

# **Network Embeddedness and the Survival of Start-ups - A census study of Swedish companies founded in 2007**

**Peter Dahlin**<sup>1</sup>

peter@pdahlin.com

**Ossi Pesämaa**<sup>2</sup>

opesamaa@hanken.fi

**Christina Öberg**<sup>3</sup>

christina.oberg@iml.lth.se

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## **ABSTRACT**

This paper examines the relation between start-up companies' embeddedness at an early stage, addressed through their actor bonds of board interlocks, and their long-term survival. This is based on the idea that the network is important for a company's business and development. For a newly-established company, a start-up, links to other companies may be limited. Board members' connections to other firms expect to help in the establishment of business relationships and hence contribute to business survival. Based on a census analysis of all Swedish limited companies established in 2007 and their board connections to all other Swedish companies, the paper concludes that embeddedness, as opposed to isolation, does have a positive effect on survival. Structural embeddedness, in both local and global scope, is positively related to survival, but the individual effects of different network measures are inconsistent. Being on an industrial market mediates the effect from global embeddedness. Contributions are made to previous research through highlighting links between actor bonds and performance of firms. To the IMP-sphere, this link is important not the least as an argument for long-term business arrangements.

**Keywords:** Board; Embeddedness; Network; Performance; Regression analysis; Survival.

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<sup>1</sup> *Mälardalen University, Sweden*

<sup>2</sup> *Hanken School of Economics, Finland and Blekinge Institute of Technology, Sweden*

<sup>3</sup> *Lund University, Sweden*

## INTRODUCTION

In a very simplified view, a successful start-up is one that survives the first few years. Whereas starting a company is a creative but also an administrative and bureaucratic process, establishing a business is another type of venture. Gaining access to resources, technology and competence are some of the crucial factors for successfully establishing the company; getting customers is another (La Rocca, Ford, & Snehota, 2013). Securing access to necessary supplies and being involved in promising partnerships sets focus on inter-organizational relationships (Gulati & Gargiulo, 1999). Depending on the characteristics of the market, the successful establishment of a business implies formation of business relationships (typically B2B-markets) or capturing market shares (typically consumer markets). Much of the challenge for a newly started company is thus the initiation of interaction with other companies, which is a multifaceted process (Dwyer, Schurr, & Oh, 1987; Håkansson & Snehota, 1995). Opportunities for developing business relationships often emanates from the current structure of relations (Ghauri, Hadjikhani, & Johanson, 2005; Gulati & Gargiulo, 1999), which implies a dilemma for startups that are not yet embedded in a network of inter-organizational relations.

In the early stage of a company's development, the need to establish relations with other companies may be hindered by its isolation, i.e. the absence of opportunities from its current network. An enabling factor in this dilemma could be the embeddedness in established business structures through the board members of the start-up. In the development and execution of a company's business plans, its board of directors contributes with administrative and strategic skills, knowledge, experience and visions. As many board members are involved in several companies they act as actor bonds to other firms and thereby to critical external resources and information (Burt, 1992; Clarysse, Knockaert, & Lockett, 2007; Pfeffer, 1972); not the least a crucial factor for start-up companies that initially lack ties to other companies. The actor bonds form a network of board interlocks and reflects one dimension of a company's embeddedness in the business context (Borgatti & Foster, 2003). Selection and recruitment of members to the board is thus an important strategic factor which a newly started company (to a large extent) can influence (Feld & Ramsinghani, 2014; Mizruchi, 1996).

*This paper examines the relation between start-up companies' embeddedness at an early stage, addressed through their actor bonds of board interlocks, and their long-term survival.*

The paper contributes to previous research through highlighting that link, where previous studies have predominately turned to described structures or characteristics of networks, or their connection to certain activities of the firm (e.g. Haunschild, 1993). Outcomes are predominately described as how long-term business arrangements or social relation contacts raises quality and adjustability, while rarely expressed as effects on economic outcome or survival. To the IMP-sphere, this link is important not the least as an argument for long-term business arrangements. The paper also integrates the IMP-perspective with social network ideas in its link between business performances and interlock networks.

The rest of the paper is structured as follows: After this introduction, two main building blocks for the paper are described; the embeddedness of businesses, and board members and their inter-organizational links. We go on by developing hypotheses to capture the link between start-ups' board interlocks and their survival, after which the method is presented. The paper is based on a census analysis of all Swedish limited companies established in 2007 and their survival five years later. The result section presents the findings of the hypotheses. The paper ends with discussing the findings and ideas for further research.

