Marburg Geography

Working Papers on
Innovation and Space

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05.15

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Impressum:

Working Papers on Innovation and Space
Philipps-Universität Marburg

Herausgeber:

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Erschienen: 2015

New Firm Survival: The Interdependence between Regional Externalities and Innovativeness

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Abstract:

This paper provides evidence that the effect of agglomeration externalities on survival is moderated by the start-up's innovative behavior. It is shown that localization externalities are prevalent particularly in non-high-tech environments and unfold a positive influence on survival for less innovative companies, while their highly innovative counterparts do not benefit or even suffer from spatial concentration. On the contrary, highly innovative high-tech start-ups benefit from a diverse economic structure which enhances their likelihood for survival by fostering the emergence of beneficial inter-industry spill-overs.

Keywords: Firm survival, Innovation, Externalities

JEL Classifications: D22, L26, O33, R11

1 Introduction

The level of entrepreneurial activity has been and still is a very important topic for policy-makers. Researchers have been focusing on the determinants of the emergence of new firms (e.g. ARMINGTON & ACS, 2002; FRITSCH & FALCK, 2007). While these studies contribute to an explanation of regional variations in entrepreneurship, they have not much to say about the processes, which affect the success of start-ups in the phase after their foundation. In fact, the fail-rate among young firms is very high; around 50% of all new manufacturing plants close down within the first five years, and only 20% survive longer than ten years (MATA & PORTUGAL, 1994; KNAUP, 2005). Hence, "the survival or success of new firms is more essential to a regional economy than merely the presence of a large number of new firms" (SCHUTJENS & WEVER, 2000: 136). Consequently, many researchers have turned towards finding determinants of the survival prospects of newly founded firms. Although many studies have been undertaken in this area, the mechanisms underlying new firm survival are still far from being understood.

We contribute to this understanding in two ways. First, recent research (PE'ER & KEIL, 2013) suggests that regional externalities are not affecting all start-ups in the same way. Instead, the impact of externalities on start-ups is moderated by certain company characteristics. So far, only few company attributes and only certain types of regional externalities, have been accounted for (PE'ER et al., 2014; PUIG et al., 2014). We provide a first study that analyses the moderating role of the innovation behavior of start-ups on their benefiting from regional localization as well as Jacobs externalities. Second, studies on Germany are so far rare, so that we check previous empirical findings for a large number of German start-ups. The focus of our study is on the relationship between new firm survival and externalities emerging from a specialized and/or diversified regional economy.

The study relies on new and representative panel survey data, which contains information about 6,776 German firms from nearly all economic sectors that were started between 2007 and 2011. This data provides the opportunity to gain valuable insights into the first critical years of the analyzed start-ups. By applying a semiparametric Cox regression, the study is able to demonstrate that start-ups that introduce national or global market novelties are not benefiting or even suffering from a specialized economic structure. In contrast, highly innovative entrepreneurial firms appear to benefit from a diversified economic surrounding. Thereby the study adds knowledge to agglomeration as well as entrepreneurship research by deepening the understanding of the relationship between agglomeration,

innovation and new firm survival.

To achieve these goals, this study is structured as follows: First, the theoretical background on the types and sources of agglomeration externalities is presented. Subsequently, a literature review about previously identified empirical determinants of new firm survival is provided. In Section three, hypotheses are derived. The used data and the applied statistical approach are described in Section four. The results of the statistical analysis are presented and discussed in Section five. The final chapter presents the limitations of the study and concludes.

2 Theory and empirical evidence

2.1 Theory

"Regardless of the country, spatial concentration of aggregate activity is a fact of the economic landscape" (MCCANN & FOLTA, 2008: 533). The only reasonable explanation for this tendency to concentrate lies in the assumption that firms in some way benefit from being located in proximity to each other. Usually, agglomeration externalities (which are here understood as any kinds of external economies arising from regional economic structure) are classified into *localization externalities* and *Jacobs's externalities* (MCCANN & FOLTA, 2008).

Localization externalities are thereby associated to an accumulation of similar organizations from the same industry. These externalities need to be strong enough to overrule potential adverse effects of congestion - such as high levels of rent and traffic - and increased competition in strong concentrations of similar firms (FOLTA et al., 2006; PREVEZER, 1997; SCHMALENSEE, 1978). In general, the literature explains spatial concentrations by pointing out that companies in close proximity not only experience increased competition, but also profit from a superior access to specialized labor, specialized inputs, technology spillovers as well as greater demand (MCCANN & FOLTA, 2008).

JACOBS (1969) assumes that knowledge generated in one industry may also be adapted in another industry (Jacob's externalities). It is important to bear in mind that Jacob's and localization externalities are not mutually exclusive. On the one hand, a region that holds a specialization in a certain industry might well also possess a diverse economic structure in remaining branches. On the other hand, it seems fruitful to assume that there are different kinds of spillovers that emerge out of

different agglomeration economies. TÖDTLING et al. (2009) show that interactions with similar partners are related to incremental and process innovations, in contrast, spillovers, which recombine knowledge and technologies from a diversified network, should lead to more radical product innovations

2.2 Evidence on new firm survival

Agglomeration externalities and their influence on the survival chances of new businesses

The theoretical framework has sketched the differentiation between agglomeration externalities that either emerge out of an accumulation of similar firms or from a diversified economic structure. NEFFKE et al. (2012) show that young companies are affected by these agglomeration effects differently compared to established firms. Therefore, we discuss in the following those studies that deal with new or young companies.

