobility Network
Both the information about early hires and the embeddedness measures based on betweenness (or eigenvector) centrality in the network of labor flows are included in Cox proportional hazard regressions estimating the hazard of exit for all firms with identifiable backgrounds that entered the molds industry between 1986 and 2009. Our focus on entrants’ early-year employees in constructing our variables reflects our intention to balance data availability and potential endogeneity problems. An alternative approach would be to regularly update both hirings and network positions of all firms throughout their history in the industry and to employ a framework with time-varying covariates and multiple observations per firm. We refrained from doing so because hires in any one period may reflect the expectation of being successful in the future. Both hirings and survival may be affected by the same “shock” (e.g., developing a promising innovation), and accordingly the direction of causality between labor mobility and firm survival may be blurred. Note also that using information from a firm’s earliest history is not without limitations, either. Specifically, some firms enter the industry at such a small size that in their first year they are not recorded in the Quadros de Pessoal, which gives rise to a problem of left truncation (cf. Cleves et al., 2010). This problem is attenuated in later years as firms grow bigger.

To minimize biases that might be introduced by defining our mobility and embeddedness variables for the firms’ second post-entry years, all entrants that do not survive for at least three years are excluded from the analysis. Their elimination reduces our sample to 627 entrants, of which 245 are spin-offs. In Table 1 we present the correlations between the variables. To assess how sensitive our findings are to the choice of measurement years, we replicated our analysis using information about network embeddedness in their third post-entry year.

<table>
<thead>
<tr>
<th></th>
<th>Marinha</th>
<th>Oliveira</th>
<th>Spin-offs</th>
<th>Molds Workers</th>
<th>Non-molds workers</th>
<th>BC Marinha</th>
<th>BC Oliveira</th>
<th>EC Marinha</th>
<th>EC Oliveira</th>
<th>Workers L-L firms</th>
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<tr>
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<td>0.355***</td>
<td>0.0545</td>
<td>0.265***</td>
<td>0.073</td>
<td>0.172***</td>
<td>0.518***</td>
<td>0.084*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Workers L-L firms</td>
<td>0.296**</td>
<td>0.128**</td>
<td>0.204***</td>
<td>0.370***</td>
<td>0.112**</td>
<td>0.116**</td>
<td>0.095*</td>
<td>0.337***</td>
<td>0.241***</td>
<td>1</td>
</tr>
</tbody>
</table>

*** p<0.01, ** p<0.05, * p<0.1
5. Results

Table 2 reports the results of the first set of Cox regressions estimating the hazard of exiting from the Portuguese molds industry. The baseline specification (Model 1) only includes a dummy variable denoting companies located in either of the two major molds regions, Marinha Grande and Oliveira de Azeméis. Consistent with the prominent role of both clusters in the molds industry, we find that entrants located in Marinha Grande have a 34% lower hazard of exit, and entrants located in Oliveira de Azeméis have a 42% lower hazard of exit, than entrants located outside of these clusters. Model 2 adds another dummy variable denoting spin-off companies defined as outlined above. The coefficient estimated for this variable implies a 34% lower hazard for spin-offs, consistent with Hypothesis 1a. Coefficient estimates for the cluster dummies are reduced by 20-30% relative to Model 1, but remain sizeable and statistically significant at the 0.05 or 0.10 levels. This suggests that some of the agglomeration effect indicated by Model 1 may be due to the heritage of the cluster firms. However, other factors also seem to play a substantial role. Accordingly, there is only limited support for Hypothesis 1b.  

In Model 3 we begin to account for the role of embodied knowledge flows based on labor mobility. Specifically, we include the number of employees hired from other molds producers (as detailed above) in the specification of the hazard model. To control for size effects on longevity, a second variable measures the number of employees hired from non-molds firms. In line with the prediction of Hypothesis 2a, entrants with higher numbers of early within-industry hires are more long-lived than others. The coefficient estimate implies a reduction of the exit hazard by about 6% for each hire from the molds industry. In contrast, hires from outside the molds industry are not related to the exit hazard. As posited by Hypothesis 2b, including the information about early hires in the model reduces the estimated spin-off effect, albeit by less than 10%. More pronounced changes are observed in the cluster dummies, which are further decreased by 34% (Marinha Grande) and 44% (Oliveira de Azeméis) and lose their statistical significance. Consistent with Hypothesis 2c, this suggests that labor mobility is an important contributor to the advantages possessed by firms that are located within industry clusters. 

