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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. Besides entrepreneurs' pre-entry experience, 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 injection molds industry. We find that the longevity of entrants is associated with the number and quality of early employees hired from within the industry, consistent with the importance of embodied knowledge flows. Our findings do not suggest that entrants' centrality in the regional industry network enhances their longevity.

1. Introduction

Knowledge and skills acquired in prior employment are crucial determinants of entrepreneurial performance (Parker, 2004). Successful entrepreneurs who started up after leaving their jobs at incumbent firms are legendary, 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 Semiconductor, Silicon Valley's first prominent semiconductor firm. These spin-offs were key to the subsequent ascent of Silicon Valley to become the undisputed center of the global high-tech industry (Kenney and Von Burg, 1999; Moore and Davis, 2004). As is equally well known, Fairchild Semiconductor itself was formed in 1958 by a group of leading employees who had quit their jobs at Shockley Semiconductor Laboratory. Moreover, while Fairchild may be the most spectacular case of employee or spin-off entrepreneurship, many similar stories could be told.

Accounting for the distinctive performance 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, 2010, 2016; Buenstorf and Klepper, 2009, 2010), spin-off entrepreneurship 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 instead 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 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

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performance, which we also study below.

Disentangling the effects of spin-offs' superior capabilities due to the prior experience of their founders and employees from the effects of embeddedness in localized industry networks is challenging. It requires information on the backgrounds of founders and employees, as well as on their ties 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 private-sector labor market to study the longevity 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 entrants' early-hires and use within-industry labor mobility to reconstruct the network of personal ties 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 roles of both employee mobility and network position in a study of spin-off performance.

The Portuguese plastic injection molds industry is ideally suited for the purpose of this 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 survival in the Portuguese plastic 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 longevity. In contrast, our findings do not suggest that more pronounced embeddedness of entrants in the regional industry network, which we measure by betweenness centrality or alternatively by eigenvector centrality (Jackson, 2008), enhances 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 the study, and Section 4 introduces data and methods. Results are presented in Section 5. Section 6 concludes.

2. Theoretical background: spin-offs, labor mobility and agglomeration

2.1. Spin-offs and the "heritage theory" of industrial 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 – i.e. new firms organized by (teams of) entrepreneurs who previously worked at other firms in the same industry[1] – have received particularly high levels of scholarly attention. 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 al., 2012). They tend to outperform other entrepreneurial entrants (e.g., Klepper, 2007; Wenting, 2008; Dahl and Sorenson, 2014), with their success often matching that of *de alio* entrants diversifying from related markets (Klepper, 2002). Spin-offs are more likely to emerge from better-performing firms (Klepper and Sleeper, 2005; Cusmano et al., 2015). In addition, performance differentials within the group of spin-offs reflect differences in parent firm quality, as more successful parent firms tend to have more successful spin-offs (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. Evolutionary economists have highlighted organizational routines as *loci* of firm knowledge (Nelson and Winter, 1982). In an evolutionary perspective, spin-off performance can then be understood as the inheritance of organizational routines conducive to firm performance (Klepper, 2001). In this evolutionary process, incumbent firms serve as involuntary "training grounds" for aspiring entrepreneurs (Klepper, 2001). They enable future spin-off founders to acquire useful knowledge that can then be transferred from the parent firm to the spin-off 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. Inherited social capital may also be relevant (Dahl and Sorenson, 2014).

Taking into account the opportunity cost of giving up their current jobs, spin-off founders, in particular those who leave successful firms, are a highly select group of entrepreneurs. Starting a firm in the industry that one worked in before, instead of entering a (subjectively) new industry, may also reflect self-selection: more ambitious entrepreneurs enter markets that are more closely related to those served by their parent firms (Dahl and Sorenson, 2014). Empirically these dynamics of self-selection into spin-off entrepreneurship are difficult to disentangle from employee learning and the inheritance of capabilities through spin-off activities. Both self-selection and learning predict that spin-off founders are superior to the founders of other *de novo* firms, and that more successful parent firms have more successful spin-offs.

In terms of geography, the majority of entrepreneurs start their ventures close to where they previously worked (Figueiredo et al., 2002). Spin-offs are no exception, which turns the spin-off process into a powerful source of regional industry agglomeration. As more successful firms have more, and more successful, spin-offs, and each generation of spin-offs creates a new set of potential parent firms, regions where early successful entrants are located may become the geographic centers of an evolving industry. Firms located in these regions may be more successful than firms located elsewhere, which reflects their superior capability base due to larger shares of spin-offs from high-quality parents.

These success-breeds-success dynamics of spin-off-based cluster evolution are highlighted in the "heritage theory" of industrial agglomeration (Klepper, 2007, 2010; Buenstorf and Klepper, 2009, 2010). In contrast, the relevance of Marshallian agglomeration economies based on knowledge spillovers, labor pooling, and specialized suppliers has been discounted by the proponents of this theory. This focus on spin-off entrepreneurship is supported by empirical evidence from various industry clusters where only spin-offs, but not other entrepreneurial entrants located in the same region, outperformed more isolated competitors (ibid.; Boschma and Wenting, 2007; Wenting, 2008; Heebels and Boschma, 2011; but cf. Cusmano et al., 2015, for a deviating result).