## **STRUCTURAL EMBEDDEDNESS OF COMPANIES**

The embeddedness of firms could be seen as how businesses are encapsulated in structures of social relations, as described in Granovetter's (1985) seminal work on the issue; or as how a company develops long-term relationships to other firms and become dependent on them based on business integration and resource provision. The latter viewpoint indicates how firms adjust to each other, while also becoming affected by decisions taken separately by those companies the firm is connected with. The views on embeddedness are complementary in the sense that social relations constitute one dimension of the business ties between firms, varying in importance over time and with business foci. Studies have indicated how collaborations may start from social relations, and how social relations may carry business ties forward in the space between business engagements (Havila & Wilkinson, 2002). The actor bonds of individuals also have shown to be important for the continuity of business relationships (Gedeon, Fearne, & Poole, 2009). Commitment and trust as fundamentals for deeper business relationship engagement rely on individuals' perception of the other firm, its ability to deliver, but also a 'face-representation' of the relationship.

Social relations have been studied as structural, relational and cognitive dimensions of social capital (Nahapiet & Ghoshal, 1998). Structure can be understood as interactions and their 'location' (central/peripheral) in the network. Relational aspects describe the 'assets' of the exchange, including trust. The cognitive dimension includes meaning, shared understandings and goals (Tsai & Ghoshal, 1998). The structural dimension hence points to how a party (referred to as a node in the network) may be a more or less central player. With the conceptualization of networks as indefinite, such centrality could not be described as an absolute position, but requires measurements of number of links to others ('degree') and/or criticality of sustained links (see further below).

The link between networks and performance has predominately been studied as a non-monetary one; pointing to knowledge transfer and learning (e.g. Larson, 1992) as raising quality of output. Monetary arguments are for the most part linked to explanations for repeated exchanges (Williamson, 1979) and how embeddedness may shift the ontological view on economic return from maximization to satisfaction. Discussions are also that social relations offset claims on economic return either as immediate self-interests behaviors, or as outcome becomes long-term focused or risk-reductive. Uzzi (1997) investigated the link between structural embeddedness and performance. His conclusions indicate positive and negative economic outcomes, also pointing to how effects are different on the firm and

network level. Positive outcomes include allocative efficiency, economies of time, complex adaptation, and Pareto improvements, hence forwarding arguments that in turn could be used to explain the existence of long-term relationships and their features. Negative outcomes point to how risks may rise as the consequence of dependence, and how longevity may decrease informational flows beyond constituted networks.

## **BOARD NETWORKS**

The board of directors, including the executive officers, is responsible for the survival and success of the company, but it can have different roles in a company. Besides the legal and formal responsibilities, the board is often involved in forming or controlling the company's strategies. Distinguishing between tasks for the board and tasks for the top management team may not be evident and the set of issues involving the board may differ for each company (Adams, Hermalin, & Weisbach, 2010; Zattoni & Pugliese, 2012). The board members are important resources for the company, contributing with their knowledge and experience, but also with their contacts as well as access to information and resources outside the company (Burt, 1992; Pfeffer, 1972).

Composing the team of directors is also of interest to start-up literature. The board is an extension of the small team involved in a start-up and can have a large impact on the development of a nascent business (Feld & Ramsinghani, 2014). It is quite common for companies founded on seed money to include a representative of the venture capital in the board, which naturally adds experience but can also be a signal of approval by the venture capitalist (Ferrary & Granovetter, 2009). The board's ability to consider a wider range of alternatives is considered a strength, which is seen as a positive effect of diversity in terms of age, background and gender (Edling, Hobdari, Randøy, Stafsudd, & Thomsen, 2012; Smith, Smith, & Verner, 2006). Different companies may need different boards. For example, the internationalization of boards has shown to be associated with the internationalization of the company (Oxelheim, Gregoric, Randoy, & Thomsen, 2013).

Many directors are active in more than one company, and create links between these companies, which is referred to as 'board interlocks' or 'interlocking directorates'. Adding up such links forms a network of overlapping boards of directors, which can be studied with a wide array of research questions concerning, for example, the composition of the board or the company's position in this board network and its impact on the company's development (Borgatti & Foster, 2003; Mizruchi, 1996; Westphal, Seidel, & Stewart, 2001). The board networks of large and publicly listed companies tend to be 'locally' clustered with a short average distance, i.e. most companies are connected by only a few steps, which means that the board network structure is well apt to widely spread information and practices (Davis, Yoo, & Baker, 2003; Kogut, 2012). In larger, more diverse samples, the 'small world' characteristics are less evident (Cohen, Frazzini, & Malloy, 2008; Edling et al., 2012).