WENNBERG & LINDQVIST (2010) present an overview of early studies, investigating the effect of localization effects on new firm survival. They arrive at conflicting results because these studies use "different levels of geographical aggregation and different measures of agglomeration [as well as] different levels of industry aggregation" (WENNBERG & LINDQVIST, 2010: 225). WETERINGS & MARSILI (2012) provide an explanation for the so far heterogeneous findings. By applying a competing risk model they are able to show that spatial concentration of industries lowers the probability of exit by failure and increases the likelihood of exit by merger & acquisition (M&A). Investigations that account for different modes of exit concordantly find a positive relationship between localization externalities and new firm survival, whereby these effects appear to be relevant in traditional and low-tech sectors and seem to be stronger for relative agglomeration measures which are depicted on a broader geographical scope (RENSKI, 2011; WENNBERG & LINDQVIST, 2010; WETERINGS & MARSILI, 2012). Recent research also shows that the influence of regional externalities might also be moderated by individual company characteristics. Interaction effects have e.g. been found for endowment with assets and human capital (PE'ER & KEIL, 2013), internationalization activities (PUIG et al., 2014) or company growth patterns (PE'ER et al., 2014).

Focusing on economic diversity, RENSKI (2011) offers the only study that explicitly links new firm survival to Jacob's externalities. By applying a measure which indicates how far a local industry structure differs from the national composition (DURANTON & PUGA, 2000) it can be shown that

industrial diversity generally increases survival chances for new firms. This relationship is particularly pronounced for knowledge-intensive start-ups and also exhibits a stronger impact when it is depicted on a broader geographical scope.

Innovative activities and entrepreneurial survival

There is quite a broad supply of literature regarding the effects of innovative behavior on the success of small and medium sized companies (ROSENBUSCH et al., 2011 for a meta-analytic review). However, these studies mainly use growth-related performance measures and thereby only allow for indirect conclusions in terms of company survival. Conversely, the existing studies that directly correlate innovative activities to company survival often include companies of all ages and do not account for differences between entrepreneurial and established firms (BUDDELMEYER et al., 2010; FONTANA & NESTA, 2009).

Only a few studies directly link innovative activity to company survival and examine start-up businesses only or separately. Innovative behavior of firms is measured in different ways. On approach focuses on the use of intellectual property rights (HELMERS & ROGERS, 2010; JENSEN ET AL., 2008). Another common empirical strategy is based on questions in surveys about the innovativeness of products or the technology used to differentiate between more or less innovative start-ups.

In an early study of Dutch manufacturing companies, CEFIS & MARSILI (2006) arrive at the conclusion that in low-tech industries, young firms' survival benefits from innovation, while for high-tech industries there is no such innovation premium observable. Thus, being an innovator even can increase the risk of failure in the longer term. This potentially endangering effect of innovations is supported by BOYER & BLAZY (2014), who find a significant and negative relationship between the status of being an innovator and survival prospects for French micro-start-ups. By applying a competing risk model that disentangles exit by failure and exit by merger or acquisition, CEFIS & MARSILI (2011) are able to show for Dutch manufacturing companies that non-innovative companies in low-tech industries, as well as innovating companies in high-tech industries, have the highest exposure to risk of failure. This leads them to the conclusion that in low-tech industries, being innovative is a sufficient condition to survive, while in the fast changing environment of high-tech industries, being innovative may only represent the entry point to competition. As innovation is the common denominator of these high-tech

companies, there is a need to outperform competitors with highly innovative and risky products.

3 Hypotheses

As outlined in the introduction we focus on two aspects: The impact of agglomeration externalities on new firm survival and the interaction between agglomeration effects and innovation. More recent studies tend to show a beneficial impact of localization externalities on new firm survival, which seems more prevalent in low-tech-environments. Studies of the effects of localization externalities for the German case are so far missing. Nevertheless, we expect a confirmation of the results from other countries:

H1a: Regional localization externalities exhibit a positive influence on new firm survival in non-high-tech environments.

Insights on the influences of economic diversity on new firm survival are almost entirely missing. So far, only RENSKI (2011) takes up this question, and finds that Jacob's externalities increase the probability of company survival, especially in high-tech environments. Consecutively, one important goal of this study is to validate this result by testing the following hypothesis.

H1b: Regional diversity exhibits a positive influence on new firm survival in high-tech environments.

Recent studies show that the impact of agglomeration externalities do not only depend on the technological environment, but also on individual company characteristics (PE'ER & KEIL, 2013; PE'ER et al., 2014; PUIG et al., 2014). So far, only few different company attributes have been tested as potential moderators of localization externalities. To the authors' knowledge, no study has tested in how far localization effects are moderated by the innovative behavior of the start-up. The role of company attributes for the importance of Jacob's externalities has not been studied in the context of start-ups so far.