These considerations about the performance of spin-offs and their role in industrial clustering inform the first hypotheses to be tested in

[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.

the subsequent empirical analysis:

H1a. *Spin-offs outperform other* de novo *entrants.*

H1b. *Spin-offs contribute to the performance differential between* de novo *entrants located in industry agglomerations and* de novo *entrants located outside of agglomerations.*

2.2. Early employees and the performance of entrants

The capabilities of entrepreneurial ventures are not only based on their founders' knowledge. Early employees also bring relevant knowledge and social capital to the firm, particularly if they have acquired work experience in other firms active in the same industry (Braguinsky, 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 that the firm can draw upon (all else equal).[2] Second, not only the number but also the backgrounds of early-hires matter. Entrants that hire employees from industry incumbents, particularly from successful ones, should be able to tap into the useful industry-related knowledge that these employees have acquired. 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 (Carias and Klepper, 2010; Cheyre et al., 2014). The quality of early employees may thus be a relevant factor underlying spin-off 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. *Early-hires with industry experience contribute to the performance differential between spin-offs and other* de novo *entrants.*

2.3. Embeddedness in regional industry networks and the performance of entrants

The backgrounds of founders and early employees not only contribute to the capabilities of entrants. They are also associated with how embedded entrants are in the regional industry network (Granovetter, 1985, 2017; Powell et al., 2012). Personal ties to members of other firms in the industry may be crucial to access relevant knowledge. For instance, prior evidence shows that links to past co-inventors based on labor mobility and social networks provide important channels of innovation-related knowledge flows (Almeida and Kogut, 1999; Breschi and Lissoni, 2009). Embeddedness in the regional industry network may also matter for the access to funding and other valuable resources (Sorenson and Audia, 2000; Dahl and Sorenson, 2014).

These considerations suggest a twofold effect of within-industry labor mobility on the performance of entrants: it adds to the firm's capability endowment and also contributes to its embeddedness in the industry network. 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. In this regard, labor inflows are beneficial while adverse effects are expected from labor outflows. In other words, B's gain corresponds to A's loss. On the other hand, labor mobility between A and B also establishes a direct tie between both firms, which opens a channel for future knowledge flows between these firms as well as others to which they are linked. This effect is independent of the direction of mobility. After the move, the moving employee can contact her former co-workers, and the former co-workers can also contact her. So while A loses some of its capability base if an employee moves to B, at the same time it increases its embeddedness in the regional industry network. Regarding embeddedness, both A and B may gain from the labor flow between them.

We operationalize the extent of ("structural"; cf. Granovetter, 2017) embeddedness by how centrally an entrant is located in the regional network and investigate whether centrality is systematically associated with firm performance. In addition, as most spin-off entrepreneurs locate close to their parent firm (see above), spin-offs are very likely part of the regional industry network created by labor mobility. Embeddedness in the regional industry network may, therefore, provide another element in the account for spin-off performance.

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

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. *Embeddedness in the regional industry network contributes to the performance differential between spin-offs and other* de novo *entrants.*

Adopting longevity as a measure of firm performance, we will test these hypotheses in the empirical context of the highly clustered Portuguese plastic injection molds industry. This provides us with the opportunity to directly study how embodied knowledge and regional embeddedness contribute to the performance of spin-offs, which is highlighted in the "heritage theory" of industrial agglomeration. At the same time, the Portuguese plastic injection molds industry shares many characteristics of "Marshallian" industrial districts found in Italy and elsewhere (cf., e.g., Becattini, 1990; Becattini et al., 2009; Menzel and Fornahl, 2010; Hervas-Oliver et al., 2017; Morrison and Boschma, 2017). A long tradition in economic geography has attributed the high degree of spatial concentration, and also the impressive performance of many firms located in these industrial districts, to precisely the Marshallian agglomeration economies that are discounted in the "heritage theory". Labor pooling in thick regional labor markets and the importance of localized social ties are two of the advantages conventionally attributed to industrial districts. Accordingly, even though assessing the relative merits of the competing accounts of industrial clustering is not the primary objective of the subsequent analysis, our results will also be informative about the role of Marshallian agglomeration economies in our empirical context, i.e. the Portuguese plastic injection molds industry. To set the stage, this industry will be introduced in the next section.

3. Empirical context: the Portuguese plastic injection molds industry

Plastic parts are ubiquitous in day-to-day life. They are made by injection processes using molds, with each new variety of plastic good requiring a new custom mold to be designed and constructed. Technological requirements for molds have become increasingly demanding over time. Present-day precision molds are characterized by extremely small tolerances; their production uses a variety of different materials as well as sophisticated optical and information technologies (Henriques, 2008). Producing a complex precision mold may require several months (Silva, 1996; Sopas, 2001).