Formal board meetings, held a number of times per year, in combination with informal personal interaction are distinct situations where business relevant information is exchanged,

experience is gained and contacts are made. Consequently, inter-organizational links through board members have been found important for the spread of corporate practices and structures (Davis et al., 2003; Haunschild, 1993).

## HYPOTHESES

Following the theoretical review, and pursuing the paper's aim to examine the relation between board network embeddedness and the survival of start-ups, a number of hypotheses can be generated.

A company needs to establish business relationships to customers, suppliers and partners in order to survive. Opportunities for developing business relationships are often found in the current network context, which is an issue for start-up companies, which cannot be expected to have established business relationships from day one. In other words, the embeddedness of a company provides the basis for future embeddedness.

The members of the board are, amongst other things, channels for business relevant information and the company's extended outreach in the business community. As such, the embeddedness through board interlocks should be important in the early phase of start-up companies, when other types of inter-organizational links have not yet been established. This leads to the first hypothesis:

*Hypothesis 1: Being linked to other companies through interlocking directorates has a positive influence on the survival of startups.*

If embeddedness is an influencing factor, variations in the effect should be related to the characteristics of the network structure and the company's position within it. In network analysis, the centrality of a node describes its position within the structure, but a wide variety of centrality measures take aim at different aspects within the concept of centrality (Freeman, 1979). Being central in terms of reach and closeness is different from being central as a gatekeeper or bridge or in terms of prestige or influence. Having links to many nodes is different from having links to the "right" nodes (Bonacich, 2007). Furthermore, some measures focus solely on the node itself, whereas others are descriptions of the structure surrounding the node (Freeman, 1979; Marsden, 2002). From the literature on board networks, its effect is suggested to be based on reach and reputation as well as access to information, which is reflected by different sets of centrality measures (de Nooy, Mrvar, & Batagelj, 2011; Wasserman & Faust, 1994).

A distinction can be made between *local measures*, considering only immediate neighbors of a given node, and *global measures*, considering all nodes structurally linked to a given node (Batagelj, 1996). This puts focus on how wide scope of embeddedness that is relevant to consider, and two hypotheses are aimed at this question.

The reach of a newly started company is quite limited. The direct links to another company carries knowledge about the startup, through the common board members. The second-order

links may also learn about the startup, as the startup's board members spread the word. This means that the network context at a maximum of two steps from the startup should be of particular relevance. The larger this 'local' context is, the more opportunities could appear:

*Hypothesis 2: A higher level of local embeddedness is positively associated with survival.*

In the 'global' scope, being part of a large structure means being part of a larger business context. Having (indirect) links to a large number of companies could mean more openings to connect with suitable business partners. Being part of a larger network context should also imply a greater heterogeneity, and links beyond the immediate and well-known context is suggested to be important to find opportunities (Granovetter, 1985). Consequently:

*Hypothesis 3: A higher level of global embeddedness is positively related to survival.*

The role of inter-organizational relations is expected to differ depending on the type of market the company is targeting. Whereas long-term business relationships has shown to offer a good understanding of business-to-business markets (Håkansson, 1982; Håkansson & Snehota, 1989), other markets might be dominated by discrete transactions (Dwyer et al., 1987). The level of emphasis on interaction can be a matter of perspective, but can also related to different market behavior, for example depending on the number of buyers and sellers on the market (Sheth, Gardner, & Garrett, 1988). It is thus reasonable to assume that embeddedness is more important to companies acting in a context where business relationships are important, such as industrial markets, as opposed to more anonymous mass markets:

*Hypothesis 4: The effect of embeddedness on survival is stronger for companies targeting industrial markets.*

The central concepts, and hypothesized relations, are summarized in Figure 1.