We measure innovative behavior by market novelties, which are connected rather to radical instead of incremental innovations. Intra-industry spill-overs – a first aspect of localization externalities – are supposed to lead to incremental product and process innovations (TÖDTLING et al., 2009; FRENKEN et al., 2007), so that they are not connected to our innovation measure. Regarding the remaining aspects

of localization externalities – such as local labor and suppliers - PE'ER & KEIL (2013) have shown that companies with little endowment of tangible and intangible assets benefit from agglomeration externalities. In contrast, well-endowed start-ups are not dependent on these advantages, but rather experience the drawbacks of increased competition. Being in possession of a market novelty can be understood as a form of intangible asset endowment and the following hypothesis can be derived:

H2a: The survival of start-ups that introduce market novelties is negatively affected by localization externalities.

Jacob's externalities arise from inter-industry spill-over, which lead to a recombination of knowledge from different sectors and, thus, to rather radical product innovations (TÖDTLING et. al., 2009). If such spill-over effects are present, their relevance should be moderated by the status of introducing radical product innovations. If innovative behavior, as usually believed, increases survival prospects of newly founded firms, regional diversity should increase the survival rate of innovative start-ups. However, it also seems legitimate to assume that a recombination of diversified knowledge deteriorates survival chances by creating more complex and risky innovations. Empirical knowledge on this issue in the context of new firm survival is not available. Nevertheless, we follow the former arguments and hypothesize:

H2b: The survival of start-ups that introduce the products with the highest degree of novelty is positively affected by a diverse regional economic structure.

4 Data and methodology

4.1 Data

We use data from the Mannheim Start-up Panel (formerly named *KfW/ZEW Start-up Panel*) of the Centre for European Economic Research (ZEW). The data covers annual surveys of 6,776 firms that were founded between 2007 and 2011. 1,074 closing events were observed between 2008 and 2012. The panel covers nearly all industries and is representative of the whole of Germany, excluding only agriculture, mining and quarrying, electricity, gas and water supply, health care, and the public sector. The sample is stratified according to two criteria: start-ups that received financial support by the KfW

banking group and start-ups in the high-tech sector[1] are oversampled. The parent population (the Mannheim Enterprise Panel of the ZEW) is maintained by the ZEW in cooperation with *Creditreform*, the largest business information service in Germany. The entities are legally independent firms (hence de-merger foundations or subsidiaries are excluded), which are run by at least one full-time entrepreneur. The survey data is collected by computer-aided telephone interviews by a professional vendor with those engaged in the management of the newly founded businesses (FRYGES et al., 2009). A survivor bias could exist in the first two cohorts which consist not only of start-ups of the previous year but up to three years before the first interview. To avoid this bias the panel was reduced to only those companies, which have been founded in the immediate year prior to their first interview. Additionally, to secure a sufficient number of observations for all periods of analysis time, the maximum amount of time under observation for each company is set to four years, meaning that the cohort of 2007 will only be monitored until the wave of 2011.

Survival as dependent variable

The aim of the analysis is to explain the time elapsed between entry and exit of the company. In this respect, the panel possesses the advantage that the *Creditreform* database allows to determine the month when a company actually started to actively participate in business life (e.g. by renting business rooms or taking out a loan). In terms of company exit, a common problem with empirical research is that little information is available for subjects that have left the panel. It is therefore difficult to distinguish whether a firm is no longer in existence, or if the subject has simply changed their contact details or alike. A great advantage of the present data is that here are two independent sources about firm closures. Besides information regarding a firm's closure that is obtained by interviews, some firms are recognizable as closed according to an identifier within the *Creditreform* database. Additionally, for companies that no longer respond and are not labeled as closed otherwise *Creditreform* directly researched their status. However, closing information by identifiers and research might be available with a considerable lag, so that a period of unmonitored time between the last interview and the date of closing might exist (FRYGES et al., 2009). In this analysis, an unobserved period of one year is accepted; otherwise the company becomes labeled as right censored at the time of the last interview. Finally,

[1] The definition of high-tech industries follows the approach of LEGLER & FRIETSCH (2006).

previous research has revealed that different ways of company exit from the market might represent different economic outcomes. However, in the present data a differentiation between different exit modes is not possible. This naturally reduces the significance of the results and needs to be carefully considered in the interpretation of the obtained outcomes.

Variables representing agglomeration externalities

Agglomeration externalities are depicted on the level of 258 labor market regions. This approach is used for two reasons: On the one hand, different authors have found that the effects of agglomeration externalities on new firm survival are stronger, when a broader regional scope is applied (RENSKI, 2011; WENNBERG & LINDQVIST, 2010). On the other hand, these regions form functional rather than administrative entities. Their delineation follows daily commuting patterns, reflecting the regional scale for regular interactions. Accordingly, it should be unlikely that spill-over effects reach beyond these boundaries (ECKEY et al., 2006). As for the classification of industries, a three-digit level NACE classification (FEDERAL STATISTICAL OFFICE, 2008) is applied. The two agglomeration variables represent averages of the period 2008 to 2012 and are based on data of the Establishment History Panel of the *Institute for Employment Research (IAB)*, which covers all establishments with at least one marginal part-time employee in Germany (GRUHL et al., 2012).