Portugal is one of the world's centers of the molds industry. The Portuguese molds 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 1160 km^2

[2] The number of early employees obviously cannot be considered as exogenously given, because 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 a superior performance of entrepreneurial firms.

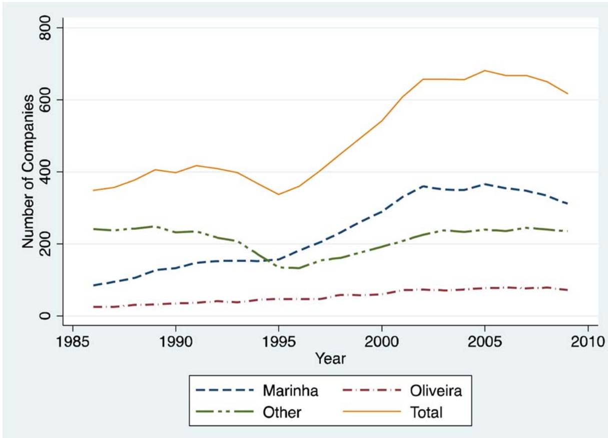

Fig. 1. Evolution of the Number of Companies by Region.

and also has a co-located plastics industry (Costa, 2013) (Oliveira: 8% of all companies and 161 km^2). 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 injection 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 in Marinha Grande was organized in 1946. It had its roots in a workshop manufacturing molds for the regional glass industry, and, as a center of networking, training of employees, and organizational innovation, was an important driver of the industry's subsequent evolution. Worker training and specialization also provided the foundation for a powerful 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).

The Portuguese plastic injection molds industry is considered to be technologically advanced and innovative. Export activities have been documented since 1954. Over time, the share of exports increased until almost the entire production was sold internationally (Gomes, 2005). Parallel to the rise in exports, the number of new entrants into the industry soared. In the second half of the 1990s, the industry experienced a large increase in the number of firms (cf. Fig. 1), which was driven by a growth of the external demand from the EU countries and the penetration of the automotive market. 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 de Azeméis cluster concentrates on the market segment of larger molds. With 21 versus 11 employees on average, Oliveira de Azemeís firms also tend to be larger than Marinha Grande firms.

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',[3] a total of 1066 observations. Most of these firms are small (mean size across the industry is 17.4 employees in this period).

Table 1a
Employee Mobility within the Molds Industry and Across Industries.

		Molds Workers	Non-molds Workers
Marinha	Local Share	98%	72%
	Non-local Share	2%	28%
Oliveira	Local Share	97%	44%
	Non-local Share	3%	56%
Other	Local Share	40%	47%
	Non-local Share	60%	53%

Spin-offs are identified as follows. We look at the backgrounds of the new entrants' founder(s)[4] and classify a firm as a spin-off if at least one founder had worked in a molds company in the previous five years. The five-year cutoff is chosen to allow for employment spells outside the focal industry immediately before entering with a spin-off. At the same time, it is plausible that relevant knowledge and social capital of prospective spin-off founders decays over time. In total, 39% of the 627 entrants for which background information could be attained[5] are spin-offs, which attests to the relevance of this type of entrepreneurial venture in the Portuguese molds industry. 79% of the spin-off founders in our sample enter in the first or second year after they were last observed as employees in the 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 1986–2009 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 eight years prior to her 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.[6] While long-term survival admittedly is a crude proxy for 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 4867 third-year employees of entrants into the molds industry, 1978 (41%) have prior molds industry experience, and 1639 (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. Moreover, Table 1a shows that firms inside the clusters hire more local workers, in particular among those with industry experience, than firms located elsewhere. Spin-offs are more likely to hire from within the molds industry (Table 1b).

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; i.e. including both entrants and incumbent firms) as nodes in the industry network. Two individual firms are linked by an (undirected) tie whenever there was at least one mobility event involving a job move from one of the

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

[4] Individuals denoted as 'employer' in the data are considered to be founders.

[5] The omitted entrants without background information mostly reflect corporate divestitures or short-term survivors.

[6] We also assessed the quality (proxied by longevity) of the parents of spin-offs but decided to remove it from our analysis because it was highly collinear with the spin-off dummy. Parent firm size as an alternative proxy of spin-off quality turned out to be non-predictive and is therefore not included in the subsequent empirical analysis. This is not surprising, considering that molds firms tend to be small due to weak economies of scale. Results of model specifications including this variable are very similar to those reported below. They are available from the authors.

Table 1b
Employee Mobility: Spin-offs vs Other Entrants.

