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Micro-level Evidence on the Survival of German Manufacturing Industries - A Multidimensional Analysis

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Success or Failure? A Multi-Dimensional Analysis of Business-, Industry- and Region-Specific Determinants of Survival

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Abstract

This paper analyzes business-, industry- and region-specific survival determinants. The data is for all German manufacturing businesses in the 1992-2005 period. Our results suggest that the probability of survival is lower for small, young and for relatively mature establishments. A relatively high start-up size, an above average share of highly qualified employees in the establishments as well as a high qualification of the regional workforce has a positive effect. We find higher hazard rates in agglomerated areas and generally in the eastern part of the country. Hazard rates are also higher in capital-intensive industries, in industries with a high minimum efficient size and in industries with high labor-unit costs. Establishments in high-tech industries enjoy relatively good survival prospects. A rather specialized regional industry structure increases the risk of failure.

Key words: New firm survival, hazard rates, duration analysis, entrepreneurship

JEL classification: C41, L25, L26, L60

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1. Introduction¹

It is widely recognized that entrepreneurship and new business formation can make an important contribution to economic growth. Their main effect on economic growth is, however, not solely due to job creation within the new businesses because they simultaneously may displace incumbent businesses. Probably more important than their job creation is that they spur innovative competition by challenging the incumbents as Schumpeter (1937, 1942) has already argued for the case of radical innovations. This implies that not all new businesses are equally important for their impact on growth. It is plausible to assume that particularly those new businesses which prove to be competitive and survive exert a challenge on the incumbents while the 'mayflies', i.e. those new firms which have to exit the market after an only short period of time do not have any significant effect. This hypothesis has been confirmed by a number of recent studies (Falck, 2007; Fritsch and Noseleit, 2009; Fritsch and Schindele, 2010).

This paper analyzes the survival determinants of manufacturing establishments using a multi-dimensional approach, i.e., simultaneously accounting for business-, industry- and region-specific factors. Our investigation is based on a panel data set of all German manufacturing establishments for the period 1992 to 2005. To the best of our knowledge, applying a multi-dimensional approach on survival determinants to a panel of manufacturing firms has not been done previously. Unlike most previous studies that analyzed survival determinants particularly for relatively new businesses, we include both young and mature firms. In accordance with previous studies our analysis shows that relatively small and young businesses face a relatively high hazard of exit. Higher propensity for exit is, however, also found for more mature businesses

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older than about eleven years. While a high qualification of business' employees is conducive to survival, high capital intensity and high minimum efficient size of the industry prove to be unfavorable. In contrast to some other studies (e.g., Audretsch, Howeling and Thurik, 2000) we find that belonging to a high-tech industry or to a high-growth industry is associated with positive survival prospects. Survival chances are lower in high-density areas and, generally, for businesses located in the eastern part of the country, the former German Democratic Republic.

The following section (Section 2) provides an overview on hypotheses and empirical evidence with regard to the factors that may determine the survival of businesses. Section 3 introduces the data, the estimation procedure, as well as the basic definitions of variables and the expected signs. The results of the empirical analysis are presented in Section 4 and the final section (Section 5) concludes.

2. The determinants of new business survival

Our discussion of the possible determinants of new business survival focuses on three types of influences: internal characteristics of the businesses, industry- and region-specific characteristics. We neglect factors such as personal characteristics of the entrepreneurs or business strategy since our data, unfortunately, does not cover these issues.

2.1 Business-specific characteristics

The organizational ecology literature has argued that the failure risk of new businesses will decrease as they *age* (Stinchcombe, 1965; Dunne et al. 1989; Mata and Portugal 1994; Mitchell 1994) what has been termed the 'liability of newness'. The basic argument states new businesses face a number of special problems establishing an organizational structure, establishing relationships to suppliers and customers, acquiring suitable personnel and getting the new unit working efficiently enough to hold pace with competitors (Bruederl,

Preisendoerfer and Ziegler, 1992; Carroll and Hannan, 2000; Jovanovic 2001). Moreover, start-ups tend to enter the market at a scale that is below the minimum efficient size and have to grow quickly in order to be productive (Audretsch, 1995; Farinas and Ruan, 2005; Hoppenhayn, 1992). According to such difficulties, it may take a considerable period of time until they earn their first profit. Hence, the 'liability of newness' may also be a 'liability of smallness' (Aldrich and Auster, 1986), as has been found in many empirical studies.² A further reason for higher exit rates of small firms could be that well-established firms may also have better access to capital and labor markets that, in turn, improve their survival prospects (Perez et al. 2004).

Bruederl and Schuessler (1990) and Fichman and Levinthal (1991) among others have found that with an increase of age, the hazard rate of firms follows an inverted u-shaped pattern. The probable reason for such a 'liability of adolescence' is that during the first months and years they are protected by their initial resource endowments, and do only give up when these initial resources are exhausted and hope for success has faded away. However, as firms age and gradually adapt to the environment and consolidate their market positions, the risk of failure decreases. A number of authors assume that firms may also experience a 'liability of aging' so that hazard rates increase when they mature (Hannan, 1998; Baum, 1989). The reason for such a development could be an erosion of their products, business concepts and their technology ('liability of obsolescence') or sclerotic inflexibility of long-established organizations ('liability of senescence') (Barron et al., 1994; Ranger-Moore, 1997). Problems of finding a suitable successor who is willing to take over the business may lead to higher hazard rates of older businesses, particularly of owner-managed firms.³ Empirical tests of these hypotheses are rare, probably because they require long time-series of data about cohorts of businesses which are rarely available.

² See e.g. Mata and Portugal (1994), Audretsch and Mahmood (1995), Geroski (1995), Honjo (2000), Segarra and Callejon (2002).

³ The notions of liability of senescence and newness are not contradictory but relate to two different development stages of firms, i.e., early "youth" and "maturity" (Perez et al., 2004).

By investigating hazard rates of German start-up cohorts, Schindele and Weyh (2009) could confirm a relatively high risk of exit for older firms.

According to the resource based approach firm performance should depend on the amount and the quality of resources that a business has mobilized. For example, Brixy and Kohaut (1999) and Bellmann, Bernien and Koelling (2003) found a positive impact of the technological equipment a business possesses, and Brüderl and Preisendörfer (2000) discovered the positive impact of innovative strategies on the success of new businesses. Another indicator of the quality of a new business might be the quality of the jobs that it generates. For instance, Brixy, Kohaut, and Schnabel (2006) found a positive relationship between the qualifications of the employees and the success and growth of the new businesses. Bellmann, Bernien, and Koelling (2003) confirmed the finding when they showed a positive relationship between the number of employees with vocational training and a firm's success. We, therefore, expect that the higher the quality of an entry, e.g., measured by the qualification of its employees, the greater its survival chances.

2.2 Industry-specific determinants

In industries where the *minimum efficient size* is relatively small, survival rates should be higher than in large scale industries and industries characterized by high capital intensity (Audretsch et al., 2000; Mayer and Chappell, 1992; Tveteras and Eide, 2000). This should particularly hold for new businesses which typically begin considerably below the minimum efficient size and are therefore confronted with cost disadvantages compared to their efficiently-scaled competitors (Mata et al., 1995). However, distinct barriers to entry such as a large minimum efficient size or *high-capital intensity* could also induce a self-selection process that results in relatively few, but high-quality start-ups with above-average chances of surviving (Dunne and Roberts, 1991). Due to such different and contradicting effects, the effect of the level of entry barriers and survival rates of new firms is a priori unclear

Survival chances should be relatively low in industries which are characterized by high *labor unit costs* because of problems to attain profitability (Patch, 1995). Prospering and *growing industries* should provide a more conducive environment for firm's economic success and survival than a declining industry (Bradburd and Caves, 1982; Rosenbaum and Lamort, 1992; Audretsch, 1995; Boeri and Bellmann, 1995) due to a relatively low intensity of competition. Because the industry growth rates have opposite effects on firm survival, the overall effect is a priori unclear.

According to the organizational ecology approach one may expect that firm survival will be lower in populations exhibiting a large number of new entries due to relatively intense competition on the input side as well on the output side (Hannan and Freeman, 1989; MacDonald, 1986; Sterlacchini, 1994; Audretsch, 1995). Since entries represent continuously renewed challenges to incumbents, and each generation of entrants has to face continuously renewed challenges to incumbents posed by the new waves of entrants each year (Mata and Portugal, 1994), we expect a negative impact of the *industry start-up rate* on firm survival.

Although innovative industries tend to have above-average growth rates, a high level of *innovative activity* in an industry may make entry more risky; consequently, the effect on new firm survival should be negative (Brüderl et al., 1992; Audretsch, 1995; Audretsch et al., 2000; Licht and Nerlinger, 1998). In accordance with findings of Audretsch and Mahmood (1995), Audretsch et al. (2000) and Segarra and Callejon (2002), one may therefore expect relatively low survival chances for firms operating in R&D intensive industries because of the prevalence of high uncertainty. Survival chances may, however, greatly depend on a firm's ability to develop specific capabilities, which can be improved by investing in R&D (Penrose, 1959; Wernerfelt, 1984; Barney, 1991; Teece, Pisano and Shuen, 1997). From this point of view, undertaking R&D activities might be positively related to competitive advantage and to firm survival (Perez et al., 2004). Due to these contradicting effects and empirical results, business survival in R&D-intensive industries is a priori unclear.