For the operationalization of localization externalities, previous survival studies suggest a superiority of relative quotients over absolute measures (RENSKI, 2011; WETERINGS & MARSILI, 2012). To capture localization externalities, here the *Cluster Index (CI)* by STERNBERG & LITZENBERGER (2004) is used. It consists of three regional ratios, which are all normalized by the referring national ratio:

$$CI_{ij} = ID_{ij} \times IS_{ij} \times \frac{1}{SB_{ij}} = \frac{\frac{e_{ij}}{\sum_{i=1}^{n} e_{ij}}}{\frac{i_i}{\sum_{i=1}^{n} i_i}} \times \frac{\frac{b_{ij}}{\sum_{i=1}^{n} b_{ij}}}{\frac{a_i}{\sum_{i=1}^{n} a_i}} \qquad (1)$$

where *(j)* denotes the respective industry, *(i)* the respective sub-region, (e_{ij}) the number of employed people, (b_{ij}) the number of firms, (a_i) the area size and (i_i) the number of inhabitants. The three

components are multiplicatively connected and the possible outcome ranges from zero to infinite, whereby a value of one represents the national average.

For capturing Jacob's externalities the Krugman diversification index is applied. Following DAUTH (2013), this relative index shows how far the regional industry mix deviates from the mix of the whole nation. The index takes on the value of zero if the regional industry mix equals that of the whole country. The more specialized a region is the more negative the index becomes.

$$div_{irt} = -\sum_{i'=1, i' \neq i}^{N} \left| \frac{e_{i'rt}}{e_{rt}} - \frac{e_{i't}}{e_{t}} \right| \qquad (2)$$

Innovation variables

Following the OSLO manual (OECD, 2005), all participants of the Mannheim Start-up Panel are asked every year whether they have introduced a market novelty and if so, whether this market novelty is new to the region, new to Germany or new to the world. We calculate a binary variable for each novelty degree, whose value changes from zero to one in the year of the novelty's introduction and then remains at this value. Thereby, this study is the first which is able to a) represent innovative behavior by a time-varying covariate and b) simultaneously differentiate innovations according to their degree of novelty. Since the above variable does not differentiate holding more than one product innovation of a certain novelty degree in the portfolio, an additional variable, reflecting continuous innovation efforts, is included. This variable indicates when a company holds two or more product innovations of any novelty degree in its portfolio.

Control Variables

Our data allows for manifold control variables, which have proven to be of relevance in previous empirical studies. This includes demography, experience and qualification of the founder (VAN PRAAG, 2003) as well as the company's legal form (HARHOFF et al., 1998) and current size (ALDRICH &

AUSTER, 1986). Furthermore we control for received public funding[2] (DESIAGE et al., 2010), industry sectors (AUDRETSCH, 1991) cohort effects (SINGH & LUMSDEN, 1990; STROTMAN, 2007), population density (FALCK, 2007; STEARNS et al., 1995) and East-West differences (WYRWICH, 2013). Operationalizations of these variables can be found in table 1. The metric variables for industry experience and current employment are transformed to their log-values, as this approach is preferred by some previous empirical studies (BRÜDERL et al., 1992) and higher AICs in our analyses. The data has additionally been divided in a high-tech and non-high-tech group (see table 1). Regressions will also be run for these categories separately.

4.2 Descriptive Analysis

Table 1 contains descriptive statistics for all independent variables. It is indicated whether a potential change of the variables over time is explicitly considered. All spatial variables refer to the region in which the business was founded, although a very small fraction of start-ups change their location during the observation period. This is controlled for in an unreported insignificant control variable. The overrepresentation of firms belonging to high-tech industries allows us to conduct separate analyses for these economically crucial sectors. Regarding the innovation variables, Table 1 shows that innovations leading to market novelties are a) not very common and b) unequally distributed between high-tech and non-high-tech sectors. Even fewer firms report market novelties in more than one year. Tests for multicollinearity among independent variables using variance inflation factor have revealed only one problem: It is not possible to include interaction terms between innovation and agglomeration variables together with the respective innovation variable. Since these interaction terms are the focus of this paper, the direct impact of innovation on new firm survival is only considered for the variables reflecting continuous innovation.

[2] However, the results for this variable are subject to secrecy and are not allowed to be reported

Table1: Descriptive statistics of all independent variables (weighted values).