		Spinoffs		Non-spinoffs	
		Molds Workers	Non-molds Workers	Molds Workers	Non-molds Workers
Marinha	Overall share	61%	39%	47%	53%
	of which local	97%	73%	99%	71%
	of which non-local	3%	27%	1%	29%
Oliveira	Overall share	54%	46%	49%	51%
	of which local	91%	63%	98%	39%
	of which non-local	9%	38%	2%	61%
Other	Overall share	37%	63%	17%	83%
	of which local	53%	50%	31%	46%
	of which non-local	47%	50%	69%	54%
Total		54%	46%	34%	66%

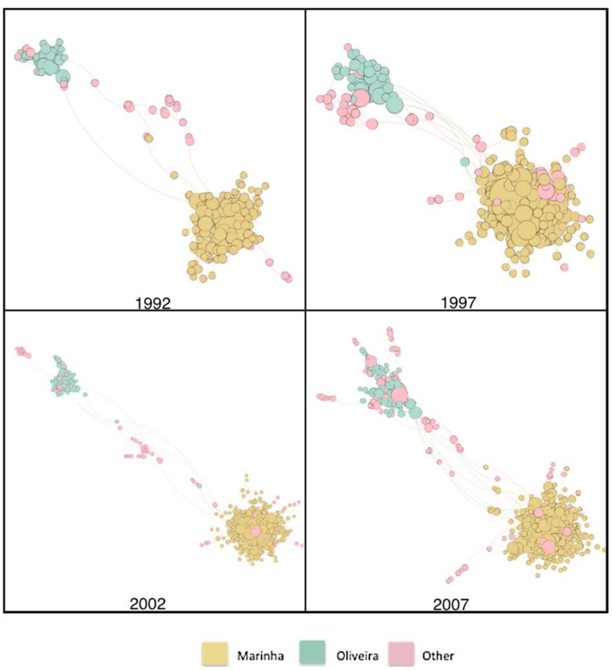

Fig. 2. Labor Mobility Network.

firms to the other in the prior five years. As we are interested in the existence of communication channels between the two firms based on 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. Fig. 2 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. This is consistent with the large extent to which firms in the clusters rely on their local labor markets, as shown in Tables 1a and 1b.

Reflecting the strongly localized nature of industry networks indicated in Fig. 2, we also constructed regional industry networks for the Marinha Grande and Oliveira de Azeméis clusters. We focus on the positions of firms in these regional networks in our econometric analysis.[7] Specifically, we adopt betweenness centrality and eigenvector

[7] Very similar results were obtained when the position in the unified industry network across all firm locations was alternatively employed to measure the embeddedness of entrants.

Table 2
Descriptive Statistics.

	Obs.	Mean	Std. Dev.	Min	Max
Marinha	627	0.43221	0.49578	0	1
Oliveira	627	0.10207	0.30299	0	1
Spin-offs	627	0.39075	0.48831	0	1
Molds workers	627	3.15471	9.13198	0	164
Non-molds workers	627	4.60766	10.75218	0	196
BC Marinha	627	0.00007	0.00058	0	0.00912
BC Oliveira	627	0.00034	0.00407	0	0.07028
EC Marinha	627	0.03466	0.08916	0	0.75053
EC Oliveira	627	0.02666	0.10187	0	1
Workers L-L firms	627	0.43700	0.49641	0	1

centrality as (alternative) measures of how embedded an individual firm is in the regional industry network.

Betweenness centrality 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). Betweenness centrality is a useful measure of embeddedness in the industry network on theoretical grounds, as it accounts for the ease with which potentially sensitive information can be acquired by a firm based on the 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 of its 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.).

Eigenvector centrality is adopted as an alternative measure of regional 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 connections' 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 all these contacts are relatively isolated in the network.

We calculate both centrality measures based on firms' network positions in their second post-entry year. Accordingly, these measures reflect the links of entrepreneurs as well as those established through the mobility of early employees. Spin-offs are advantaged in the construction of the centrality measure since they tend to be linked to their founders' prior employers (unless these have exited or are located in a different region). This advantage is reflected in our data, as the average betweenness centrality of spin-offs is four to five times higher than that of non-spin-offs (0.0004881 vs 0.0001068), and the average eigenvector centrality of spin-offs is about 10% higher (0.080 vs 0.073).

Table 3
Correlations.

	Marinha	Oliveira	Spin-offs	Molds Workers	Non-molds workers	BC Marinha	BC Oliveira	EC Marinha	EC Oliveira	Workers L-L firms
Marinha	1									
Oliveira	−0.294***	1								
Spin-offs	0.278***	0.065	1							
Molds workers	0.045	0.214***	0.035	1						
Non-molds workers	−0.125**	0.134***	−0.113**	0.293***	1					
BC Marinha	0.126**	−0.019	−0.001	0.089*	0.006	1				
BC Oliveira	−0.035	0.185***	0.024	0.191***	0.063	0.013	1			
EC Marinha	0.388***	−0.131***	0.198***	0.257***	0.044	0.400***	0.060	1		
EC Oliveira	−0.058	0.355***	0.055	0.265***	0.073	0.172***	0.518***	0.084*	1	
Workers L-L firms	0.296***	0.128**	0.204***	0.370***	0.112**	0.116**	0.095*	0.337***	0.241***	1

*** $p < .01$.
** $p < .05$.
* $p < .1$.

Centrality measures are set to zero for firms located outside the clusters or if no labor flows from or to other cluster firms are observed (possibly reflecting poor reporting of marginal firms).