2.3 Region-specific determinants

The observation that economic activity tends to be clustered in space (Audretsch and Feldman, 1996; Porter, 1998; Cooke, 2002) suggests that certain agglomeration economies exist which can compensate for the negative effect of density such as intense competition from other firms located in the vicinity which may lead to relatively intense competition on the input-side as well as on the output-side of the market. Such advantages of setting up a new business in a large agglomeration could include the availability of large, differentiated labor markets and of specialized services, easy access to research institutions, spatial proximity of large numbers of customers as well as other firms in the industry that may facilitate knowledge spillovers. It is, however, unclear whether such advantages result from the proximity to firms that are related to the same industry (localization economies) or to diverse kinds of actors and institutions (urbanization economies). The respective empirical evidence is rather mixed. While several studies found evidence for positive effects of being located in an agglomeration on firm survival (Keeble and Walker, 1994; Fotopoulos and Louri, 2000), other studies (e.g., Audretsch and Vivarelli, 1995; Gerlach and Wagner, 1994) identified a significant negative impact. Hence, the impact of agglomeration as such is a priori unclear.

A main reason for the unclear effect of agglomeration on new business survival may be the close relation of respective indicators such as population density and other measures like qualification structure of employees, regional R&D intensity, intensity of regional competition, regional price-level etc.

Associated with agglomeration theories, some researchers have noted the importance of industry localization. Based on the assumption that knowledge externalities exist within the same industry, Loesch's (1954) location theory indicated the relevance of industry localization. Within this context, Arrow (1962) suggested the concept of sticky knowledge, Romer (1986, 1990), Lucas (1993), and Krugman (1991) found that concentration of industry within geographical regions facilitated knowledge spillover across firms and that externality within a geographical boundary yields increasing returns. Focusing on spillovers among

firms within an industry, the Marshall-Arrow-Romer (MAR) model suggests that geographical specialization absorbs knowledge spillovers among firms. The geographical specialization emphasized in the MAR model is assumed to be within an industry, not across industries. Differing from the MAR theory, Jacobs (1969) indicated that diversity of industries and knowledge spillovers across geographically close industries promotes innovation and growth. For Jacobs (1969), exchange of complementary knowledge across diverse industries yields greater returns because it allows for new economic knowledge-inter-industry spillover (Acs et al., 2006). Whereas Glaeser et al. (1992) and Feldman and Audretsch (1999) investigated industry specialization versus diversity on employment growth, Acs et al. (2006) analyzed specialization versus diversity on firm survival, and they came to the same conclusion – that industry specialization does not help employment growth and firm survival. Dumais et al. (2002) found that plants are less likely to close in regions that belong to the geographic centers of the industry, while entry is more likely and growth is faster on the periphery. However, this result refers to plant closure in general and not the closure of newly founded businesses. Based on these findings, we expect a positive impact of a region's industry specialization on business survival.

A high level of innovative activity in a region (e.g., measured by the *share of R&D employees*) could be conducive to new business survival due to a high level of regional spillovers (Krugman, 1991). On the other hand, a highly innovative environment make entry more risky; consequently, its effect on firm survival could be negative (Brüderl et al., 1992; Audretsch, 1995; Audretsch et al., 2000). For this reason, the effect of innovation activity at a certain location on the survival of businesses is a priori undetermined.

We expect a negative relationship between the *regional start-up rate* and business survival because a high level of entry should lead to relatively high levels of competition and intensive market selection.

Regional employment growth serves as an indicator of local demand. Since prospering demand should be conducive to the survival of new businesses we expect a positive effect on the survival chances. Regional

employment growth can also be regarded an indicator for the overall economic strength of the region in which a new business is located.

Germany offers the unique possibility of comparing developments in two parts of the country, East and West Germany, which have experienced rather different political regimes and are characterized by rather distinct socio-economic conditions. While the western part of the country became a prospering market economy after World War II, East Germany has been under a socialist regime until the year 1990 and is since then experiencing a fundamental process of transformation to a market-driven system (Fritsch, 2004). There are only few studies investigating differences in firm success and survival in East and West Germany which is probably mainly due to data limitations. It has been shown that East German entry cohorts in the early 1990s experienced relatively high survival rates (Brixly and Grotz, 2004; Fritsch, 2004) what may be explained by the 'density delay' hypothesis which posits that organizations which were set-up at a time where the economic environment has not been very crowded have higher survival rates than organizations founded in periods with higher density (Carroll and Hannan, 1989, 2000).⁴ Accordingly, as more and more firms had entered the East German market, survival rates of entry cohorts declined year by year and, after 1998, were below the West German level (Fritsch, 2004). Our dataset covers start-up cohorts of the years 1992 to 2005 and allows a more detailed analysis of differences in the survival of new businesses between the two parts of the country.

3. Data and empirical methodology

Our data about the survival of German manufacturing establishments are based on the Establishment History Panel prepared and provided by the Institute for Employment Research at the Federal Employment Agency. It contains

⁴ Due to the fact that East Germany faced a nearly complete lack of entrepreneurial activity up to the year 1989, there was a 'window of opportunity' for entrepreneurs during the first years following the transition characterized by limited competition and many market opportunities that resulted from the rather limited availability of goods and services under the former socialist regime.

information about all German establishments that have at least one employee subject to mandatory social security payments (see Spengler, 2008, for a description of the data). Hence, businesses consisting only of the owner are not included what leads to a slight underestimation of the whole business population. However, businesses enter the database as soon as the first employee is hired.⁵ The data provides calendar date information about 1.3–2.5 million establishments per year, i.e. we know the exact date at which a new business entered or exited the data base. Although the data provides information on West German establishments from the year 1975 onwards, we restrict our analysis to those businesses that have been set up in the 1992 to 2005 period in order to compare the development of East and West German firms.⁶ By restricting the sample to businesses that have been set up between 1992 to 2005 we avoid left-censoring – a problem in duration analysis that is caused if it is only known that birth happened before a specific point in time without knowing the exact point in time. Nevertheless the data might contain another source of left-censoring: a new business will be observed for the first time when an employee that is subject to social assurance and thus the real time of entry might be delayed. For several reasons, such as the engagement of seasonal workers or data misspecifications, there are many businesses in the dataset with a survival time of less than one year, often for just a few days and weeks. Since the majority of such cases can hardly be regarded to represent the activity of new economic entities we excluded them if the survival time was less

⁵ There may be some misspecification in the data because the year of hiring a first employee is taken as the time of start-up even if the establishment was already in existence prior to this time without any employee subject to mandatory social insurance. The share of such cases is, however, rather small (see Fritsch and Brixy, 2004). There is no database available in Germany that provides complete coverage of those new businesses that never have any employees, so the number of these cases is unknown. Since these businesses create a job only for the founder, one may well assume that they cannot be regarded ‘Schumpeterian’ start-ups in terms of their contribution to overall employment.

⁶ We exclude all establishments with the entry date 1 January 1991 and earlier since all establishments in East Germany founded before this date show that date as their entry date even if they were set up before that time. In addition, we determine that a firm failed if the establishment exited the market not later than 31 December 2005 since all establishments that still exist show 31 December 2005 as their exit date. This leads to a slight underestimation of firm failures that exit the database on the exact date of 31 December 2005.

than one year. Furthermore, we excluded all new entities with more than 20 employees in the first year of their existence since most of these cases represent a reorganization of an already existing firm such as the establishments of a subsidiary plant.⁷ The analyses reported here are restricted to the manufacturing sector since the service industries represent a total different case that should be analyzed separately.

Previous analyses of new business survival often used binary choice models, i.e., probit and logit models (Audretsch, 1995; Boeri and Bellmann, 1995), or tobit models (Wagner (1994) using yearly information on entry and/or exit of new entities. Whereas these traditional cross-section techniques examine the unconditional average probability of the occurrence of an event during a certain period (in most cases during a year) or the average duration (time of survival), a survival duration model allows to control for both the occurrence of an event (i.e., the failure of a firm) and the timing of the event (i.e., the elapsed time till the failure took place). More generally, duration analysis allows to model the time to event and takes into account the evolution of the exit risk and its determinants over time (Perez et al., 2004).

Since in most cases, a number of the newcomers in a sample will not have failed during the period of analysis, the information on their life-span is incomplete and right censored. Hence, applying conventional statistical methods may result in biased and inconsistent estimates (Mata and Portugal, 1994). The hazard model is specifically designed to deal with this problem. According to Kalbfleisch and Prentice (1980), the hazard function is defined as the probability that a firm exits the market in period t given that it has survived until t and conditional on a vector of (time-varying) covariates X_t :

⁷ The number of new establishments with more than 20 employees makes up about 2.5 percent of all cases including some rare cases with several hundred employees. This is a well established procedure for cleaning the data. The results do not change very much if we include all new establishments, but the share of rather doubtful cases among the numbers with more than 20 employees in the first year is rather high.

Here, t is a non-negative random variable (duration), which is assumed to be continuous, so that $\lambda(t)$ is an instantaneous exit rate, i.e. this model encloses exit rates on a daily basis.. Estimating such a model requires an a-priori specification of the functional form. Unlike the traditional models, such as probit, logit and tobit, that all make distributional assumptions, the Cox Proportional Hazards Model (Cox, 1972) is more attractive since there exist no strong theoretical or empirical argument for a particular distributional form for the probability of firm failure (probit and logit) or firm age (tobit). Moreover, the potential problem of unobserved heterogeneity is overcome (Dolton and Van-der-Klaauw, 1995). The hazard rate in the Cox proportional hazard model is given by

$$\lambda(t) = \lambda_0(t) \exp(\beta'X)$$

where $\lambda_0(t)$ is the baseline hazard function obtained for values of covariates equal to zero ($X=0$). Hence, the effect of the independent variables is a parallel shift of the baseline function, which is estimated for all those firms surviving up to a particular point in time. By leaving the baseline function unspecified, the model is estimated maximizing a partial likelihood function related to the vector of coefficients β .

In a first step of analysis, we first conducted two non-parametric tests of equality of survival functions across several groups of firms (e.g., East and West German businesses, businesses in R&D-intensive and non-R&D intensive industries, etc.) and found that there are statistically significant differences with regard to the hazard rate between these groups (Cleves et al., 2004). In addition, we conducted stratified Log-rank tests for the equality of survival functions of East and West German firms, controlling for the R&D intensity of the industry.