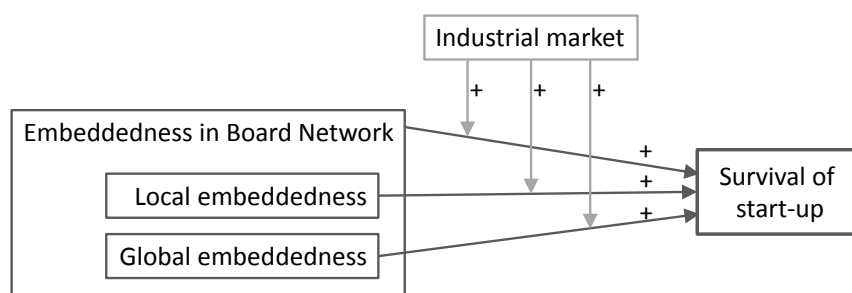


Figure 1 Hypothesized model of embeddedness and survival of start-ups.

## METHOD

The outlined research aim requires the possibility to follow start-ups over time, and obtain different measures at different points of time for these companies. Capturing network embeddedness poses additional challenges to empirical studies. To capture the network structure embedding a company, the dataset must include more than the focal companies.

Network variables are often measured through self-reports of links to other companies. Such ego-net based data collection can capture the local embeddedness, but is not appropriate for global network variables, which require the “whole” network to be analyzed. These requirements have been met by using a dataset containing data for several points in time on all Swedish limited companies (“Aktiebolag”). The dataset is based on information from openly available databases, and originates from the information reported to different government organizations. The complete dataset has been used to address the network dimensions, whereas more specific data on a set of start-ups have been extracted as a kind of panel data (Hsiao, 2003).

Based on the founding date stated in the government registration, 27,559 limited companies were started in Sweden in 2007. These are the start-ups in focus of this paper. For the temporal dimension, this means that the relative start of time ( $t_0$ ) is 2007. The embeddedness is assessed through data on the boards of directors by autumn 2009, i.e. in average about two years after the start of the company ( $t_2$ ). The survival of the company is assessed at the end of 2012 ( $t_5$ ), i.e. after five to six years of business. This timeline is summarized in Figure 2.

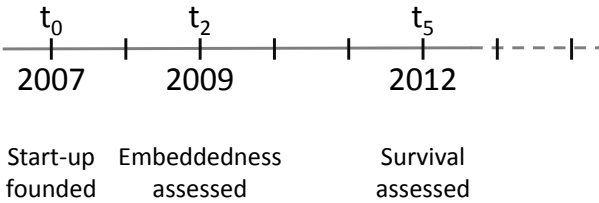


Figure 2 Timeline of the study

Of the original 27,559 start-ups, 1105 ended already 2007 or 2008. For another 293 companies, data on the board members is missing for 2009. This reduces the number of start-ups that are included in the analysis to 26,161. The analysis will be made through binominal logistic regression, as the survival of start-ups is to be predicted through aspects of embeddedness.

**Dependent variable**

The survival of the start-ups is measured as a firm-level dummy variable indicating whether the company *is active* 2012. Not being active (0) includes initiated or completed bankruptcy, liquidation or merger (absorbed by other company) reported during 2012 at the latest. It also includes companies registered as “passive”, i.e. currently not doing business but still remain registered. All others are considered active (1).

**Network embeddedness variables**

The embeddedness at an early stage is addressed through the company’s position in the network of board interlocks during fall 2009, which gives the start-ups around two years to recruit and form the board of directors. This aspect is based on an analysis of the board

members of 343610 active limited companies in Sweden at that time<sup>4</sup>. The 2-mode/association network of companies linked to persons was projected to a 1-mode network consisting of companies linked through common board members.

A wide variety of measures address different aspects of network embeddedness, not least within the concept of centrality (Freeman, 1979), and little guidance was found in previous studies on which to use in relation to board networks and survival of start-ups. In this analysis, twelve different network measures are used, addressing both local and global aspects of embeddedness.

The embeddedness as such, and opposed to isolation, is measured through a dummy variable, *is embedded* that reflects whether if it is linked to any other company, i.e. degree>0. It shows whether the company is isolated (0) or embedded (1) in a board network structure.