Both the information about early-hires and the measures of centrality in the regional networks 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. Exits are observed for about 44% of all entrants in the dataset. They reflect "real" exits due to the closure of the respective firm. There are a small number of cases where firm identifiers changed in the dataset but the majority of workers remained employed and the location did not change. These are interpreted as continuing firms in the hazard rate analysis. Our focus on entrants' early-year employees in constructing our variables reflects the intention to balance data availability and potential endogeneity problems. An alternative approach would be to regularly update 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 would be blurred. 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. Table 2 shows descriptive statistics for our sample, and in Table 3 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.

5. Results

5.1. Main results

Table 4 reports the results of the first set of Cox regressions estimating the hazard of exiting from the Portuguese plastic injection molds industry. The baseline specification (Model 1) only includes dummy variables 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 Portuguese plastic injection 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.[8] 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, which supports 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 spin-offs among the cluster firms. While this finding is consistent with Hypothesis 1b, spin-off background alone is not sufficient to account for the superior performance of firms located in the Marinha Grande and Oliveira de Azeméis clusters.[9]

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 firm 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 larger 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. Including the information about early-hires in the model reduces the estimated spin-off effect, albeit by less than 10%, suggesting that access to better earlier employees contributes modestly to the superior performance of spin-offs. 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.

Model 4 further includes measures of entrants' embeddedness in the regional industry networks. 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;

[8] These numbers are based on the hazard ratios corresponding to the coefficients reported in Tables 1a and 1b, which are obtained by taking the exponential of the coefficient estimate. Hazard ratios indicate the relative change in the hazard associated with a unit change in the respective variable. They provide the most straightforward way of interpreting results from a Cox regression. Note that meaningful marginal effects cannot be estimated for Cox regressions because the duration-dependent baseline hazard is not specified (Buis, 2012).

[9] As noted above, prior work finds that spin-off performance is associated with the quality of parent firms, and some of the agglomeration effects suggested by our findings may, in fact, reflect differences in spin-off quality. Our ability to control for parent quality is limited by the nature of the data we use. Parent firm size or longevity turned out to be non-predictive. Including them in the model specification leaves the results for other variables virtually unchanged.

Table 4
Cox-Proportional Hazards (Full Sample) (coefficients).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Marinha	−0.418***	−0.305**	−0.200	−0.213	−0.180	−0.154	−0.127
	(0.128)	(0.133)	(0.137)	(0.138)	(0.142)	(0.141)	(0.144)
Oliveira	−0.540**	−0.429*	−0.241	−0.253	−0.246	−0.184	−0.199
	(0.228)	(0.231)	(0.234)	(0.238)	(0.256)	(0.240)	(0.256)
Spin-off		−0.411***	−0.376***	−0.368***	−0.369***	−0.341**	−0.346**
		(0.139)	(0.141)	(0.142)	(0.142)	(0.143)	(0.143)
Number of molds workers hired			−0.060***	−0.062***	−0.056**	−0.038*	−0.035
			(0.020)	(0.020)	(0.022)	(0.020)	(0.021)
Number of non-molds workers hired			0.003	0.003	0.003	0.004	0.004
			(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Betweenness Centrality in Marinha				95.837		111.955	
				(98.510)		(98.206)	
Betweenness Centrality in Oliveira				5.626		6.541	
				(20.243)		(19.938)	
Eigenvector Centrality in Marinha					−0.504		−0.347
					(0.996)		(0.988)
Eigenvector Centrality in Oliveira					−0.061		0.123
					(0.822)		(0.808)
Workers from long--lived molds firms						−0.342**	−0.327**
						(0.165)	(0.166)
Observations	627	627	627	627	627	627	627
Time at risk	6473	6473	6473	6473	6473	6473	6473
Number of failures	275	275	275	275	275	275	275
Log-likelihood	−1624.961	−1620.417	−1613.326	−1612.902	−1613.190	−1610.745	−1611.234
p-value	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Harrell's C	0.571	0.599	0.620	0.620	0.621	0.618	0.627
Somers' D	0.141	0.199	0.239	0.240	0.241	0.257	0.254

Standard errors in parentheses.
*** $p < .01$.
** $p < .05$.
* $p < .1$.

see above), so are their standard errors, and neither of the coefficients is anywhere close to being statistically significant. Counter to the above 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 Hypothesis 3a.[10] The same holds for Model 5, which employs eigenvector centrality instead of betweenness centrality to account for a firm's position in the regional industry network. Coefficient estimates for centrality in the Marinha Grande and Oliveira de Azeméis networks are both negative, but far from attaining statistical significance at conventional levels.[11] 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.

To better account for the quality of the capabilities brought in by workers, we finally include in the hazard model a proxy for the quality of early-hires (Models 6 and 7). This is a dummy variable denoting entrants who hired one or more employees from a firm that (eventually) survived for at least seven years. This admittedly crude proxy suggests that employee quality is systematically related to firm longevity. In both models, the coefficient estimate is statistically significant at the 0.05 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. This may suggest that part of the advantage of being located in the clusters is explained by easier access to better workers.