Table 1: Explanatory variables and expected signs⁸

Determinant	Definition	Expected sign for relationship with business failure risk
Age	Number of years the establishment is operating in the respective year.	(-)
Age ²	Quadratic term of age.	(+)
Start-up size	Number of employees in the establishment at the time of set-up.	(-)
High education level	Binary variable with the value = 1 if the number of highly qualified employees in the establishment is above the mean value of the number of highly qualified employees in all establishments; value = 0 otherwise.	(-)
R&D intensive	Binary variable with the value = 1 if the industry is classified as R&D intensive ⁹ ; value = 0 otherwise.	(+/-)
High-tech	Binary variable with the value = 1 if the industry is classified high-tech ¹⁰ ; value = 0 otherwise.	(+/-)
Minimum efficient size	75 th percentile of establishment size when establishments are ordered by the number of employees. ¹¹	(+)
Industry employment growth	Yearly percent change of the number of employees in the industry (3-digit level).	(+/-)
Industry start-up rate	Number of yearly start-ups in an industry per 1,000 employees in the respective industry and year.	(+)
Capital intensity	Capital stock divided by the number of employees multiplied by the hours worked by the employees per industry (2-digit) and year (Source: EU KLEMS Database).	(+/-)
Labor unit costs	Compensation of employees over gross output per industry (2-digit) and year (Source: EU KLEMS Database).	(+)
Share of regional R&D employees	Number of employees in the region with a degree in engineering or natural science (Source: German Federal Statistic Office).	(+)

⁸ The correlation of all variables used in the analysis is displayed in Table A1 in the Appendix.

⁹ According to Grupp and Legler (2000), manufacturing industries are classified as R&D-intensive if the ratio of R&D expenditures over sales is 3.5 percent and higher.

¹⁰ High-tech industries (Grupp and Legler, 2000) have a ratio of R&D expenditures over sales higher than 8.5 percent.

¹¹ The minimum efficient size of the respective industry is defined as the number of employees that the establishments have to achieve in order to be profitable (Wagner 1994; Audretsch 1995). It is measured by the 75th percentile of establishment size of the respective industry and year, i.e. 75% of all establishments in this industry have at least this certain number of employees.

Regional employment growth	Yearly percent employment change in the respective region.	(-)
Regional start-up rate	Number of yearly regional start-ups per 1,000 employees in the respective region and year.	(+)
Specialization index	Employment share of industry i in region j , relative to the respective industry's share in national employment. ¹²	(-)
Specialization index ²	Quadratic term of specialization index.	(+)
Employment density	Number of inhabitants in a region per square kilometer (log).	(+/-)
East	Binary variable with the value = 1 if the establishment is located in East Germany, value = 0 for location in West Germany.	(+/-)

4. Results

A first visual impression of survival chances of new businesses over time can be provided by a non-parametric kernel smoothed estimate of the hazard function (Figure 1).¹³ It indicates the probability that a business fails in a particular period given that it has survived up to this period. In general, we found that the hazard rate first increases up to the second year of survival and then continuously decreases until the sixth year in East Germany and the ninth year in West Germany. After this minimum has been attained hazard rates increase monotonically at least until year thirteen.¹⁴ In general, the survival probability of new businesses seems to be higher in the West as compared to the East. Since the pattern of failure risk during the first four years after entry is about parallel for both parts of the country, one can say that both East and West German establishments are faced with a liability of newness and a liability of adolescence to about the same manner. Beginning in the fourth year, however, ,

¹² This specialization index measures *Marshallian* specialization externalities and is calculated according to Feldman and Audretsch (1999), Paci and Usai (1999), and van der Panne (2004).

¹³ Since the estimator of the hazard function requires a large number of failures at each time point to avoid too much variability in the values and the estimator is undefined at points where there are no observed events, we used an elaborate method of averaging called kernel smoothing (for details, see Klein and Moeschberger, 2003)).

¹⁴ The kernel smoothed estimates of the hazard function have to be interpreted with caution since they are not reliable in the right tail where the number of subjects still being followed is rather small (Hosmer et al., 2008).

the gap between East and West German businesses in terms of business survival starts to grow and persist for the rest of the observation period. Possible explanations for a higher failure risk of East German establishments after about 4 years are manifold. For example, East German businesses, on average, tend to have inferior resource endowments in terms of financial resources, entrepreneurial skills, human capital, experience in operating a business, etc. and worse local market and demand conditions than their West German counterparts. Since the number of start-ups and businesses in East Germany is much higher during the first years (1991-1996), the characteristics of the hazard rate for Eastern Germany for the first 4-6 years tends to be mainly influenced by businesses being set up during the first years after reunification, the time in which the window of opportunity still lasts. Thus, the pattern of hazard rates (Figure 1) can also be regarded as a confirmation of the “density delay” hypothesis which states that organizations set-up at a time when the market was not very crowded have higher survival chances than organizations founded in periods with higher market density (Carroll and Hannan, 1989, 2000). Since the gap in terms of business survival between East and West does not start to grow before 1998¹⁵, this implies a higher intensity of market selection and, thus, higher exit risk due to higher market density for East German businesses founded in the later years of the transformation process.¹⁶ Last but not least, most start-ups in East Germany are highly subsidized. Especially in the first years after the reunification of Germany, the nearly complete lack of entrepreneurial activity in the former German Democratic Republic (GDR) led to an ambitious political goal of fostering entrepreneurial activity in that region of the country with the hope of narrowing the gap between East and West Germany. Hence, businesses involved in such programs have to survive

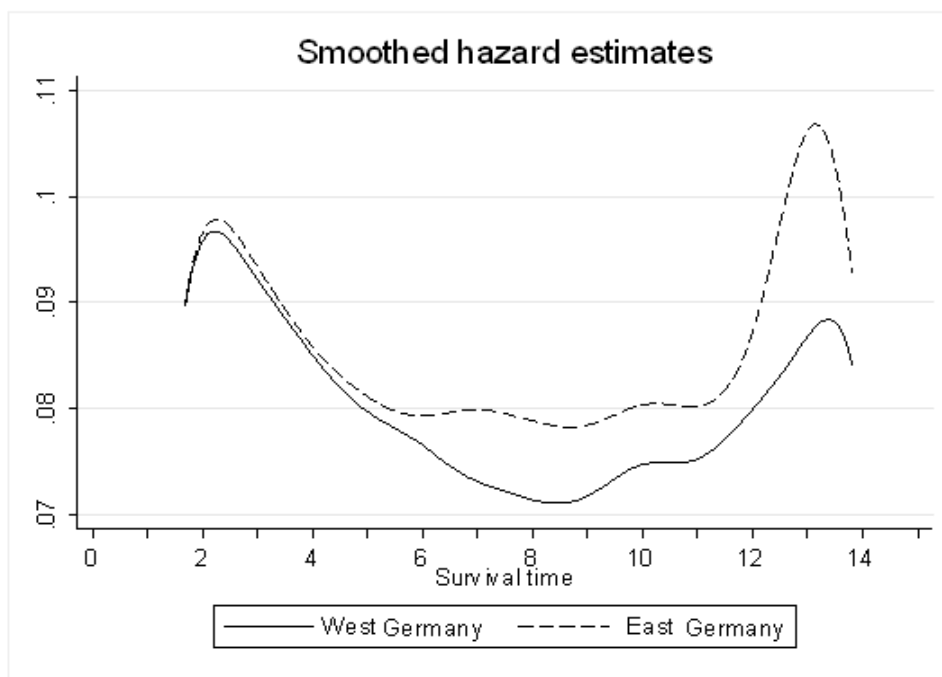
¹⁵ Since the earliest start-up time of the businesses in our sample is the year 1992, the gap of East and West German exit risk does not start before the year 1996, the time when the “window of opportunity” began to close, the industry became more crowded, and competition intensified.

¹⁶ This explanation fits with the findings of Fritsch (2004) who showed that the survival chances of East German entry cohorts in the years 1993 to 1997 are relatively high and above the West German level, but the survival rates of later cohorts were below the West German level. But, of course, also start-ups from later years are included in the East German hazard rate, so that this interpretation has carefully to be taken into account.

without any financial assistance from a certain point of time after the program ends. In contrast to most West German businesses where the selection mechanisms already spawned the most efficient start-ups that were adapted to the environment and could consolidate their market positions, the failure risk for East German businesses seems to persist on a relatively high level after the subsidy programs end, whereas it continues to decrease in West Germany.

On average, there were 212,505 manufacturing establishments in our dataset of which 103,942 (45.91 percent) failed during the period of analysis (Table 2). The mean survival time amounts to 6.58 years. About 25 percent of the establishments have a survival time of more than 10 years and 5 percent survived longer than 14 years. On average, the establishments started with three employees; just about 10 percent of all establishments started with more than 10 employees. Moreover, only 10 percent of the establishments had an above-average share of highly educated employees and were operating in industries classified as R&D-intensive, whereas 7 percent were active in high-tech industries.

Figure 1: Non-parametric hazard rates in East and West Germany



There are pronounced regional differences in the three-year (Figure 2) and the ten-year (Figure 3) survival rates which strongly indicate the importance of regional factors. Relatively high survival rates are particularly found in the southern regions of West and East Germany. Except for the regions around Hamburg, the survival rates were much lower in the northern part of the country, especially in the Ruhr area north-west of Cologne. This spatial pattern seems to primarily indicate a North-South divide than an East-West divide. Except for the highly agglomerated areas in the south of Germany, such as Stuttgart and Munich, survival rates appear to be lower survival in urbanized areas such as Berlin, Hamburg, the Ruhr area, and in Frankfurt.