Descriptive statistics of independent variables

Variable	Description	Mean			SD			Min			Max			Time
	Sample:	FULL	HT	NHT	FULL	HT	NHT	FULL	HT	NHT	FULL	HT	NHT	Variance
Continuous variables														
Experience_log	Log of highest experience in industry at founding	2.167	2.383	2.148	1.045	0.86	1.057	0	0	0	3.912	3.912	3.912	Invariant
Employ_log	Log of current employment in full time equivalents	0.781	0.773	0.782	0.803	0.78	0.805	0	0	0	6.1	4.85	6.1	Variant
Pop_density	Population density	603.9	678.4	597.5	803.8	872.7	797.2	38.1	38.1	38.1	3927.9	3927.9	3927.9	Invariant
Cluster_index	Relat. industrial density, stock & establishment size	5.516	5.772	5.494	43.58	8.93	45.35	0	0	0	3840.5	82.97	3840.5	Invariant
Jacobs	Deviation from national industry mix	-0.517	-0.503	-0.516	0.113	0.112	0.113	-1.107	-1.107	-1.107	-0.318	-0.323	-0.318	Invariant
Dummy variables														
KFW-funding	Promoted by the KfW banking group	0.060	0.027	0.063										Invariant
Industry_Sector1	Cutting-edge manufacturing *(high-tech)*	0.004	0.048											Invariant
Industry _Sector2	High-tech manufacturing *(high-tech)*	0.004	0.049											Invariant
Industry _Sector3	Technology-intense services *(high-tech)*	0.055	0.689											Invariant
Industry _Sector4	Software & consultancy *(high-tech)*	0.017	0.214											Invariant
Industry _Sector5	Non-high-tech manufacturing *(non high-tech)*	0.044		0.048										Invariant
Industry _Sector6	Skill-intense services *(non high-tech)*	0.073		0.080										Invariant
Industry _Sector7	Business-oriented services *(non high-tech)*	0.118		0.129										Invariant
Industry _Sector8	Consumer-oriented services *(non high-tech)*	0.354		0.385										Invariant
Industry _Sector9	Construction *(non high-tech)*	0.125		0.136										Invariant
Industry _Sector10	Wholesale and retail trade *(non high-tech)*	0.205		0.222										Invariant
Cohort_2007	Entry to panel 2007	0.228	0.225	0.229										Invariant
Cohort_2008	Entry to panel 2008	0.281	0.260	0.283										Invariant
Cohort_2009	Entry to panel 2009	0.226	0.246	0.225										Invariant
Cohort_2010	Entry to panel 2010	0.164	0.160	0.165										Invariant
Cohort_2011	Entry to panel 2011	0.100	0.108	0.099										Invariant
German_involved	German involved in founding	0.907	0.961	0.902										Invariant
Women_involved	Woman involved in founding	0.241	0.119	0.252										Invariant
Quali_academic	Founder(s) graduated from university or college	0.360	0.612	0.338										Invariant
Legal_form	Entered market as capital company	0.350	0.557	0.332										Invariant
East-West	Located in East Germany	0.211	0.183	0.214										Invariant
Novelty_regional	Regional market novelty in product portfolio	0.089	0.084	0.090										Variant
Novelty_national	National market novelty in product portfolio	0.097	0.147	0.092										Variant
Novelty_global	Global market novelty in product portfolio	0.041	0.108	0.036										Variant
Contin_Innovation	Two or more market novelties in product portfolio	0.035	0.062	0.033										Variant
N		13899	5293	8606										

4.3 Methodology

To test the hypotheses a semiparametric Cox regression (COX, 1972) is used. The advantages of this most widely used approach lie in its flexibility and the robustness due to an absence of distributional assumptions. Graphical tests as well as a *Grambsch-Therneau Test* (GRAMBSCH & THERNEAU, 1994) indicate no violations of the preconditioned proportional hazards assumption in any model specification. Within the model Breslow approximation for tied failures is applied. By fitting a model with shared group-level frailty, it is additionally controlled for potential unobserved within-group correlation among start-ups, which are located in the same labor market region. Accordingly, the hazard function for subject *j* in group *i* then reads as

$$h_{ij}t = h_0(t)\ \alpha_i\ exp(\beta_0 + x_j\beta_x) \tag{3}$$

where h_o is the so called *baseline hazard and exp()* is taken to secure that $h_{ij}t\ ()$ cannot become negative, t is time, x_j is a row vector of multiple predictors and β_x is a column vector of regression coefficients and α_i represents the unobservable positive quantities. These random effects are assumed to follow a gamma distribution with a mean of 1 and a variance of θ, which is estimated from the data. For ease of interpretation, coefficients are reported in an exponentiated way, so that they represent hazard ratios.

Potential biases in the model might be associated to non-random panel attrition, which causes that only start-ups with certain characteristics remain in the panel. To test for this bias, an additional Cox regression is run, whereby the failure event is now formed by surviving start-ups which exit from the panel before the expiration of the analysis[3]. The results of this analysis are reported in appendix 1 and show that most of the variables are not significantly related to the probability of panel attrition. However, for a few variables significant results have been found. To address this potential bias, the original survival model is repeated in a parametric accelerated failure time (AFT) (HUTTON & MONAGHAN, 2002) model with log-logistic distribution. As AFT-models devote a prominent role to survival duration, they are less vulnerable to data loss by censoring (CADER & LEATHERMAN, 2011). The results are reported in appendix 2 and reveal no serious differences in algebraic signs and

[3] A violation of the proportional hazards assumption thereby required a stratification of the model according to founding cohorts.

significances, which would challenge the interpretation of the results of the Cox model. Accordingly, the results can be considered robust against model specification and potential sample selection bias. Finally, when analyzing the influence of geographic characteristics on new firm survival, problems of geographic self-selection might arise. In this context, self-selection would mean that the objects select themselves into a region with certain characteristics leading to a generally biased result. RENSKI (2011) names location choice and the founder's experience as potential sources for geographical self-selection. However, empirical evidence shows that start-ups normally are not subject to complex location decisions (NERLINGER, 1999; MOSSIG, 2000). Regarding founder's experience the present study is able to control for the founder's industry experience and thereby shows that the applied study design, with control variables accounting for initial firm and founder heterogeneity, generally makes the presence of a heavy bias due to geographical self-selection unlikely.