Harrell's C and Somers' D statistics (Newson, 2010) were computed to compare the goodness of fit among the models.[12] We find that the ability of our models to predict survivors in pairwise comparisons substantially increases when information about pre-entry experience and early-hires (including the quality of their prior employers) is taken into consideration. In contrast, when adding our embeddedness measures to the model specification, the increase in either value is very small (Models 4 and 5 in comparison to Model 3).

Above we conjectured that embodied knowledge flows through the hiring of employees from within the industry (Hypothesis 2b) and embeddedness in the regional industry network (Hypothesis 3b) help explain why spin-offs perform better than other *de novo* entrants. To further test this prediction, we split the sample and estimate the above models separately for both types of entrants. Results are reported in Table 5 (Models 4a–7a refer to spin-offs, whereas Models 4b–7b refer to other *de novo* entrants).[13] It indeed appears as if spin-offs were able to benefit more from early-hires than other startups. The coefficient estimated in Model 4a implies that each additional worker from the molds industry reduces the exit hazard of spin-offs by more than 11%, which

[10] This result is very robust to changes in the model specification and in the measurement of embeddedness. No significant coefficient of the betweenness centrality measure was obtained in a model without any other explanatory variables or in various other specifications. 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. When betweenness centrality was measured for the third post-entry year (see above), its 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.

[11] That coefficient estimates are much smaller than for betweenness centrality reflects generally much higher values of eigenvector centrality.

[12] Note also that while the overall predictive power of our models is modest, Somers' D is always positive and obtains a maximum of 0.254 in Model 7. Accordingly, when two observations are compared and one of them survives the other, the survivor is 25% more likely to have the lower predicted hazard in Model 7. Values of Harrell's C are consistently above 0.5 and reach 0.627 in Model 7, implying that the probability of the survivor having the lower exit hazard (plus half the probability of equality in hazards) is about 63% (Newson, 2010).

[13] Due to small numbers of observations in the spin-off sample, a coefficient for betweenness centrality in the Oliveira cluster could not be estimated. This variable is therefore omitted in Models 4a and 6a.

Table 5
Cox-Proportional Hazards (Spin-offs vs Non-Spin-offs) (coefficients).

VARIABLES	Only Spin-offs				Only Non-Spin-off Entrants			
	(4a)	(5a)	(6a)	(7a)	(4b)	(5b)	(6b)	(7b)
Marinha	0.194	0.254	0.202	0.275	−0.464***	−0.406**	−0.373**	−0.344*
	(0.273)	(0.290)	(0.275)	(0.293)	(0.175)	(0.179)	(0.180)	(0.183)
Oliveira	−0.823	−1.048**	−0.816	−1.030*	0.027	0.142	0.141	0.208
	(0.508)	(0.531)	(0.509)	(0.531)	(0.274)	(0.284)	(0.280)	(0.288)
Number of molds workers hired	−0.120***	−0.125**	−0.113**	−0.111*	−0.042**	−0.030	−0.025	−0.019
	(0.044)	(0.050)	(0.052)	(0.057)	(0.020)	(0.020)	(0.018)	(0.018)
Number of non-molds workers hired	−0.003	−0.005	−0.002	−0.002	0.002	0.002	0.002	0.002
	(0.031)	(0.033)	(0.031)	(0.033)	(0.006)	(0.005)	(0.005)	(0.005)
Betweenness Centrality in Marinha	402.549**		392.060*		59.206		86.621	
	(199.997)		(204.433)		(126.176)		(124.625)	
Betweenness Centrality in Oliveira					4.814		5.205	
					(18.672)		(18.442)	
Eigenvector Centrality in Marinha		0.328		0.293		−1.514		−1.032
		(1.396)		(1.397)		(1.672)		(1.637)
Eigenvector Centrality in Oliveira		1.928		1.944		−1.087		−0.831
		(1.206)		(1.197)		(1.087)		(1.059)
Workers from long--lived molds firms			−0.070	−0.149			−0.377*	−0.307
			(0.295)	(0.298)			(0.200)	(0.203)
Observations	245	245	245	245	382	382	382	382
Time at risk	2546	2546	2546	2546	3927	3927	3927	3927
Number of failures	79	79	79	79	196	196	196	196
Log-likelihood	−380.337	−380.561	−380.309	−380.435	−1059.046	−1058.047	−1057.241	−1056.868
p-value	0.001	0.003	0.002	0.005	0.003	0.003	0.001	0.002
Harrell's C	0.639	0.639	0.641	0.640	0.590	0.596	0.599	0.601
Somers' D	0.279	0.278	0.282	0.281	0.180	0.191	0.199	0.202

Standard errors in parentheses.
*** p < .01.
** p < .05.
* p < .1.

compares to about 4% for non-spin-off entrants in Model 4b. Note also that for spin-offs the coefficient remains sizeable and significant in Models 5a to 7a, whereas for non-spin-offs the variable loses its significance in Models 5b to 7b. These differences are consistent with the prediction of Hypothesis 2b, but we cannot rule out that they are non-systematic.[14] Network embeddedness is not associated with a significant reduction of the exit hazard for either type of entrant. If anything, the results of the models with separate samples might be taken to indicate that spin-offs have less to gain from embeddedness than other *de novo* entrants. Models 4a and 6a even suggest a significant reduction in longevity for spin-offs with high levels of betweenness centrality. In any case, our results do not provide support to Hypothesis 3b.[15]