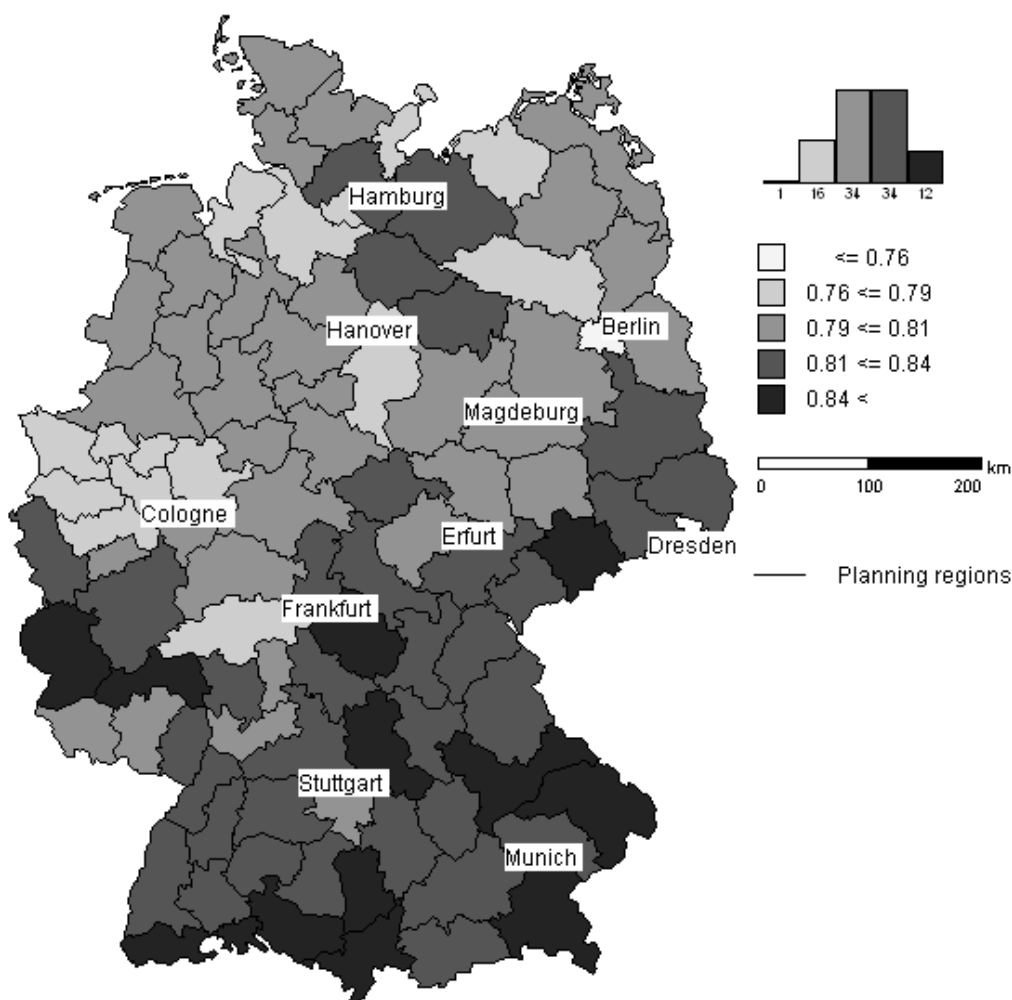


Figure 2: Regional distribution of the survival rates after 3 years

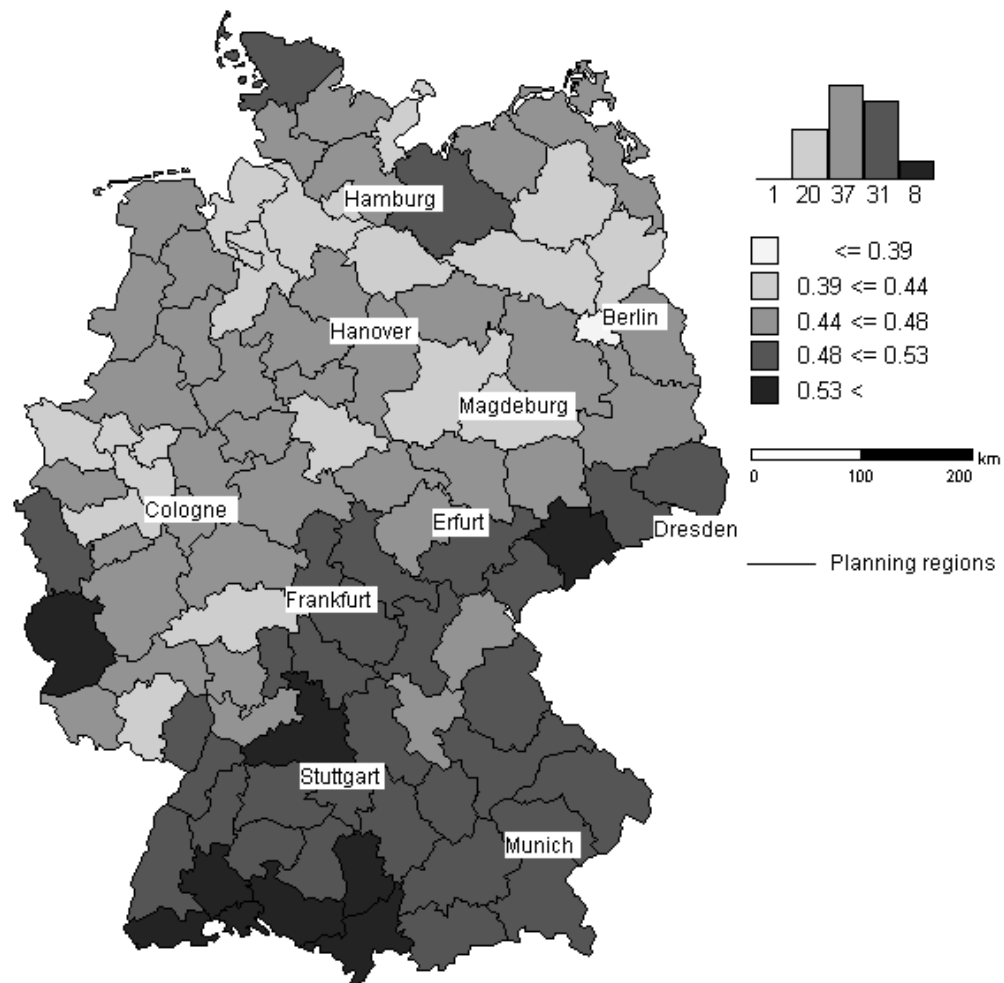


Figure 3: Regional distribution of the survival rates after 10 years

Table 2: Descriptive statistics

Variable	Number of observations	Mean	Median	25% perc	75% perc	90% perc	95% perc	99% perc	Std. dev.	Minimum	Maximum
Survival time	212,505	6.58	6.00	3.09	9.67	12.87	14.00	14.25	3.94	1.00	14.50
Age	1 151,699	4.74	4.00	2.00	7.00	10.00	11.00	13.00	3.25	1.00	14.00
Age ²	1 151,699	32.98	16.00	4.00	49.00	100.00	121.00	169.00	40.78	1.00	196.00
Start-up size (log)	1 098,113	1.04	1.10	0.00	1.61	2.30	2.64	2.94	0.88	0.00	3.00
		2.82	3.00	1.00	5.00	10.00	14.00	19.00	2.41	1.00	20.00
High education level	1 151,699	0.11	0.00	0.00	0.00	1.00	1.00	1.00	0.31	0.00	1.00
R&D intensive	1 151,699	0.24	0.00	0.00	0.00	1.00	1.00	1.00	0.43	0.00	1.00
High-tech	1 151,699	0.07	0.00	0.00	0.00	0.00	1.00	1.00	0.26	0.00	1.00
Minimum efficient size (log)	1 151,699	1.91	1.79	1.61	2.30	2.71	2.89	3.69	0.58	0.00	5.92
		6.79	5.99	5.00	10.00	15.00	18.00	40.00	1.79	1.00	372.50
Industry employment											
Growth	1 031,581	0.11	0.09	0.03	0.15	0.26	0.40	0.69	0.15	-2.74	4.63
Industry start-up rate (log)	1 151,481	2.95	3.00	2.39	3.58	4.03	4.44	5.54	0.94	-1.14	6.91
Capital intensity (log)	1 151,699	-2.66	-2.86	-3.14	-2.30	-1.59	-1.37	-1.12	0.65	-4.01	-1.04
Labor unit costs (log)	1 151,699	-1.27	-1.21	-1.41	-1.13	-1.06	-1.01	-0.95	0.19	-1.74	-0.91
Share R&D employees (log)	1 051,492	3.95	3.96	3.47	4.38	4.77	5.01	5.46	0.64	1.76	7.06
Regional employment											
growth	1 120,999	0.12	0.07	0.00	0.17	0.35	0.55	1.07	0.23	-5.67	3.48
Regional start-up rate (log)	1 151,699	2.85	2.83	2.58	3.06	3.27	3.42	4.77	0.46	1.46	5.62
Regional employment											
density (log)	1 151,699	3.67	3.33	2.66	4.54	5.84	6.21	6.55	1.31	0.43	6.76
Regional specialization											
index	1 151,699	1.58E+03	3.99E+02	2.20E+02	1.02E+03	3.05E+03	5.40E+03	1.67E+04	1.92E+04	7.39E+01	1.32E+07
Regional specialization											
index squared	1 151,699	3.69E+08	1.59E+05	4.85E+04	2.92E+07	9.33E+06	2.92E+09	2.78E+10	1.67E+11	5.46E+03	1.74E+14
East Germany	1 151,699	0.37	0.00	0.00	1.00	1.00	1.00	1.00	0.48	0.00	1.00

Since we expected differences in the survival rates of East and West German businesses as well as between businesses belonging to R&D-intensive or high-tech industries compared to businesses in other industries, we conducted two non-parametric tests of equality of survival functions (Log-rank test and Wilcoxon-Breslow-Gehan test) across groups of businesses and stratified Log-rank tests of the equality of survival functions (Table 3). The results indicate statistically significant higher survival chances in West Germany as compared to East Germany as well as higher survival chances for businesses belonging to R&D-intensive industries and high-tech industries. Differences in survival rates between R&D-intensive industries and non-R&D-intensive industries are, however only statistically significant in West Germany but not in East Germany. These results imply to additionally estimate the Cox proportional hazard model differentiated by the groups (East and West Germany, R&D- versus non R&D-intensive industries, high-tech versus non high-tech industries) to analyze the survival determinants more specifically.