5 Results

To answer the proposed hypotheses, regressions are run for the full sample of all 6,776 start-ups, as well as for high-tech (2,588 subjects) and non-high-tech environments (4,188 subjects) separately. For all models, the hazard rate is low for the initial phase, then rises sharply and peaks after about one and a half years, with a tendency to decrease thereafter. This pattern favors the idea of a liability of adolescence and a *honeymoon phase* after the founding (FICHMAN & LEVINTHAL, 1991; BRÜDERL & SCHÜSSLER, 1990).

Table 2: Results of the semiparametric Cox regression.

Results of Cox regression						
	Model 1 Full Sample		*Model 2* High-Tech		*Model 3* Non-High-Tech	
	HR	p-Value	HR	p-Value	HR	p-Value
Cohort controls	YES		YES		YES	
Sectorial controls	YES		YES		YES	
KfW funding control	YES		YES		YES	
German_involved	**0.791**	**(0.041)***	0.716	(0.151)	0.812	(0.117)
Quali_academic	0.953	(0.509)	0.977	(0.843)	0.959	(0.654)
Woman_involved	**1.186**	**(0.024)***	1.259	(0.130)	1.166	(0.078)
Experience_log	**0.863**	**(0.000)*****	**0.821**	**(0.001)*****	0.878	(0.**000**)***
Employ_log	**0.865**	**(0.001)****	**0.786**	**(0.005)****	0.904	(0.058)
Legal_form	**0.526**	**(0.000)*****	**0.438**	**(0.000)*****	0.612	(**0.000**)***
East_West	0.869	(0.140)	0.769	(0.121)	0.925	(0.474)
Cluster	**0.987**	**(0.047)***	0.999	(0.937)	0.981	**(0.018)***
Jacobs	0.914	(0.773)	0.923	(0.879)	0.969	(0.930)
Pop_density	1.000	(0.416)	1.000	(0.730)	1.000	(0.175)
Contin_Innovation	**0.664**	**(0.018)***	0.756	(0.250)	0.581	**(0.032)***
Reg_Nov #Cluster	**1.021**	**(0.039)***	1.013	(0.506)	1.025	**(0.047)***
Nat_Nov #Cluster	**1.034**	**(0.001)*****	**1.033**	**(0.038)***	1.037	**(0.006)****
Glob_Nov #Cluster	1.007	(0.525)	0.994	(0.764)	1.018	**(0.031)***
Reg_Nov #Jacobs	1.015	(0.943)	1.164	(0.683)	0.972	(0.908)
Nat_Nov #Jacobs	1.363	(0.220)	0.994	(0.987)	1.812	(0.088)
Glob_Nov #Jacobs	**0.576**	**(0.043)***	**0.456**	**(0.034)***	0.703	(0.360)
N	13,899		5,293		8,606	
Number of exits	1,074		367		707	
P.H.-test	0.313		0.857		0.336	
Shared frailty	**0.027**		0.082		0.186	

Exponentiated coefficients
$^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$

5.1 Control variables

For the unreported industry dummies, results are largely insignificant within the subsamples, indicating that the applied division in high-tech and non-high-tech leads to a quite homogeneous classification. Significant results for the unreported cohort dummies can be interpreted in the way that founding conditions are imprinted and play a critical role for the survival also in later years after founding (SINGH & LUMSDEN, 1990). A woman in the founding team reduces survival chances, however, only in the overall sample significantly, while the nationality generally seems to be non-relevant. Experience in the industry proves to be a generally beneficial attribute, while no significant relation is found between academic education and survival. These results point in the direction that not general, but rather specific qualification is of importance (COLOMBO et al., 2004). Company size is positively associated to survival prospects; however this effect appears to be driven by the conditions in the high-tech

subsample, thereby supporting the idea of a liability of smallness in this technological environment (ALDRICH & AUSTER, 1986). A very strong and constant significance is found for the legal form the start-up entered the market with. According to DOMS et al. (1995) and TVETERAS & EIDE (2000), this can be explained by high capital requirements for the founding, which induce a self-selection of promising and well-endowed start-ups. Finally, the insignificant results for the East-West dummy and population density show that there are no differences in survival between these regions beyond effects that can be traced back to other variables.