Model 4 further includes measures of entrants’ embeddedness in the regional industry networks. As detailed above, embeddedness is proxied by the betweenness centrality of the focal firm; it is separately calculated for the Marinha Grande and the Oliveira de Azeméis clusters. Although coefficient estimates for the betweenness centrality measures are sizeable (reflecting that values of betweenness centrality tend to be very small; see above), so is the standard error of the estimate, and neither of the coefficients is anywhere close to being statistically significant. Counter to predictions, they moreover are positive. The other estimates in the model are almost unchanged as compared to Model 3. Accordingly, no empirical support is obtained for the predictions of Hypotheses 3a-c. The same holds for Model 5, which employs eigenvector centrality rather than

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6 As noted above, prior work finds that spin-off performance is associated with the quality of parent firms. Our ability to control for parent quality is limited by the nature of the data we use. As a consequence, some of the agglomeration effects suggested by our findings may in fact reflect differences in spin-off quality.

7 This result is very robust to changes in the model specification and measurement of embeddedness. No significant coefficient of the betweenness centrality measure was obtained when no other explanatory variables were included, or in various other specifications of the model. The same is true for using an overall measure of embeddedness across the various locations of the industry or for alternative scales of betweenness centrality measures. When betweenness centrality was measured for the third post-entry year (see above), its
betweenness centrality to account for a firm’s position in the regional industry network. Coefficient estimates for Marinha Grande and Oliveira de Azeméis are both negative, but far from attaining statistical significance at conventional levels. At least in our empirical context and in the way we measure regional embeddedness, it does not seem to be systematically related to the survival chances of new entrants into the industry.

Table 2 - Cox-Proportional Hazards (Full Sample) (coefficients)

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marinha</td>
<td>-0.418*** (0.128)</td>
<td>-0.305** (0.133)</td>
<td>-0.200 (0.137)</td>
<td>-0.213 (0.138)</td>
<td>-0.180 (0.142)</td>
<td>-0.154 (0.141)</td>
<td>-0.127 (0.144)</td>
</tr>
<tr>
<td>Oliveira</td>
<td>-0.540** (0.228)</td>
<td>-0.429* (0.231)</td>
<td>-0.241 (0.234)</td>
<td>-0.253 (0.238)</td>
<td>-0.246 (0.256)</td>
<td>-0.184 (0.240)</td>
<td>-0.199 (0.256)</td>
</tr>
<tr>
<td>Spin-off</td>
<td>-0.411*** (0.139)</td>
<td>-0.376*** (0.141)</td>
<td>-0.368*** (0.142)</td>
<td>-0.369*** (0.142)</td>
<td>-0.341*** (0.143)</td>
<td>-0.346** (0.143)</td>
<td>-0.346** (0.143)</td>
</tr>
<tr>
<td>Number of molds workers hired</td>
<td>-0.060*** (0.020)</td>
<td>-0.062*** (0.020)</td>
<td>-0.056** (0.022)</td>
<td>-0.038* (0.020)</td>
<td>-0.035 (0.021)</td>
<td>-0.034 (0.021)</td>
<td>-0.035 (0.021)</td>
</tr>
<tr>
<td>Number of non-molds workers hired</td>
<td>0.003 (0.006)</td>
<td>0.003 (0.006)</td>
<td>0.003 (0.006)</td>
<td>0.004 (0.005)</td>
<td>0.004 (0.005)</td>
<td>-0.342** (0.165)</td>
<td>-0.327** (0.166)</td>
</tr>
<tr>
<td>Workers from long-lived molds firms</td>
<td>95.837 (98.510)</td>
<td>111.955 (98.206)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Betweenness Centrality in Marinha</td>
<td>5.626 (20.243)</td>
<td>6.541 (19.938)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Betweenness Centrality in Oliveira</td>
<td>-0.504 (0.996)</td>
<td>-0.347 (0.988)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eigenvector Centrality in Marinha</td>
<td>-0.061 (0.822)</td>
<td>-0.123 (0.808)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eigenvector Centrality in Oliveira</td>
<td>627</td>
<td>627</td>
<td>627</td>
<td>627</td>
<td>627</td>
<td>627</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>-1624.961</td>
<td>-1620.417</td>
<td>-1613.326</td>
<td>-1612.902</td>
<td>-1613.190</td>
<td>-1610.745</td>
<td>-1611.234</td>
</tr>
<tr>
<td>p-value</td>
<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