Table 3: Non-parametric tests for the equality of survival functions

	East and West Germany				East Germany		West Germany	
	Log-rank		Wilcoxon		Log-rank		Log-rank	
	Chi ²	Pr>Chi ²	Chi ²	Pr>Chi ²	Chi ²	Pr>Chi ²	Chi ²	Pr>Chi ²
East Germany	35.28	(0.0000)	12.38	(0.0000)	--		--	
R&D-intensive	39.87	(0.0000)	7.05	(0.0004)	1.81	(0.1782)	44.89	(0.0000)
High-tech	411.01	(0.0000)	291.35	(0.0000)	113.57	(0.0000)	296.17	(0.0000)

Estimations of the multivariate Cox proportional hazard model (Table 4) indicate a u-shaped pattern of business survival over time. Accordingly, the relatively high risk of failure for young businesses first tends to decrease with age and then continuously increases again. The relatively high exit rates for older businesses that we find in our data may have a number of different reasons such as erosion of technology, products, business concepts, or management strategies. A further explanation could be that owners close their

business in order to retire or that they transfer their business to a successor, what is classified as an exit and an entry in our database.¹⁷ In addition, we found evidence supporting the liability of smallness hypothesis suggesting higher survival probabilities for businesses that start on a relatively large scale. The significantly negative sign for our measure of an industry's minimum efficient size clearly indicates that small scale entry is particularly critical in industries in which small entries face relatively large cost disadvantages compared to their efficiently scaled competitors. High quality of human capital as indicated by an above-average share of highly educated employees (employees with a tertiary degree) leads to a lower exit-risk.

R&D intensity and a high-tech character of an industry have a strong positive effect on business survival rates.¹⁸ This result supports the argument that investment in R&D leads to a comparative advantage and higher survival chances. The level of capital intensity and labor unit costs in the respective industry were also statistically significant with the expected sign. This indicates that the higher the level of capital intensity and labor unit costs in an industry, the higher the risk of failure because a larger amount of resources is needed to attain the industry's minimum efficient size.

Regional specialization in a certain industry clearly has a negative effect on survival chances. Hence, we do not find any evidence for localization economies on business survival. A relatively high start-up rate in the respective industry or region leads to comparatively low survival rates which may be explained by a relatively high intensity of competition that results from the high level of entry. According to our results prosperous growth in the particular industry or in the region is conducive to business survival. In estimations for East and West Germany together regional employment density has a highly significant positive

¹⁷ In the Social Insurance Statistics, new businesses are identified by the emergence of a new establishment number; accordingly, disappearance of an establishment number is counted as an exit. The establishment number is linked to the person responsible for the payment of social insurance contributions, which in case of non-incorporated firms is the business owner. Hence, in case of ownership change the Social Insurance Statistics records an exit and an entry.

¹⁸ By excluding the high-tech dummy from the regressions, we also obtained a significant negative coefficient for R&D-intensive industries. Due to space restrictions, we did not include two additional models, but the results can be ordered from the authors.

sign indicating lower survival prospects in agglomerations. This seems to hold particularly for West Germany while in the estimations for East Germany the regional employment density remains insignificant. While the regional share of R&D employees seems to be conducive to the survival of new businesses in West Germany our estimations indicate the opposite relationship for an duration analysis of businesses in East Germany. A possible explanation for this result might be a competitive disadvantage of R&D intensive businesses in East-Germany. Thus East-German start-ups in regions with high shares of E&D employment might face relatively stronger competition from West-German or international firms that might result in relatively lower duration probabilities compared to other East-German start-ups that do not face such strong competition.

There are a number of interesting differences among the determinants of survival between East and West Germany. On average, businesses located in East Germany face a higher exit risk than those in West Germany. Whereas agglomeration diseconomies can only be found for West German businesses, we found a negative impact of a high share of R&D employees for East German establishments, whereas we found a positive impact on business survival for West German establishments. Moreover, the negative impact of capital intensity and labor unit costs is much larger in East Germany than in West Germany.

Table 3 shows the significant differences between the survival of East and West German establishments as well as between businesses belonging to R&D-intensive or high-tech industries compared to other industries, and we estimate alternative models differentiated by these groups.

Table 4: Regression results

<i>Dep. Variable: Hazard rate</i>	<i>East and West Germany (I)</i>	<i>West Germany (model II)</i>	<i>East Germany (III)</i>
Age	-0.416*** (-88.93)	-0.406*** (-68.10)	-0.443*** (-54.14)
Age ²	0.0125*** (28.15)	0.0126*** (21.17)	0.0120*** (16.31)
Start-up size	-0.125*** (-27.12)	-0.121*** (-21.78)	-0.140*** (-16.73)
High education level	-0.0848*** (-6.21)	-0.0924*** (-5.27)	-0.0725*** (-3.25)
R&D intensive	-0.00527 (-0.41)	-0.0180 (-1.20)	0.0259 (1.08)
High-tech	-0.104*** (-5.13)	-0.0914*** (-3.81)	-0.144*** (-3.76)
Minimum efficient size	0.200*** (12.32)	0.190*** (9.66)	0.223*** (7.83)
Industry employment growth	-0.0818* (-1.81)	-0.0738 (-1.43)	-0.0767 (-0.86)
Industry start-up rate	0.0284** (2.02)	0.0173 (1.01)	0.0545** (2.22)
Capital intensity	0.114*** (16.16)	0.0877*** (10.21)	0.166*** (13.25)
Labor unit costs	0.226*** (9.62)	0.137*** (5.02)	0.462*** (10.19)
Regional share of R&D employees	-0.0089 (-0.94)	-0.0370*** (-3.60)	0.131*** (5.51)
Regional employment growth	-0.0531** (-2.57)	-0.0474** (-2.29)	-0.0597 (-0.66)
Regional start-up rate	0.0669*** (3.29)	-0.0111 (-0.39)	0.209*** (5.83)
Regional employment density	0.0617*** (15.86)	0.0738*** (15.58)	0.00499 (0.61)
Regional specialization index	5.19e-06*** (3.51)	5.21e-06*** (2.72)	5.05e-06*** (2.67)
Regional specialization index squared	-0.0000 (-1.35)	-0.0000 (-1.09)	-0.0000 (-1.36)
East Germany	0.170*** (14.44)		
Time dummies	yes	yes	yes
Number of observations	167,101	117,233	49,868
Pseudo R-squared	0.0257	0.0237	0.0374
LogPseudoLikelihood	-892547	-598364	-244661

Notes: Cox proportional hazard model. Robust z-statistics are given in parentheses. ***Statistically significant at the 1% level; **Statistically significant at the 5% level; *statistically significant at the 10% level.

The main differences between R&D intensive or high-tech businesses and non R&D intensive and non high-tech businesses (Table A2 and A3) are pertain to the impact of the minimum efficient size, to capital intensity and to labor unit costs in the respective industry. The negative relationship between the minimum efficient size and business survival is much stronger in R&D-intensive or high-tech industries. Whereas the negative impact of capital intensity and labor unit costs is much stronger in R&D intensive industries than in non R&D intensive industries, we did not find any significant results related to these effects in high-tech industries.

5. Summary and Conclusions

Employing a rich, establishment-level data set from German manufacturing for the years 1992 to 2005, we conducted a multidimensional analysis of business-, industry- and region-specific survival determinants. The estimations of a Cox proportional hazards model suggest that the probability of exit is higher for young, for relatively small as well as for mature businesses. Besides the general finding of a higher exit risk in high-density areas an above-average level of highly qualified employees working in an establishments decreases the probability of exit. Furthermore, establishments in capital-intensive industries, in industries with a relatively high minimum efficient size and with high labor unit costs face higher hazard rates. Establishments in high-tech industries enjoy better survival prospects. However, a specialized regional production structure increases the failure risk. Comparing East and West Germany we found higher survival chances in the West of the country.

This paper provides evidence that regional industry specialization is not beneficial for the survival of newcomers in a respective industry, although the negative effect of regional industry specialization is decreasing for higher levels of specialization. This result adds some interesting points to the findings of Dumais et al. (2002) who discovered that closure is less likely in those regions that belong to the current geographic centers of an industry and tends to increase geographic concentration. Our results suggest that in German

manufacturing industries not only a business's entry but also its survival chances (in opposition to closure in general) are forces that reduce geographic concentration. Possible benefits from geographically bounded, within-industry spillovers seem to be of less importance than the counterforce of intensified local competition for survival.

Since the results show that establishment size is positively related to business survival, it is important for a company to quickly achieve a minimally efficient size in order to be successful in the market. The comparatively high ancillary labor cost in Germany as well as labor market inflexibilities due to regulations such as dismissal protection may result in a severe disadvantage for new business survival in Germany. Although East Germany, on average, nearly converged to the West German level in terms of entrepreneurial activity (Schindele, 2009), entrepreneurship policy could do more than simply enhancing the number of start-ups in East German regions. Since East German businesses tend to have a higher failure risk, policy should focus on enhancing the quality of start-ups, especially in R&D and high-tech industries.