The *local embeddedness* is measured through a construct and consists of a number of network measures that reflects the close context of a node in a network. One is *degree*, being the number of other (unique) companies that each company is linked to through one or more common board members. Duplicate links, i.e. multiple common board members are treated as one link. The *weighted degree*, on the other hand, considers multiple links and shows the number of links to other companies. Whereas degree shows how many companies are in the 1-step neighborhood of the company, the *size of 2-step neighborhood* shows how many companies are reachable in two steps, i.e. both “directly” and “indirectly” linked. The *numbers of links* within the 1-step and 2-step neighborhood respectively are both included in the component as indicators of the possible information flow within the local context. The *tendency to cluster* in the 1-step respectively 2-step neighborhood shows how well-connected the local context is in relative terms, and thus resembles the density concept. These clustering coefficients have been set to zero for isolated companies, for which these measures cannot be calculated (division by zero), and the measure includes a compensation effect that considers the increasing difficulty for high clustering as the number of nodes increases. Finally, an *eigenvector centrality* measure reflects the importance of a node, by iteratively letting the centrality of a node being influenced by the centrality of the nodes it is connected to, as being linked to many other companies is different from being linked to the “right” companies (Bonacich, 2007; Kleinberg, 1999).

This set of variables thus represent local embeddedness through the structure at a maximum of two steps out from the focal company. High local embeddedness means direct or indirect links to many other companies, but also that there are many links among those companies, although the focal company must not be peripheral in this structure.

The *global embeddedness* is addressed through three different measures. *Closeness centrality* reflects how close a node is to the other nodes in the network (Sabidussi, 1966; Wasserman & Faust, 1994). *Betweenness centrality* reflects the importance of a node by its potential role as being on the (shortest) path joining other pairs of nodes, which can be important for

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<sup>4</sup> The total number of active companies in the dataset for 2009 was 350,912, but not all had reported information about board members and they were thus not included in the network analysis. The official statistics (Bolagsverket) reports 350,903 companies for 2009.

communication and flows of information (Freeman, 1977; Wasserman & Faust, 1994). The *domain size* is the number of reachable nodes, i.e. the number of other nodes that are part of the same structure. The Swedish board network for year 2009 does not form one coherent structure, so the domain size will vary. Finally, a dummy variable indicating whether a company is part of the *main domain*, i.e. the largest structural component, was derived from the domain size.

Together, these measures implies that a high level of global embeddedness means that a company is part of a large structure, preferably the largest, with many other companies theoretically reachable, but also that it is relatively close and important in relation to all the other companies.

All network measures were calculated with Pajek (de Nooy et al., 2011), with the exception of the size of the 2-step neighborhood which was obtained through a SQL-query. Due to large variations in the scales of the network measures, they have all been standardized to Z-scores.

The theoretically based division of the network measures into local and global embeddedness respectively is largely supported by an exploratory factor analysis, where two relatively distinct components form (see Table 1). The first component, largely representing local embeddedness, has a Cronbach's alfa of 0.986 (8 items) and the second component, corresponding to global embeddedness, has a Cronbach's alfa of 0.732 (3 items). The dummy variable indicating inclusion in the main domain is excluded from the factor analysis as it is derived from the variable domain size.

Reducing the network variables to constructs risks eliminating the potentially valuable variations between the measures. Therefore, in addition to using the two constructs in the regression models, the network measures are kept as discrete variables in an exploratory regression analysis. In those parts, stepwise backward removal is used to reduce the number of factors and handle the specification problem of a priori selecting which network measures to include (Hsiao, 2003). This procedure may increase the bias of the resulting model, but reduces variance and gains in interpretability (Hastie, Tibshirani, & Friedman, 2009).

<b>Component</b>	<b>1</b>	<b>2</b>
Degree (weighted)	<b>.996</b>	
Links in 1-neighborhood	<b>.993</b>	
Links in 2-neighborhood	<b>.993</b>	
Clustering 1	<b>.988</b>	
Clustering 2	<b>.988</b>	
Degree	<b>.987</b>	
AuthorityWeight	<b>.877</b>	
Size 2-neighborhood	<b>.783</b>	.421
Closeness		<b>.970</b>
Domain size		<b>.950</b>
Betweenness		<b>.455</b>
Eigenvalue	7.322	2.202
% of Total Variance	66.6	20.0

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Notes: Principal component analysis. Rotation: Varimax with Kaiser Normalization. Factor loadings <0.1 are suppressed.

Table 1 Result of exploratory factor analysis

### **Industrial market**

Whether or not a company targets an industrial market was decided based on the self-stated industry classifications, using the Swedish Standard Industrial Classification system which is based on the European Union's NACE rev.2. These classifications do not primarily represent the types of markets, which means that the distinction of industrial companies is neither perfect nor complete. Two main groups of companies were assumed to target industrial markets: industrial manufacturing companies (classes 10-33) and wholesale (class 46). These are distinguished through the dummy variable *IND*.