Comparing the results of Models 4a–7a and Models 4b–7b also suggests differences in how important agglomeration is for the different types of entrants into the Portuguese plastic injection molds industry. Specifically, within the group of spin-offs, we do not find a significant difference in exit hazards between those located in the Marinha Grande cluster and those located outside the clusters, whereas Models 5a and 7a suggest that spin-offs located in the (smaller) Oliveira de Azeméis cluster performed particularly well. In contrast, among the non-spin-offs we obtain a substantial and consistently significant reduction in the exit for entrants that locate in the geographic center of the industry (Marinha Grande). These patterns do not suggest that, controlling for differences in early-hires and regional embeddedness, spin-offs are generally better able to benefit from agglomeration. If anything, the opposite seems to hold. For firms whose founders are not industry insiders, locating in the center of the industry may be helpful to overcome their disadvantage.

5.2. Robustness checks

In this subsection, we explore the robustness of the above results when the sample of firms or the measures of embodied knowledge are modified. First, as noted above, we so far assumed a centrality value of zero for all 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 4c to 7c in Table 6. 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 4c and 5c we obtain significant coefficient estimates for Marinha Grande (at the 0.10 level in Model 5c), whereas both cluster dummies remain insignificant in Models 6c and 7c. Otherwise, except for Model 7c, 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 6c: from long-lived firms only) are associated with longer survival in the industry, but embeddedness in the regional industry network is not.

As a second check, we replace the count variable measuring the number of early-hires from within the molds industry by a dummy variable indicating all entrants that employ at least one worker with industry experience. To control for firm size effects on longevity, we also include the total number of employees in the specification. In Table 7, we report results for this modified specification, focusing on the models corresponding to Models 4–7 in Table 4 (as well as 4c to 7c in Table 6) above.

This second robustness check provides further support to our earlier

[14] We directly tested for significant differences in how early-hires from the molds industry are related to the longevity of spin-offs vs non-spin-offs by estimating variants of Models 3–7 that include an additional interaction term (spin-offs*number of molds workers hired). The coefficients estimated for this interaction term are negative and sizeable throughout, but not significant at conventional levels. Detailed results are available from the authors.

[15] Interaction terms to estimate differences in how spin-offs and other entrants are affected by regional embeddedness (cf. previous footnote) did not yield statistically significant results.

Table 6
Cox-Proportional Hazards (Restricted Sample) (coefficients).

VARIABLES	(4c)	(5c)	(6c)	(7c)
Marinha	−0.312**	−0.273*	−0.245	−0.212
	(0.152)	(0.158)	(0.157)	(0.162)
Oliveira	−0.413	−0.420	−0.322	−0.349
	(0.273)	(0.297)	(0.278)	(0.300)
Spin-off	−0.323**	−0.331**	−0.306**	−0.315**
	(0.148)	(0.148)	(0.149)	(0.149)
Number of molds workers hired	−0.051**	−0.046**	−0.032	−0.029
	(0.021)	(0.023)	(0.021)	(0.022)
Number of non-molds workers hired	−0.012	−0.012	−0.011	−0.011
	(0.011)	(0.011)	(0.011)	(0.011)
Betweenness Centrality in Marinha	98.612		110.603	
	(98.734)		(98.582)	
Betweenness Centrality in Oliveira	7.864		8.045	
	(20.163)		(19.938)	
Eigenvector Centrality in Marinha		−0.435		−0.313
		(1.006)		(1.001)
Eigenvector Centrality in Oliveira		0.100		0.226
		(0.839)		(0.827)
Workers from long--lived molds firms			−0.293*	−0.282
			(0.173)	(0.174)
Observations	579	579	579	579
Time at risk	6073	6073	6073	6073
Number of failures	253	253	253	253
Log-likelihood	−1464.873	−1465.248	−1463.435	−1463.924
p-value	0.000	0.000	0.000	0.000
Harrell's C	0.629	0.629	0.637	0.635
Somers' D	0.259	0.258	0.274	0.270

Standard errors in parentheses.
***p < .01.
** p < .05.
* p < .1.

findings. The coefficient of the dummy variable indicating firms with industry-experienced employees is significantly negative in all models that do not control for the quality of their prior employers (Models 4d, 5d, 4e and 5e). With these controls, the coefficient is reduced and no longer significantly different from zero. Larger firm size is associated with lower hazards in the models estimated for the restricted sample. Signs, sizes, and significance of the coefficients for all other variables are very similar to those reported above.

6. Concluding remarks

The role of spin-off entrepreneurship in the evolution of regional industry agglomerations 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 located in the same clusters, that showed outstanding performance. 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, possibly based on their stronger embeddedness within the regional industry network.