Appendix

Table A1: Correlation table

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 Survival time	1.00 0.00																		
2 Age	0.65 0.00	1.00 0.00																	
3 Age ²	0.60 0.00	0.96 0.00	1.00 0.00																
4 Start-up size	0.07 0.00	0.04 0.00	0.04 0.00	1.00 0.00															
5 High education level	0.03 0.00	0.03 0.00	0.03 0.00	0.18 0.00	1.00 0.00														
6 R&D intensive	0.00 0.24	0.00 0.00	0.00 0.00	0.07 0.00	0.16 0.00	1.00 0.00													
7 High-tech	0.00 0.18	0.05 0.00	0.05 0.00	0.00 0.18	0.13 0.00	0.49 0.00	1.00 0.00												
8 Minimum efficient size	-0.07 0.00	0.05 0.00	0.05 0.00	0.19 0.00	0.20 0.00	0.31 0.00	0.07 0.00	1.00 0.00											
9 Industry empl. growth	0.04 0.00	-0.34 0.00	-0.31 0.00	0.03 0.00	0.04 0.00	0.08 0.00	0.03 0.00	0.04 0.00	1.00 0.00										
10 Industry start-up rate	0.08 0.00	-0.34 0.00	-0.31 0.00	-0.10 0.00	-0.17 0.00	-0.31 0.00	-0.23 0.00	-0.75 0.00	0.32 0.00	1.00 0.00									
11 Capital intensity	-0.02 0.00	0.11 0.00	0.10 0.00	-0.06 0.00	-0.09 0.00	-0.46 0.00	-0.19 0.00	-0.26 0.00	-0.24 0.00	0.11 0.00	1.00 0.00								
12 Labor unit costs	0.02 0.00	-0.28 0.00	-0.26 0.00	0.04 0.00	0.00 0.01	0.06 0.00	-0.05 0.00	0.08 0.00	0.42 0.00	0.28 0.00	-0.65 0.00	1.00 0.00							
13 Share R&D employees	-0.06 0.00	-0.20 0.00	-0.20 0.00	-0.06 0.00	-0.01 0.00	0.06 0.00	0.05 0.00	-0.02 0.00	0.17 0.00	0.08 0.00	-0.10 0.00	0.09 0.00	1.00 0.00						

to be continued...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
14 Regional empl. growth	0.01 0.00	-0.30 0.00	-0.27 0.00	-0.03 0.00	-0.03 0.00	0.00 0.00	-0.04 0.00	-0.07 0.00	0.45 0.00	0.33 0.00	-0.11 0.00	0.26 0.00	0.21 0.00	1.00 0.00					
15 Regional start-up rate	0.02 0.00	-0.39 0.00	-0.35 0.00	-0.03 0.00	-0.04 0.00	-0.02 0.00	-0.06 0.00	-0.15 0.00	0.40 0.00	0.55 0.00	-0.15 0.00	0.38 0.00	0.16 0.00	0.36 0.00	1.00 0.00				
16 Employment density	-0.05 0.00	-0.02 0.00	-0.02 0.00	0.00 0.00	0.04 0.00	0.05 0.00	0.07 0.00	-0.01 0.00	0.01 0.00	-0.02 0.00	-0.05 0.00	0.00 0.04	0.52 0.00	-0.03 0.00	-0.14 0.00	1.00 0.00			
17 Spec. index	0.00 0.03	-0.02 0.00	-0.02 0.00	-0.01 0.00	0.00 0.17	-0.02 0.00	-0.01 0.00	-0.04 0.00	-0.02 0.00	0.06 0.00	0.01 0.00	0.00 0.01	0.01 0.00	0.02 0.00	0.04 0.00	0.00 0.00	1.00 0.00		
18 Spec. index sq	0.00 0.20	0.00 0.06	0.00 0.16	0.00 0.27	0.00 0.58	0.00 0.19	0.00 0.51	-0.01 0.00	-0.01 0.00	0.01 0.00	0.00 0.56	0.00 0.62	0.00 0.02	0.00 0.21	0.00 0.04	0.00 0.82	0.79 0.00	1.00 0.00	
19 East Germany	0.11 0.00	0.08 0.00	0.09 0.00	0.11 0.00	0.07 0.00	-0.03 0.00	-0.02 0.00	-0.05 0.00	0.10 0.00	0.14 0.00	0.00 0.00	0.08 0.00	-0.49 0.00	-0.17 0.00	-0.11 0.00	0.06 0.00	-0.01 0.00	0.00 0.26	1.00 0.00

Table A2: Regression results for (non) R&D intensive businesses

Dep. Var.: Hazard rate	Non R&D intensive	R&D intensive	Non R&D intensive	Non R&D intensive	R&D intensive	R&D intensive
	All	All	West Germany	East Germany	West Germany	East Germany
Age	-0.415*** (-78.54)	-0.422*** (-41.83)	-0.405*** (-60.11)	-0.444*** (-48.16)	-0.410*** (-32.09)	-0.443*** (-24.83)
Age2	0.0123*** (24.60)	0.0132*** (13.65)	0.0124*** (18.56)	0.0121*** (14.55)	0.0131*** (10.11)	0.0119*** (7.39)
Start-up size	-0.130*** (-24.57)	-0.110*** (-11.68)	-0.129*** (-20.28)	-0.136*** (-14.22)	-0.0934*** (-8.34)	-0.158*** (-9.10)
High education level	-0.114*** (-6.49)	-0.0377* (-1.71)	-0.132*** (-5.72)	-0.0938*** (-3.34)	-0.0454* (-1.65)	-0.0126 (-0.34)
High-tech		0.0202 (0.85)			0.0252 (0.90)	-0.00318 (-0.07)
Min. eff. Size	0.0427** (2.23)	0.527*** (17.09)	0.0332 (1.42)	0.0672** (2.00)	0.533*** (14.49)	0.508*** (8.97)
Industry empl. growth	-0.191*** (-3.15)	0.0221 (0.31)	-0.218*** (-3.13)	-0.0614 (-0.51)	0.0530 (0.66)	-0.0733 (-0.49)
Industry startup rate	-0.104*** (-6.22)	0.239*** (9.33)	-0.113*** (-5.52)	-0.0789*** (-2.69)	0.212*** (6.89)	0.302*** (6.50)
Capital intensity	0.115*** (15.48)	0.625*** (6.87)	0.0861*** (9.55)	0.174*** (12.95)	0.653*** (6.18)	0.508*** (2.90)
Labor unit costs	0.220*** (8.89)	1.553*** (7.53)	0.132*** (4.60)	0.463*** (9.56)	1.732*** (7.11)	1.046*** (2.72)
Share R&D employees	-0.00853 (-0.79)	-0.00649 (-0.33)	-0.0350*** (-2.98)	0.125*** (4.68)	-0.0415* (-1.94)	0.162*** (3.05)
Regional empl. growth	-0.0752*** (-3.22)	0.0232 (0.53)	-0.0651*** (-2.78)	-0.0890 (-0.87)	0.0106 (0.24)	0.0509 (0.26)
Regional startup rate	0.0683*** (2.97)	0.0619 (1.41)	-0.0210 (-0.66)	0.227*** (5.61)	0.0203 (0.33)	0.131* (1.69)
Employment density	0.0637*** (14.36)	0.0551*** (6.79)	0.0725*** (13.45)	0.0100 (1.09)	0.0772*** (7.76)	-0.00969 (-0.55)
East Germany	0.165*** (12.37)	0.188*** (7.47)				
Time dummies	yes	yes	yes	yes	yes	yes
Observations	128572	38529	89571	39001	27662	10867
Pseudo R-squared	0.0261	0.0314	0.0238	0.0384	0.0303	0.0447
LogPseudoLikelihood	-676553	-173229	-450270	-187636	-118251	-44092

Notes: Robust z-statistics are given in parentheses. ***Statistically significant at the 1% level; **statistically significant at the 5% level; * statistically significant at the 10% level.

Table A3: Regression results for (non) high-tech businesses

Dep. Var.: Hazard rate	Non high-tech	High-tech	Non high-tech	Non high-tech	High-tech	High-tech
	All	All	West Germany	East Germany	West Germany	East Germany
Age	-0.414*** (-85.75)	-0.461*** (-23.87)	-0.403*** (-65.32)	-0.443*** (-52.54)	-0.459*** (-19.42)	-0.468*** (-13.27)
Age ²	0.0123*** (26.88)	0.0157*** (9.03)	0.0124*** (19.98)	0.0120*** (15.78)	0.0168*** (7.65)	0.0136*** (4.44)
Start-up size	-0.127*** (-26.78)	-0.103*** (-5.21)	-0.125*** (-21.91)	-0.136*** (-15.90)	-0.0578** (-2.48)	-0.212*** (-5.72)
High education level	-0.0831*** (-5.68)	-0.114*** (-2.92)	-0.0954*** (-5.02)	-0.0659*** (-2.80)	-0.107** (-2.30)	-0.121* (-1.68)
R&D intensive	0.00202 (0.16)		-0.0109 (-0.72)	0.0331 (1.36)		
Min. eff. Size	0.174*** (10.65)	0.346*** (4.06)	0.166*** (8.42)	0.191*** (6.56)	0.321*** (3.27)	0.497*** (2.94)
Industry empl. growth	-0.157*** (-3.19)	0.106 (0.76)	-0.144** (-2.57)	-0.160 (-1.64)	0.0882 (0.57)	0.293 (0.92)
Industry startup rate	0.0189 (1.34)	-0.143 (-1.57)	0.00748 (0.44)	0.0455* (1.82)	-0.164 (-1.59)	-0.00974 (-0.05)
Capital intensity	0.113*** (15.92)	-0.359 (-1.03)	0.0877*** (10.17)	0.164*** (12.91)	-0.188 (-0.48)	-1.493** (-2.05)
Labor unit costs	0.216*** (9.09)	0.561 (0.86)	0.128*** (4.61)	0.456*** (9.87)	0.850 (1.14)	-1.409 (-1.08)
Share R&D employees	-0.0137 (-1.40)	0.0453 (1.14)	-0.0431*** (-4.06)	0.130*** (5.32)	0.0299 (0.70)	0.172 (1.52)
Regional empl. growth	-0.0586*** (-2.77)	0.0161 (0.18)	-0.0537** (-2.53)	-0.0620 (-0.66)	0.0315 (0.34)	-0.213 (-0.56)
Regional startup rate	0.0624*** (2.98)	0.119 (1.35)	-0.0279 (-0.96)	0.226*** (6.13)	0.302** (2.39)	-0.159 (-1.05)
Employment density	0.0627*** (15.66)	0.0472*** (2.90)	0.0743*** (15.24)	0.00529 (0.63)	0.0773*** (3.84)	-0.00627 (-0.17)
East Germany	0.165*** (13.60)	0.217*** (4.34)				
Time dummies	yes	yes	yes	yes	yes	yes
Observations	155711	11390	108994	46717	8239	3151
Pseudo R-squared	0.0252	0.0463	0.0231	0.0371	0.0456	0.0645
LogPseudoLikelihood	-840482	-35415	-562433	-231069	-24206	-8644

Notes: Robust z-statistics are given in parentheses. ***Statistically significant at the 1% level; **statistically significant at the 5% level; * statistically significant at the 10% level.