### **Control variables**

As described, companies that had gone bankrupt or otherwise disappeared as self-sustaining companies already before 2009 were excluded from the analysis. The hypothesized model assumes that business activities have been started, and that the company makes serious attempts to develop its business. To control for this, two dummy variables were added to the regression models. These indicate whether a report of company assets and turnover respectively exist for 2009. Not having filed the required reports to government authorities (0) is thus used as indicators that the start-up is not actively trying to establish its business.

## **RESULTS**

As mentioned, of the 27,559 Swedish companies that were started in 2007, 1,105 (4.0%) ended already during the first couple of years, 2007-2009. When looking at the status at the end of 2012, a total of 5,529 (20.1%) were out of business. As a comparison, a study by Shepherd and Wiklund (2009), following 68,830 Swedish companies, reports a staggering 44.4% end rate by the first six years. Their study was, however, performed over the turn of the millennia, which was a turbulent period when the number of bankruptcies more than doubled in some sectors (Dahlin, 2007).

This paper addresses the survival of the studied companies between 2009 and 2012, which excluded those already out of business 2009 and some cases where board data for 2009 was missing. The baseline of survival, to which this analysis relates, is therefore given by the 21,967 companies that were still active in 2012, which makes up 84.0% of the analyzed 26,161 companies that were active 2009.

Table 2 shows the tested models to determine start-up survival. Model 0 only contains the control variables, which alone gives a significant reduction of the deviance (-2 log likelihood) and raises the predictive power to 88.8%. Related to H1, model 1 shows that embeddedness,

as opposed to isolation, does have a positive effect on survival, but the improvement of the model is marginal ( $\Delta\chi^2=8$ ,  $p=.004$ ), and the hypothesis is thus partially supported.

Next, the second hypothesis suggests a positive effect from local embeddedness on the survival of start-ups. In model 2, the construct representing local embeddedness is added to the controls. The result is a significantly improved model ( $\Delta\chi^2=158$ ,  $p<.000$ ), and positive effect from local embeddedness ( $\beta=.194$ ,  $p<.000$ ) which supports H2. In further exploration of H2, all the individual network variables related to the local embeddedness were added to the control model. Parameter reduction through stepwise backward removal resulted in model 2b with four factors: degree, weighted degree and the number of links in 1- and 2-neighborhood. The inclusion of these local embeddedness factors significantly improves the model of survival ( $\Delta\chi^2=267$ ,  $p<.000$ ), although the individual effects are inconsistent.

Similarly, we expected global embeddedness to positively impact the odds of survival. First the model 3a, using the aggregated construct, shows a positive effect ( $\beta=.118$ ,  $p<.000$ ) from global embeddedness on the odds of survival. The model is slightly improved ( $\Delta\chi^2=20$ ,  $p<.000$ ), which partially supports hypothesis 3. In the exploratory regression using all four variables, only closeness centrality was dropped after optimization through backward removal, as shown in model 3b. The improvement over model 0 is significant but still relatively small ( $\Delta\chi^2=79$ ,  $p<.000$ ), and similar to model 2b, also this model shows inconsistent effects on survival from the individual measures.

The test for effects from market type (H4) is reported in model 4, a stepwise backward reduced result of a summarizing inclusion of the two embeddedness constructs and their respective interaction with the industrial market dummy, but also an interaction between the local and global constructs. The resulting model is significant ( $\Delta\chi^2=209$ ,  $p<.000$ ) and consists of local embeddedness, the interaction between local and global embeddedness and finally the interaction between industrial market and global embeddedness. Being on an industrial market is a mediator for the positive effect from global embeddedness ( $\beta=.237$ ,  $p=.011$ ), which means that the combined effect from embeddedness is stronger for companies targeting industrial markets, i.e. supporting H4.

As was shown by model 2b and 3b, the nuances in the individual network measures tend to improve the models. Therefore, an explorative analysis included all network variables and backward removal was used to simplify the result to what is shown in model 5a. In this process, a slightly different set of measures became part of the resulting model. The size of the 2-step neighborhood, the 1-step clustering variable and closeness centrality are part of this model, whereas degree, the number of links in 2-step neighborhood and the two domain variables are not. The partial overlap of the measures probably has an effect on this result. Altogether, as the number of factors increases, the bias decreases and this model perform better than the models only reflecting local or global embeddedness ( $\Delta\chi^2=288$ ,  $p<.000$ ). Still, the effects from the individual network measures vary from positive to negative.