To shed further light on this issue, in the present paper we studied 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 plastic molds industry has characteristics of "Italian-style" industrial districts. It is highly concentrated

Table 7
Cox-Proportional Hazards with Molds Worker Dummy (coefficients).

VARIABLES	Full Sample				Restricted Sample			
	(4d)	(5d)	(6d)	(7d)	(4e)	(5e)	(6e)	(7e)
Marinha	−0.203	−0.154	−0.185	−0.142	−0.269*	−0.224	−0.266*	−0.222
	(0.140)	(0.144)	(0.141)	(0.144)	(0.153)	(0.160)	(0.155)	(0.161)
Oliveira	−0.255	−0.259	−0.228	−0.240	−0.364	−0.383	−0.359	−0.382
	(0.239)	(0.254)	(0.241)	(0.255)	(0.274)	(0.295)	(0.277)	(0.298)
Spin-off	−0.356**	−0.344**	−0.352**	−0.342**	−0.309**	−0.313**	−0.308**	−0.313**
	(0.143)	(0.144)	(0.143)	(0.144)	(0.149)	(0.149)	(0.149)	(0.149)
Number of workers hired	−0.005	−0.003	−0.004	−0.003	−0.017**	−0.016*	−0.017**	−0.016*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.008)	(0.009)	(0.009)	(0.009)
Workers from molds firms (0/1)	−0.445***	−0.401***	−0.244	−0.240	−0.363**	−0.342**	−0.335	−0.330
	(0.142)	(0.144)	(0.262)	(0.262)	(0.151)	(0.152)	(0.280)	(0.280)
Betweenness Centrality in Marinha	106.333		109.093		111.227		111.546	
	(97.624)		(97.802)		(97.916)		(97.977)	
Betweenness Centrality in Oliveira	−1.995		−1.858		6.049		6.058	
	(19.318)		(19.231)		(19.745)		(19.735)	
Eigenvector Centrality in Marinha		−0.879		−0.794		−0.487		−0.482
		(0.952)		(0.956)		(0.975)		(0.980)
Eigenvector Centrality in Oliveira		−0.203		−0.157		0.151		0.154
		(0.766)		(0.766)		(0.810)		(0.812)
Workers from long--lived molds firms			−0.251	−0.205			−0.035	−0.016
			(0.282)	(0.285)			(0.302)	(0.304)
Observations	627	627	627	627	579	579	579	579
Time at risk	6473	6473	6473	6473	6073	6073	6073	6073
Number of failures	275	275	275	275	253	253	253	253
Log-likelihood	−1612.913	−1612.886	−1612.537	−1612.639	−1462.985	−1463.397	−1462.978	−1463.395
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Harrell's C	0.637	0.634	0.637	0.634	0.640	0.637	0.640	0.637
Somers' D	0.275	0.267	0.274	0.267	0.281	0.274	0.280	0.274

Standard errors in parentheses.
*** p < .01.
** p < .05.
* p < .1.

geographically, with about half of all producers located in one of two small regions that do not have any inherent 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 plastic injection molds industry focused on two potentially powerful aspects of firm performance, both of which have been suggested before as contributing to the superior performance of spin-offs: embodied knowledge flows caused by intra-industry labor mobility and firms' centrality in regional industry networks. 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 either of the two clusters were also significantly more long-lived, with spin-off background alone not fully accounting for the differences in survival. 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, 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 did not obtain evidence pointing to the competitive relevance of the strength of entrants‘ embeddedness in the regional industry network.

We interpret these findings as providing further support to the "heritage theory" of industrial agglomeration proposed by the late Steven Klepper and his collaborators. They also corroborate earlier results indicating that spin-offs benefit from hiring employees with industry experience. However, at least in our empirical context, there seems to be more to the performance of spin-offs than only their access to an experienced workforce, and it is not clear whether spin-offs are inherently superior to other *de novo* entrants in their ability to attract capable workers from within the industry.

In light of the importance that geographers generally attach to localized social networks in accounting for regional agglomeration, the above results are somewhat surprising. One possibility is that other types of social ties matter more than those that we could analyze. 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), it does not capture potentially 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). Another possibility is that access to the capabilities of superior employees is the primary channel through which social ties operate. In this case, the notion of regional embeddedness would lose most of its explanatory power, as employee mobility would then be sufficient to account for its effects. At the same time, knowing whom to hire is not enough to actually benefit from hiring. Superior capabilities are required to benefit from superior employees, and to convince them to join the fledgling firm in the first place. Benefitting from early-hires can therefore not be reduced to the effect of social ties.

The findings of our empirical analysis were pronounced and robust to various modifications in our empirical approach. We nonetheless hasten to add that the above results cannot be considered as conclusive and that substantial further work is required to corroborate them in other empirical contexts. Our analysis only covered 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. 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. Additional research exploring the importance of other types of network membership and network position than we could study, and how these relate to spin-off performance, would also be welcome. Beyond our specific research interest and empirical context, we also conclude that linked employer-employee data, which become increasingly available but so far have found little use in industry-level studies, may find fruitful application in future research endeavors.

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