References

- Abdesselam, R., Bonnet, J. and Le Pape, N. (2004), 'An Explanation of the Life Span of new French Firms', *Small Business Economics*, 23, 237-254.
- Acs, Z. (ed.) (1994), *Regional Innovation, Knowledge and Global Change*, Frances Printer, London.
- Acs, Z., Armington, C. and Zhang, T. (2007), 'The Determinants of New-firm Survival across Regional Economies. The Role of Human Capital Stock and Knowledge Spillovers', *Papers in Regional Science* 86(3), 367-391.
- Aldrich, H. E., and Auster, E. R. (1986), 'Even Dwarfs started small: Liabilities of Size and Age and their Strategic Implications', *Research in Organizational Behavior*, 8, 165–198.
- Almus, M. (2004), 'The Shadow of Death—an Empirical Analysis of the Pre-exit Performance of new German Firms', *Small Business Economics*, 23, 189–201.
- Arrow, K. J. (1962), 'Economic Welfare and the Allocation of Resources for Innovation.' In: Nelson, R. R. (ed.), *The rate and direction of inventive activity*, Princeton University Press, Princeton NJ.
- Audretsch, D.B. (1995), *Innovation and Industry Evolution*, MIT Press, Cambridge MA.
- Audretsch, D.B. (2004), 'Sustaining Innovation and Growth: Public Policy Support for Entrepreneurship', *Industry and Innovation*, 11(3), 167-91.
- Audretsch, D. B., and Feldman, M. P. (1996), 'Knowledge Spillovers and the Geography of Innovation and Production', *American Economic Review*, 86, 630–640.
- Audretsch, D.B. and Mahmood, T. (1995), 'New Firm Survival: New Results using a Hazard Function', *The Review of Economics and Statistics*, 77, 97-103.
- Audretsch, D. B. and Vivarelli, M. (1995), 'New-firm Formation in Italy: A first Report', *Economics Letters*, 48(1), 77-81.
- Audretsch, D.B., Houweling, P. and Thurik, A. R. (2000), 'Firm Survival in the Netherlands', *Review of Industrial Organization*, 16, 1-11.
- Barney, J. B. (1991), 'Firm Resources and sustained Competitive Advantage', *Journal of Management*, 17, 99-120.
- Barron, D. N., West, E., and Hannan, M. T. (1994), 'A Time to grow and a Time to die: Growth and Mortality of Credit Unions in New York City 1914–1990', *The American Journal of Sociology*, 100(2), 381–421.
- Baum, J. A. C. (1989), 'Liability of Newness, Adolescence, and Obsolescence: Exploring Age Dependence in the Dissolution of organizational Relationships and Organizations', *Proceedings of the Administrative Science Association of Canada*, 10, 1-10.

- Bellmann, L., Bernien, M., Kölling, A., Möller, I. and Wahse, J. (2003): 'Arbeitsmarktdynamik in betrieblichen Neugründungen in Ostdeutschland', *Beiträge zur Arbeitsmarkt- und Berufsforschung* 268, Nürnberg.
- Birch, D. L. (1981), 'Who creates Jobs?' *The Public Interest*, 65, 3-14.
- Birch, D. L. (1987), *Job Creation in America: How our Smallest Companies put the most People to Work*, The Free Press, New York.
- Boeri, T. and Bellmann, L. (1995), 'Post-entry Behaviour and the Cycle: Evidence from Germany', *International Journal of Industrial Organization*, 13, 483–500.
- Bradburd, R. M. and Caves, R. E. (1982), 'A Closer Look at the Effect of Market Growth on Industries' Profits', *The Review of Economics and Statistics*, 64(4), 635-45.
- Brixy, U. and Kohaut, S. (1999), 'Employment Growth Determinants in New Firms in Eastern Germany', *Small Business Economics*, 13(2), 155-70.
- Brixy U. and Grotz, R. (2004), 'Differences of the economic performance of newly founded firms in West and East Germany'. In: Michael Dowling, Jürgen Schmude and Dodo zu Knyphausen-Aufsess (eds), *Advances in Interdisciplinary European Entrepreneurship Research*, 143–152, Muenster: LIT.
- Brixy, U., Kohaut, S. and Schnabel, C. (2006), 'Zur Arbeitsplatzqualität in Neugründungen: Eine empirische Analyse mit Daten des IAB-Betriebspanels'. In: Lutz Bellmann, L. and Joachim Wagner, J. (eds.), *Betriebsdemographie, Beiträge zur Arbeitsmarkt und Berufsforschung*, 305. 147-160, Institut für Arbeitsmarkt- und Berufsforschung der Bundesagentur für Arbeit, Nürnberg.
- Brüderl, J. and Schussler, R. (1990), 'Organizational Mortality: the Liabilities of Newness and Adolescence', *Administrative Science Quarterly*, 35, 530-547.
- Brüderl, J., Preisendörfer, P. and Ziegler, R. (1992), 'Survival Chances of newly founded Business Organizations', *American Sociological Review*, 57, 227-242.
- Carree, M. A. and Klomp, L. (1996), 'Small Business and Job Creation: A Comment', *Small Business Economics*, 8(4), 317-22.
- Carree, M. A. and Thurik, R. A. (2003), 'The Impact of Entrepreneurship on Economic Growth'. In: Acs, Z. J. and Audretsch, D. B. (eds.), *Handbook of Entrepreneurship Research*, Kluwer, Boston, 437–471.
- Carroll, G. R. and Hannan, M. T.(1989), 'Density Delay in the Evolution of Organizational Populations: A Model and Five Empirical Tests', *Administrative Science Quarterly*, 34(3), 411–430.
- Carroll, G. R. and Hannan, M. T. (2000), *The Demography of Corporations and Industries*, Princeton University Press, Princeton NJ.
- Cleves, M. A., Gould, W. W. and Gutierrez, R. G. (2004), *An Introduction to Survival Analysis Using Stata*, Stata Corporation, College Station, TX.

- Cooke, P. (2002), *Knowledge Economies – Clusters, Learning and Cooperative Advantage*, Routledge, London.
- Cox, D. R. (1972), 'Regression Models and Life Tables', *Journal of the Royal Statistical Society*, 34, 187-220.
- Davis, S. J., Haltiwanger, J. and Schuh, S. (1996), 'Small Business and Job Creation: Dissecting the Myth and Reassessing the Facts', *Small Business Economics*, 8(4), 297-315.
- Dolton, P. J. and Van-der-Klauw, W. (1995), 'Leaving Teaching in the UK: A Duration Analysis', *Economic Journal*, 105, 431–444.
- Dumais, G., Ellison, G. and Glaeser, E. L. (2002), 'Geographic Concentration As A Dynamic Process', *The Review of Economics and Statistics*, 84(2), 193-204.
- Dunne, T. and Roberts, M. J. (1991), 'Variation in Producer Turnover Across US Manufacturing Industries'. In: Geroski, P. A. and Schwalbach, J. (eds.), *Entry and Market Contestability: An International Comparison*, Basil Blackwell, Oxford, 187–203.
- Dunne, T., Roberts, M. J. and Samuelson, L. (1989), 'The Growth and Failure of U.S. Manufacturing Plants', *Quarterly Journal of Economics*, 104, 671-698.
- Falck, O. (2007), 'Mayflies and long-distance runners: the effects of new business formation on industry growth', *Applied Economic Letters*, 14, 1919-1922.
- Farinas, J.C. and Ruano, S. (2005), 'Firm productivity, heterogeneity, sunk costs and market selection', *International Journal of Industrial Organization*, 23, 505-534.
- Feldmann, M.P. and Audretsch, D.B. (1999), 'Innovation in Cities: Science-based Diversity, Specialization and localized Competition', *European Economic Review*, 43, 409-429.
- Fichman, M. and Levinthal, D. (1991), 'Honeymoons and the Liability of Adolescence: a new Perspective on Duration Dependence in social and organizational Relationships', *Academy of Management Review*, 16, 442-468.
- Fotopoulos, G. and Louri, H. (2000), 'Location and Survival of New Entry', *Small Business Economics*, 14(4), 311-21.
- Freeman, J., Carroll, G.R. and Hannan, M.T. (1983), 'The Liability of Newness: Age Dependence in Organizational Death Rates', *American Sociological Review*, 48 (5), 692-710.
- Fritsch, M. (2004), 'Entrepreneurship, Entry and Performance of new Business compared in two Growth Regimes: East and West Germany', *Journal of Evolutionary Economics*, 14(5), 525-542.
- Fritsch, M. (2008), 'How Does New Business Formation Affect Regional Development?', *Small Business Economics*, 30, 1-14.