To further allow maximum usage of the available data, interaction effects between market type and all twelve network variables were added, resulting in model 5b. After backward

removal, four interactions remained, although the improvement over model 5a was minor ( $\Delta\chi^2=14$ ,  $p<.007$ ). Interaction effects were found on both local and global aspects of embeddedness, but the coefficients indicates variations in directions of the effects.

	Model 0			Model 1			Model 2a			Model 2b			Model 3a			Model 3b			Model 4			Model 5a			Model 5b		
	$\beta$	s.e.	p	$\beta$	s.e.	p	$\beta$	s.e.	p	$\beta$	s.e.	p	$\beta$	s.e.	p	$\beta$	s.e.	p	$\beta$	s.e.	p	$\beta$	s.e.	p	$\beta$	s.e.	p
Constant	-1.719	.065	.000	-1.797	.071	.000	-2.102	.078	.000	-2.102	.078	.000	-2.102	.078	.000	48.450	6.316	.000	-2.061	.077	.000	-2.089	.079	.000	-2.092	.079	.000
<b>Control variables</b>																											
Assets reported	3.233	.073	.000	3.199	.074	.000	3.639	.085	.000	3.639	.085	.000	3.639	.085	.000	3.315	.077	.000	3.568	.083	.000	3.619	.086	.000	3.624	.086	.000
Turnover reported	.864	.042	.000	.901	.044	.000	.861	.043	.000	.861	.043	.000	.861	.043	.000	.902	.043	.000	.890	.042	.000	.874	.044	.000	.874	.044	.000
<b>Embeddedness (dummy)</b>				.128	.044	.004																					
<b>LOCAL EMB (construct)</b>							.194	.016	.000										.215	.016	.000						
Degree										.741	.106	.000															
Degree (weighted)										-1.083	.128	.000										-1.033	.130	.000	-1.073	.136	.000
Size 2-neighborhood																						-.136	.040	.001	-.125	.040	.002
Links in 1-neighborhood										.806	.157	.000										.525	.125	.000	.514	.125	.000
Links in 2-neighborhood										-.260	.129	.043															
Clustering 1																						.809	.126	.000	.856	.135	.000
<b>GLOBAL EMB (construct)</b>													.118	.027	.000												
Betweenness															.080	.034	.020					.136	.039	.000	.141	.039	.000
Closeness																						.074	.024	.002	.057	.025	.021
Domain size															71.879	9.052	.000										
Main domain															-152.851	19.265	.000										
<b>LOCAL EMB * GLOBAL EMB</b>																			.154	.026	.000						
<b>Industrial market</b>																											
IND * GLOBAL EMB																						.237	.093	.011			
IND * Main domain																									.556	.188	.003
IND * Degree weighted																									-6.039	2.200	.006
IND * Clustering 2																									4.553	1.699	.007
IND * AuthorityWeight																									5.253	1.805	.004
<b>Model summary</b>	<b>value</b>	<b>df</b>	<b>p</b>	<b>value</b>	<b>df</b>	<b>p</b>	<b>value</b>	<b>df</b>	<b>p</b>	<b>value</b>	<b>df</b>	<b>p</b>	<b>value</b>	<b>df</b>	<b>p</b>	<b>value</b>	<b>df</b>	<b>p</b>	<b>value</b>	<b>df</b>	<b>p</b>	<b>value</b>	<b>df</b>	<b>p</b>	<b>value</b>	<b>df</b>	<b>p</b>
-2LL	17949			17941			17791			17682			17929			17870			17740			17661			17647		
Nagelkerke pseudo R <sup>2</sup>	.302			.302			.310			.316			.303			.306			.313			.317			.318		
$\chi^2$ of full model	5083	2	.000	5091	3	.000	5241	3	.000	5350	6	.000	5103	3	.000	5162	5	.000	5292	5	.000	5371	8	.000	5385	12	.000
$\chi^2$ of added variables†				8	1	.004	158	1	.000	267	4	.000	20	1	.000	79	3	.000	209	3	.000	288	6	.000	14	4	.007
Classification rate	88.8%			88.8%			88.8%			88.9%			88.8%			88.8%			88.9%			88.9%			88.9%		
N=26161																											
†indicates $\chi^2$ relative to Model 0 except for Model 5b where it is relative to Model 5a																											

Table 2 Tested models of determinants of start-up survival

## DISCUSSION

The results of the analysis shows that embeddedness positively impacts the odds of survival for start-ups, which was in line with the hypotheses derived from extant theory. The current study examines the Swedish start-ups from 2007, and as the dataset was large and close to complete, rather fine-tuned models could add to the explanation of start-up survival. Treating the successful establishment of a business as a binary variable, however, lacks nuances and limits the understanding of the role of embeddedness. Instead, the success of start-ups could potentially be evaluated through a performance measure reflecting the companies' profitability or growth (Shepherd & Wiklund, 2009), enabling a more nuanced model of start-up success.