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

To better account for the quality of the hires, we finally include in the hazard model a proxy for the quality of the capabilities brought by workers (Models 6 and 7). This is a dummy variable denoting entrants who hired at least one employee from a firm that (eventually) survived for at least seven years. This admittedly crude proxy suggests that employee quality is systematically related with firm longevity. In both models the coefficient estimate is statistically significant at the .05 level and implies a substantial reduction of the exit hazards of the respective firms. Controlling for the quality of employees also reduces the spin-off effect further, yet it remains non-negligible and significant. Note, moreover, that including the employee quality measure leads to a substantial further decrease in the (insignificant) coefficient estimates of the Marinha Grande and Oliveira de Azeméis dummies.

coefficient became marginally significant for Marinha Grande but remained positive, suggesting a higher hazard for entrants that are more embedded in the regional network. Results are available from the authors upon request.

8 That coefficient estimates are much smaller than for betweenness centrality is due to generally much higher values of eigenvector centrality.
This may suggest that some of the advantage of being located in the clusters is explained by easier access to better workers.

As noted above, up to now we assumed a centrality value of zero for firms in the Marinha Grande and Oliveira de Azeméis clusters for which no information on labor flows could be obtained. To check how sensitive our results are to varying this assumption, we estimated versions of Models 4-7 excluding all observations of cluster firms for which centrality measures could not be calculated (N = 48). These are reported as Models 8 to 11 in Table 3. As the excluded entrants are all located in one of the clusters and are generally marginal performers, excluding them generates stronger cluster effects. Consequently in Models 8 and 9 we obtain significant coefficient estimates for Marinha Grande (at the .10 level in Model 9), whereas both dummies remain insignificant in Models 10 and 11. Otherwise, except for Model 11, the key findings from the earlier models are reproduced. Embodied knowledge flows from hiring larger numbers of workers from within the molds industry (in Model 10: from long-lived firms only) are associated with longer survival in the industry, but embeddedness in the regional industry network is not.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marinha</td>
<td>-0.312**</td>
<td>-0.273*</td>
<td>-0.245</td>
<td>-0.212</td>
</tr>
<tr>
<td></td>
<td>(0.152)</td>
<td>(0.158)</td>
<td>(0.157)</td>
<td>(0.162)</td>
</tr>
<tr>
<td>Oliveira</td>
<td>-0.413</td>
<td>-0.420</td>
<td>-0.322</td>
<td>-0.349</td>
</tr>
<tr>
<td></td>
<td>(0.273)</td>
<td>(0.297)</td>
<td>(0.278)</td>
<td>(0.300)</td>
</tr>
<tr>
<td>Spin-off</td>
<td>-0.323**</td>
<td>-0.331**</td>
<td>-0.306**</td>
<td>-0.315**</td>
</tr>
<tr>
<td></td>
<td>(0.148)</td>
<td>(0.148)</td>
<td>(0.149)</td>
<td>(0.149)</td>
</tr>
<tr>
<td>Number of molds workers hired</td>
<td>-0.051**</td>
<td>-0.046**</td>
<td>-0.032</td>
<td>-0.029</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.023)</td>
<td>(0.021)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Number of non-molds workers hired</td>
<td>-0.012</td>
<td>-0.012</td>
<td>-0.011</td>
<td>-0.011</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.011)</td>
<td>(0.011)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Workers from long-lived molds firms</td>
<td></td>
<td></td>
<td>-0.293*</td>
<td>-0.282</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.173)</td>
<td>(0.174)</td>
</tr>
<tr>
<td>Betweenness Centrality in Marinha</td>
<td>98.612</td>
<td>110.603</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(98.734)</td>
<td>(98.582)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Betweenness Centrality in Oliveira</td>
<td>7.864</td>
<td></td>
<td>8.045</td>
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</tr>
<tr>
<td></td>
<td>(20.163)</td>
<td></td>
<td>(19.938)</td>
<td></td>
</tr>
<tr>
<td>Eigenvector Centrality in Marinha</td>
<td></td>
<td>-0.435</td>
<td></td>
<td>-0.313</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.006)</td>
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<td>(1.001)</td>
</tr>
<tr>
<td>Eigenvector Centrality in Oliveira</td>
<td></td>
<td>0.100</td>
<td></td>
<td>0.226</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.839)</td>
<td></td>
<td>(0.827)</td>
</tr>
<tr>
<td>Observations</td>
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<td>579</td>
</tr>
<tr>
<td>Log-likelihood</td>
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<td>-1465.248</td>
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<td>-1463.924</td>
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<tr>
<td>p-value</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 3 - Cox-Proportional Hazards (Restricted Sample) (coefficients)