- Fritsch, M. and Brixy, U. (2004), 'The Establishment File of the German Social Insurance Statistics', *Journal of Applied Social Science Studies*, 124, 183-190.
- Fritsch, M and Noseleit, F. (2009), 'Start-ups, Long- and Short-Term Survivors and their Effect on Regional Employment Growth', *Jena Economic Research Paper*, 2009-81.
- Fritsch, M. and Schindele, Y. (2010), The Contribution of New Businesses to Regional Employment – An Empirical Analysis (forthcoming).
- Fritsch, M. and Weyh, A. (2006), 'How Large are the Direct Employment Effects of New Businesses? An Empirical Investigation for West Germany', *Small Business Economics*, 27(2), 245-260.
- Gerlach, K. and Wagner, J. (1994), 'Regional differences in small firm entry in manufacturing industries: Lower Saxony 1979-1991', *Entrepreneurship and Regional Development* 6(1), 63-80.
- Geroski, P. A. (1995), 'What do we know about Entry?' *International Journal of Industrial Organization*, 13, 421-440.
- Glaeser E. L., Kallal, H., Scheinkman, J. A. and Shleifer, A. (1992), 'Growth in Cities', *Journal of Political Economy*, 100, 1126–1152.
- Gort, M. and Klepper, S. (1982), 'Time Paths in the Diffusion of Product Innovations', *Economic Journal*, 92(367), 630-653.
- Griliches, Z. and Ramey, H. (1995), 'Firm Productivity in Israeli Industry 1979–1988', *Journal of Econometrics*, 65, 175–203.
- Groot, H. L. F. de, Nijkamp, P. and Poot, J. (eds.) (2004), *Entrepreneurship and Regional Development*, Edward Elgar, Cheltenham, UK and Northampton, MA, USA.
- Grupp, H. and Legler, H. (2000), *Hochtechnologie 2000: Neudefinition der Hochtechnologie für die Berichtserstattung zur technologischen Leistungsfähigkeit Deutschlands*, FhG-ISI und NIW, Karlsruhe und Hannover.
- Hannan, M. (1998), 'Rethinking Age Dependence in organizational Mortality: Logical Formulations', *American Journal of Sociology*, 104, 126-164.
- Hannan, M.T. and Freeman, J. (1989), *Organizational Ecology*, Harvard University, Cambridge MA.
- Honjo, Y. (2000), 'Business Failure of new Firms: an empirical Analysis using a multiplicative Hazards Model', *International Journal of Industrial Organization*, 18, 557-574.
- Hosmer, D.W., Lemeshow, S. and May, S. (2008), *Applied Survival Analysis: Regression modeling of time-to-event Data*, Second Edition, John Wiley and Sons, New Jersey.
- Jacobs, J. (1969), *The Economy of Cities*, Random House, New York.

- Jovanovic, B. (2001), 'Fitness and Age: Review of Carroll and Hannan's Demography of Corporations and Industries', *Journal of Economic Literature*, 39, 105–119.
- Kalbfleisch, J. D., and Prentice, R. L. (1980), *The Statistical Analysis of Failure Time Data*, John Wiley and Sons, New Jersey.
- Keeble, D. and Walker, S. (1994), 'New Firms, Small Firms and Dead Firms: Spatial Patterns and Determinants in the United Kingdom', *Regional Studies*, 28(4), 411-427.
- Klein, J. P. and Moeschberger, M. L. (2003), *Survival Analysis Techniques for Censored and Truncated Data*, Second Edition, Springer, New York.
- Krugman, P. (1991), *Geography and Trade*, MIT Press, Cambridge, MA.
- Licht, G. and Nerlinger, E. (1998), 'New Technology based Firms in Germany: a Survey of the recent Evidence', *Research Policy*, 26(9), 1005-1022.
- Loesch A. (1954), *The Economics of Location*, Yale University Press, New Haven.
- Lucas, R. E. Jr. (1993), 'Making a Miracle', *Econometrica* 61, 251–272.
- MacDonald, J. M. (1986), 'Entry and Exit on the Competitive Fringe', *Southern Economic Journal*, 52, 640–652.
- Mahmood, T. (2000), 'Survival of newly founded Business: a log-logistic Model Approach', *Small Business Economics*, 14, 223-237.
- Mata, J. and Portugal, P. (1994), 'Life Duration of new Firms', *Journal of Industrial Economics*, 42, 227-246.
- Mata, J., Portugal, P. and Guimaraes, P. (1995), 'The Survival of new Plants: Start-up Conditions and post-entry Evolution', *International Journal of Industrial Organization*, 13, 459-481.
- Mayer, W.J. and Chappell. W. F. (1992), 'Determinants of Entry and Exit: An Application of the Compounded Bivariate Poisson Distribution to U.S. Industries, 1972-1977', *Southern Economic Journal*, 58, 770-778.
- Mitchell, W. (1994), 'The Dynamics of Evolving Markets: the Effects of Business Sales and Age on Dissolutions and Divestitures', *Administrative Science Quarterly*, 39, 575-602.
- Neumark, D., Zhang, J. and Wall, B. (2006), 'Where the Jobs Are: Business Dynamics and Employment Growth', *Academy of Management Perspectives*, 20, 79-94.
- Paci, R. and Usai, S. (1999), 'Externalities, Knowledge Spillovers and the spatial Distribution of Innovation', *Geojournal*, 49, 381-390.
- Panne, G. van der (2004), 'Agglomeration externalities: Marshall versus Jabco's', *Journal of Evolutionary Economics*, 14, 593-604.
- Patch, E. P. (1995), *Plant Closings and Employment Loss in Manufacturing*, Garland Publishing, New York.
- Penrose, E. (1959), *The Theory of the Growth of the Firm*, Basil Blackwell, London.

- Pérez, S. E., Llopis, A. S. and Llopis, J. A. S. (2004), 'The Determinants of Survival of Spanish Manufacturing Firms', *Review of Industrial Organization*, 25(3), 251-273.
- Porter, M. (1998), 'Clusters and the new economics of competition', *Harvard Business Review*, 76(6), 77–90.
- Ranger-Moore, J. (1997), 'Bigger may be better. But is older wiser? Organizational Age and Size in the New York Life Insurance Industry', *American Sociological Review*, 62(6), 903–920.
- Reynolds, P. D. (1994), 'Autonomous Firm Dynamics and Economic Growth in the United States, 1986-90', *Regional Studies*, 27, 429–442.
- Reynolds, P. D. (1999), 'Creative Destruction: Source or Symptom of Economic Growth?' In: Acs, Z., Carlsson, B. and Karlsson, C. (eds.), *Entrepreneurship, Small and Medium-Sized Enterprises and the Macroeconomy*, Cambridge University Press, Cambridge, 97–136.
- Romer, P. (1986), 'Increasing Returns and long-run Growth', *Journal of Political Economy*, 94, 1002–1037.
- Romer, P. (1990), 'Endogenous Technological Change', *Journal of Political Economy* 98, 71–102.
- Rosenbaum, D. I., and Lamort, F. (1992), 'Entry, Barriers, Exit, and Sunk Costs: An Analysis', *Applied Economics*, 24, 297–304.
- Schindele, Y. (2009), How long does it take to become an Entrepreneurial Society – The Case of German Convergence in Self-Employment (mimeo).
- Schindele, Y. and Weyh, A. (2009), 'The direct Employment Effects of new Businesses in Germany revisited: An Empirical Investigation for 1976 – 2004', *Small Business Economics*, DOI 10.1007/s11187-009-9218-2.
- Schumpeter, J.A. (1937), *Business Cycles*
- Schumpeter, J.A. (1942), *Capitalism, Socialism, and Democracy*,
- Segarra, A., Callejon, M. (2002), 'New Firms Survival and Market Turbulence: new Evidence from Spain', *Review of Industrial Organization*, 20, 1-14.
- Spengler, A. (2008), 'The Establishment History Panel', *Schmollers Jahrbuch/The Journal of Applied Social Science Studies*, 128(3), 501–509.
- Spletzer, J. R. (2000), 'The Contribution of Establishment Births and Deaths to Employment Growth', *Journal of Business and Economic Statistics*, 18, 113-126.
- Sterlacchini, A. (1994), 'The Birth of New Firms in Italian Manufacturing', *Journal of Industry Studies*, 1, 77–90.
- Stinchcombe, A. L. (1965), 'Social Structure and Organizations'. In: March, J. G. (ed.), *Handbook of Organizations*. Rand McNally, Chicago.

- Teece, D. J., Pisano, G. and Shuen, A. (1997), 'Dynamic Capabilities and Strategic Management', *Strategic Management Journal*, 18(7), 509–533.
- Timmer, M. P., O'Mahony, M. and van Ark, B. (2007), 'EU KLEMS Growth and Productivity Accounts: An Overview, International Productivity Monitor', *Centre for the Study of Living Standards*, 14, 71-85
- Tveteras, R. and Eide, G. E. (2000), 'Survival of New Plants in Different Industry Environment in Norwegian Manufacturing: A Semi-Proportional Cox Model Approach', *Small Business Economics*, 14, 65-82.
- Vivarelli, M. (2004), 'Are all the Potential Entrepreneurs so good?' *Small Business Economics*, 42, 141-154.
- Wagner, J. (1994), 'The Post-Entry Performance of New Small Firms in German Manufacturing Industries', *Journal of Industrial Economics*, 42, 141-154.
- Wagner, J. and Sternberg, R. (2004), 'Start-up Activities, individual Characteristics, and the regional Milieu: Lessons for Entrepreneurship Support Policies from German micro Data', *The Annals of Regional Science*, 38(2), 219-240.
- Wernerfelt, B. (1984), 'A Resource-based View of the Firm', *Strategic Management Journal*, 5, 171-180.