The inter-organizational relations making up the structural embeddedness were in this study addressed through interlocking directorates, i.e. a formal governance dimension. This is naturally a simplification of the multiplex embeddedness of business companies; different dimensions are likely to interact. Capturing inter-organizational relations in a wider scope is a major challenge for empirical studies, but complementing directorate interlocks with other links should offer a richer representation of companies' embeddedness.

## POST-HOC ANALYSIS

The effects from the individual network variables were inconsistent, some increases the survival odds whereas others decreases them, as shown in models 2b, 3b, 5a and 5b. The effect from degree, i.e. the elementary aspect of local embeddedness addressing the direct links to other companies, is worth looking further into.

The degree measure shows a mean value of 14.5 (median 1), with a range between 0-1,312. As many as 168 of the 26,161 startups have a degree value of over 1,000, i.e. they are linked to over a thousand other companies through their board members. This either means that they have very large boards or, more likely, that there are some individuals that are part of a very large number of company boards. Such extreme values (outliers) can have a large impact when fitting the logistic regression models (Hastie et al., 2009; Rousseeuw & Christmann, 2003).

These companies have very high scores on many of the network variables, not just degree, but comparing this group of companies (degree  $\geq 1000$ ) to the others shows indications of lower business activity. Furthermore, of particular relevance to this study, they have a significantly lower survival rate of 66.7% compared to 84.1% (Pearson  $\chi^2=37.6$ ,  $p<.001$ ).

Due to the nature of this dataset, the extreme values are less likely to be measurement errors, but rather special cases, indicating a very specific phenomena. At a closer look, these appear to be "ready-made companies", or "shelf companies", i.e. companies registered in the sole purpose of being sold and transformed later on, thereby offering a shortcut through the formal procedures. They can be identified through the names (see rules at [bolagsverket.se](http://bolagsverket.se)) but also through the absence of annual reports and business activities (Shepherd & Wiklund, 2009).

As mentioned, they are highly embedded companies that show little business activity and poor performance. In this study, they induce a strong negative effect of embeddedness, which is likely to affect the result of the analysis. In studies of active businesses, this type of latent companies should be excluded if possible.

## CONCLUSIONS

This paper deals with the survival of start-ups, and particularly whether embeddedness in structures of other companies improve the likelihood of survival. All tested models show that considering embeddedness improves the predictability of survival of the studied start-ups. When more nuances of embeddedness are considered, more of the variation in survival can be covered. The overall effect of network embeddedness was positive, although the individual indicators showed inconsistent effects. The interpretation of these results is that a higher level of network embeddedness (through interlocking directorates) at an early stage increases the odds of survival for startups.

The findings give support to the hypothesized positive effect from embeddedness on the survival of start-ups, but the effects are equivocal and need further studies. As have been discussed in the post-hoc analysis, some start-ups are quite extreme from an embeddedness perspective. It is suggested that these are a special type of company that should not be treated as an actively started company. If so, they should be excluded from the 2007 dataset, but on the other hand, such companies started earlier may have been put into business during 2007 and should thus be included in the dataset.

Predicting the survival of start-ups is of great interest to a number of stakeholders, not least investors, banks and business partners. The effects of classification problems is often evaluated through the wrongly classified cases. In this case, false negatives leads to missed business opportunities, whereas the false positives means betting on the wrong horse. 84% of the Swedish start-ups from 2007 that survived the first two years were still active 2012, i.e. five years after they were founded. By using the tested models, which of the companies that will survive or not can be predicted with an 88.9% accuracy. This means that, if model 5b was to be used, 1,526 of the 4,194 failed start-ups would be correctly identified, and the potential benefit from correctly categorizing these can be contrasted with the lost opportunities in the 235 surviving companies wrongly classified as non-survivals.

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