5.2 Interdependence of externalities and innovation

First, Table 2 shows that the Cluster-Index has an increasing effect on survival. Apart from a significant interaction between national market novelties and localization externalities in high-tech environments, this effect appears to be driven by the non-high-tech subsample mainly. Hence, in line with hypothesis H1a and previous empirical findings (RENSKI, 2011; WETERINGS & MARSILI, 2012), localization externalities appear to be beneficial and important in non-high-tech environments. However, not all companies are affected by these effects in the same way. The coefficients for the interaction terms with regional and global market novelties are of comparable size but indicate an unbeneficial impact, so that they counterweight the effect of the localization externalities. This means that start-ups that introduce regional or global market novelties seem not to profit from localization externalities. The situation is even more pronounced in the case of start-ups with national market novelties. The interaction coefficient is highly significant and the effect is larger than the overall effect of localization externalities, so that start-ups with national market novelties are even hurt by a high Cluster-Index. This partly supports hypothesis H2a and the findings of PE'ER & KEIL (2013): start-ups that are endowed with highly innovative products are not gaining advantages from being collocated. Probably, they can provide themselves with the necessary inputs internally, and do not rely on exploiting external sources, but might even suffer from the drawbacks of being located in a close spatial concentration to similar firms. In contrast, less innovative start-ups seem to benefit from externalities, such as a local pool of labor, suppliers and purchasers.

For the Jacob's externalities we do not find a significant overall impact, neither for high-tech nor for non-high-tech industries. Thus, hypothesis H1b cannot be confirmed. The only significant effect that we find in the context of Jacob's externalities is a significantly negative relationship between the

hazard rate and the interaction term between a diverse regional economic structure and global market novelties, which appears to be driven by high-tech start-ups. Hence, hypothesis H2b is confirmed, but only for the most innovative activity and high-tech firms. Following the arguments that led to this hypothesis, this can be interpreted in the way that a) inter-industry spill-over seem to be present and b) the recombination of knowledge from different sectors leads to more promising innovation projects. With regards to the idea that high-tech start-ups are under a high pressure to innovate (CEFIS & MARSILI, 2011), this might reflect their need to utilize knowledge from different sectors to gain them a competitive advantage. Following this interpretation might also provide a possible answer to the question as to why non-high-tech start-ups with worldwide novelties are not affected by Jacob's externalities. As these companies are under lower pressure to introduce these kinds of radical innovations, they might also be under lower pressure to find and exploit diverse sources of knowledge. Finally, the outcome for continuous innovation efforts arrives at a significant and beneficial result, which appears to be mainly driven by the non-high-tech environment.

Although the presented results lead to interesting results and largely matched the hypotheses, they also entail elements of uncertainty and lead to some unexpected results. The basic indicator for Jacob's externalities is not even getting close to exhibiting a statistically significant influence. One possibility for this unexpected result might lie in the operationalization of this measurement. The test for shared frailty indicates that there is an unobserved correlation among entities belonging to the same labor market region, which might indicate that not all regional effects are adequately integrated in the model. However, on the one hand, the significant effect of shared frailty is only present in the full sample model and vanishes when the analysis is conducted separately for the subsamples. On the other hand, the specification for Jacob's externalities follows RENSKI (2011), who has detected a significant relationship for this variable. An additional possibility for an empirical misspecification could be that the applied regional scope is still too small. However, the applied regional level was carefully chosen and the presence of shared frailty within these spatial entities undermines this argument. A further source of uncertainty lies in the ability to distinguish between different ways of exiting the market. This is critical, as previous empirical findings have shown that the determinants of exit vary according to the exit's means. It might be possible that potentially hypothesis-conforming results for Jacob's externalities are not detectable, because the influence of regional characteristics on exit by failure is balanced out by the opposing effect on exit by M&A. However, if this was the main reason for the unpredicted results, it is hard to explain why other parameters behave as expected. Either this spatial

variable is the only one which shows an opposing effects on different ways of exit – which appears unlikely and would be hard to reason – or the potential influence was very weak anyway, so that even small biases causes it to vanish. Remaining possibilities have to be searched for in the underlying data. At first, the study is based on a new database, which differs from previous databases in such crucial areas as sectorial composition, definition of company death and minimum employment thresholds. Accordingly, transferring results from existing studies is necessarily associated with uncertainty. Finally, CAINELLI et al. (2014) have pointed out that the influences of the regional economic structure on new firm survival are rather long-ranging. Hence, the short analysis time of four years might not be sufficient to find significant relationships for Jacob's externalities.

6 Conclusions

This paper provides evidence that the effect of agglomeration externalities on survival is, indeed, moderated by the innovative behavior of start-ups. It becomes clear that localization externalities are prevalent in non-high-tech environments. Furthermore, only the less innovative companies appear to benefit from being located in a cluster, while start ups holding market novelties in their portfolio even suffer from spatial concentration. As for regional diversity, in most cases no significant relationship between Jacob's externalities and new firm survival is found. Only high-tech start-ups, which have introduced a global market novelty, are positively affected by a diverse regional economic structure. However, this only extends insofar as the moderating effect is prevalent in high-tech industries. This significant effect can be interpreted as an indirect evidence of the presence of inter-industry spill-overs, leading to promising radical innovations.