Standard errors in parentheses

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

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6. Concluding remarks

The role of spin-off entrepreneurship in the evolution of regional industry agglomeration is the subject of an ongoing debate. According to the “heritage theory” of agglomeration, industry clusters may develop even if and where traditional agglomeration economies are not operative. The power of the spin-off process to generate capable new entrants that tend to locate close to their roots is highlighted instead. Consistent with this theory, in various empirical contexts it was spin-offs, but not other de novo entrants, whose performance appeared to be boosted by being located in industry agglomerations. However, finding that only spin-offs benefit from being part of an industry cluster might also indicate their superior capability of accessing and exploiting cluster benefits such as pooled labor and knowledge spillovers.

To shed further light on this issue, in the present paper we studied the performance of de novo entrants into one of Portugal’s signature industries: the plastic injection molds industry. Portuguese molds manufacturers predominantly export their products, and Portugal is one of the global leaders in this industry. Moreover, the Portuguese molds industry has characteristics of “Italian-style” industrial districts. It is highly concentrated geographically, with about half of all producers located in one of the two rural regions where the industry clusters, even though both regions do not have any distinctive advantages for molds production. Molds makers tend to be small and are part of extensive networks of horizontally and vertically specialized firms. A large share of them were organized as intra-industry spin-offs.

Our analysis of the Portuguese molds industry focused on two potentially powerful aspects of firm performance, which both have been suggested before as contributing to the superior performance of spin-offs located in agglomerated regions: embodied knowledge flows caused by intra-industry labor mobility and firms’ embeddedness in regional industry networks stemming from contacts between their members and those of other firms in the industry. We exploited the fact that extraordinarily rich information is provided in Portuguese linked employer-employee data, allowing us to reconstruct spin-off dynamics and intra-industry labor mobility over a period of 24 years.

Similarly to earlier work, we found that as a group spin-offs outperformed other de novo entrants into the industry. Entrants located in one of the two clusters were also significantly more long-lived. We could then show that firm longevity was systematically associated with the number of early employees hired from within the industry, consistent with the importance of embodied knowledge flows. Early hires account for about 10% of the estimated spin-off premium in performance. They also help explain why entrants in the two industry clusters performed better than more isolated entrants, and after accounting for the number and quality of early hires no systematic performance difference remained between clustered firms and those that are located elsewhere. In contrast, we could not find any evidence pointing to the competitive relevance of how strongly an entrant is embedded in the regional industry network, which we proxied by entrants’ centrality in the regional industry network.

Even though these patterns of findings are pronounced and showed to be robust to various modifications in our empirical approach, we hasten to add that they cannot be considered as conclusive. Our analysis covered only a single industry in a single country. Even though the Portuguese molds industry is innovative and globally competitive, Marinha Grande is a far cry from Silicon Valley, and our findings may not generalize to high-technology or science-based industries. In
addition, while the Portuguese linked employer-employee data have proven to be highly suitable to our analyses, there are limitations in the data we could use for this study. Most importantly, privacy concerns prevent us from matching them with other sources of information, and we miss some of the smallest firms in the industry. In addition, even though measuring regional embeddedness in terms of network positions established through prior employee mobility seems conceptually superior to other network measures used in the literature (e.g., based on co-patenting or joint activities in publicly funded R&D projects), doing so does not capture relevant links based on subcontracting or other forms of commercial relationships among the firms. We also could not disentangle the roles of membership versus centrality in the regional network (Owen-Smith and Powell, 2004). Finally, the nature of our analysis does not allow us to interpret the estimated relationships as causal.

We conclude from the above analysis that there is more to the performance of spin-offs than just a particularly strong ability to benefit from agglomeration. Knowing whom to hire appears part of the picture, but not the full explanation. So while our results provide further support to the “inheritance theory” of agglomeration, what exactly it is that spin-offs “inherit” remains an open question for future research. Beyond our specific research interest and empirical context, we also conclude that linked employer-employee data, which become increasingly available but have found little use in industry-level studies so far, may find fruitful application in future research endeavors.
References