Although the analysis has confirmed that the direction taken by this research appears promising and fruitful, the study also suffers from drawbacks and limitations, which open up spaces for further research. Besides the above discussed inability to differentiate between exit routes, the study only tracks companies for the time span of four years. With hazard rates typically reaching a peak around two years (VAN PRAAG, 2003, BRÜDERL et al., 2007), this period still covers the most critical phase after founding. However, in some industries, empirical results suggest that hazard rates reach their maximum much later - after around seven years (AGARWAL & AUDRETSCH, 2001).

With respect to the innovation variables, this study overcame some drawbacks of previous

investigations. However, the applied design doesn't deliver any information about start-ups which are engaged in innovative activities not leading to market novelties, such as process and incremental product innovations. Finally, in light of the results for the interaction between innovation and Jacob's externalities, a split of industrial diversity in related and unrelated variety (FRENKEN et al., 2007) seems promising.

Finally, these results not only contribute to scientific knowledge, but also bear some important practical implications for policy makers. Around three percent of all non-high-tech firms indicate that they invented a global novelty. With regards to the spatial environment, a policy implication could lie in the finding that non-high-tech start-ups with global novelties are not able to profit from a diverse economic environment. One possible reason could be that they miss out on this opportunity as they are simply not under the same pressure to exploit knowledge from other sectors. Accordingly, economic promotion could aim to sensitizing the relevant start-ups to these possibilities and provide them with access to knowledge from diverse sources. This could, for instance, be done by establishing adequate regional networks or financial support of joint innovation projects.

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Appendix

Appendix 1

Appendix 1: Results of test for non-random panel attrition.

Results of Cox regression for full sample with panel attrition as failure event

	HR	p-Value
Sectorial controls	YES	
KfW funding control	YES	
German_involved	0.794	**(0.010)***
Quali_academic	0.805	**(0.000)*****
Woman_involved	1.013	(0.829)
Experience_log	0.909	**(0.000)*****
Employ_log	0.976	(0.454)
Legal_form	1.102	(0.091)
East_West	0.963	(0.546)
Cluster	1.000	(0.613)
Jacobs	1.487	(0.065)
Pop_density	1.000	(0.944)
Contin_Innovation	1.125	(0.387)
Novelty_regional	0.956	(0.596)
Novelty_national	1.093	(0.255)
Novelty_global	0.872	(0.198)
Number of Subjects	4501	
P.H.-test	0.93	

Stratified by cohorts
Exponentiated coefficients
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix 2:

Appendix2: Results of robustness check in parametric model setting.

Results of parametric regression with loglogistic distribution in accelerated-failure-time-metric

	Model 1 Full Sample		*Model 2* High-Tech		*Model 3* Non-High-Tech	
	HR	p-Value	HR	p-Value	HR	p-Value
Cohort controls	YES		YES		YES	
Sectorial controls	YES		YES		YES	
KfW funding control	YES		YES		YES	
German_involved	**1.220**	**(0.016)***	1.288	(0.115)	1.201	(0.058)
Quali_academic	1.036	(0.487)	1.012	(0.883)	1.032	(0.625)
Woman_involved	**0.895**	**(0.038)***	0.853	(0.128)	0.906	(0.116)
Experience_log	**1.111**	**(0.000)*****	**1.141**	**(0.001)*****	**1.100**	**(0.000)*****
Employ_log	**1.100**	**(0.002)****	**1.173**	**(0.005)****	1.068	(0.078)
Legal_form	**1.538**	**(0.000)*****	**1.759**	**(0.000)*****	**1.381**	**(0.000)*****
East_West	1.078	(0.265)	1.163	(0.189)	1.031	(0.703)
Cluster	1.008	(0.072)	1.000	(0.968)	**1.013**	**(0.025)***
Jacobs	1.120	(0.612)	1.116	(0.764)	1.070	(0.800)
Pop_density	1.000	(0.445)	1.000	(0.794)	1.000	(0.205)
Contin_Innovation	**1.399**	**(0.005)****	1.276	(0.143)	**1.551**	**(0.013)***
Reg_Nov #Cluster	0.987	(0.086)	0.995	(0.686)	0.983	(0.071)
Nat_Nov #Cluster	**0.973**	**(0.000)*****	**0.975**	**(0.022)***	**0.972**	**(0.007)****
Glob_Nov #Cluster	0.996	(0.603)	1.008	(0.553)	**0.988**	**(0.040)***
Reg_Nov #Jacobs	1.031	(0.839)	0.886	(0.644)	1.097	(0.611)
Nat_Nov #Jacobs	0.777	(0.153)	0.972	(0.910)	0.639	(0.068)
Glob_Nov #Jacobs	**1.475**	**(0.046)***	**1.764**	**(0.031)***	1.297	(0.348)
Constant	1030.787	(0.000)***	734.317	(0.000)***	1157.957	(0.000)***
Ln_gam constant	0.608	(0.000)***	0.589	(0.000)***	0.615	(0.000)***
Ln_the constant	0.045	(0.000)***	0.085	(0.002)**	0.035	(0.000)***
N	13,899		5,293		8,606	
Number of exits	1,074		367		707	
Shared frailty	**0.010**		0.060		0.108	

Exponentiated coefficients

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$