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The Effect of Industry, Region, and Time on New Business Survival – A Multi-Dimensional Analysis

MICHAEL FRITSCH[a,⋆], UDO BRIXY[b] and OLIVER FALCK[c]
[a]*Faculty of Economics and Business Administration, Technical University Bergakademie Freiberg, Lessingstraße. 45, 09596 Freiberg, Germany;*
[b]*Institute for Employment Research at the Federal Employment Services, Regensburger Straße 104, 90327 Nuremberg, Germany;*
[c]*Faculty of Economics and Business Administration, University of Passau, Innstraße 27, 94032 Passau, Germany*

Abstract. We analyze the effect of industry, region, and time on new business survival rates by means of a multi-dimensional approach. The data relate to West German districts in the 1983–2000 period. The survival chances of start-ups tend to be relatively low in industries characterized by a high minimum efficient size and high numbers of entries. We find that regional characteristics play a rather important role and that introducing the regional dimension leads to considerable improvements of the estimation results. The significance of the regional dimension is also reflected in a remarkably high level of neighborhood effects.

Key words: Entry, hazard, market selection, new firm survival.

JEL Classification: D21, L10, M13, R10.

I. Introduction

Setting up a firm can be an arduous task. Entering a market and competing successfully is subject to severe uncertainty and requires diverse qualifications that are rarely contained in one single person. As a result, a considerable proportion of new firms leave the market relatively soon after entering; thus, in some industries or regions only a minority of the entrants is able to survive for a longer period of time.

Understanding this selection process could contribute considerably to our knowledge about the main determinants that drive the market processes and the development of firm populations. While considerable progress in our knowledge about new firm formation processes has been made

⋆Author for correspondence: E-mail: michael.fritsch@tu-freiberg.de

in recent years (cf. Fritsch and Falck, 2006), the determinants of success and failure of newly founded businesses are still rather unclear. One main reason for this deficit may be the lack of adequate data for analyzing the development of entry cohorts. A particular shortcoming of nearly all of the available studies is that they do not systematically account for the regional dimension. The results of the empirical analysis presented in this paper clearly show that regional factors play an important role and add significantly to the explanation of new business survival.

Our analysis of new business survival is based on unique data of yearly start-up cohorts over a 15-year period. The data cover all private sector firms with at least one employee and are available for 52 industries and the 326 West German districts (*Kreise*). We do not know of any other study of new business survival that was based on such differentiated and comprehensive data. Due to this empirical base, we should be able to identify the influences on the success and failure of newly founded establishments that are specific to the particular industry, region, and period of time much more reliably than other analyses.

We begin with a review of the hypotheses and the empirical evidence on new-firm survival obtained so far (Section II). Section III briefly describes the data, and Section IV is devoted to the general survival pattern of the new establishments. The results of the multivariate analysis are reported in Section V. Finally, we summarize our main results and draw conclusions for policy as well as for further research (Section VI).

II. Hypotheses

Empirical studies have shown that new firms are characterized by a relatively high risk of failure during the first years of their existence. The main reasons for such a *liability of newness* are the problems of setting up an organizational structure and getting the new unit to work efficiently enough to keep pace with their competitors. Another reason for the new firms' relatively high vulnerability to closure is that quite often the firms have to survive a certain time period before the first profit is attained. Some authors assume that older firms also face a relatively high likelihood of closing down. The reason for such a *liability of aging* could be the sclerotic inflexibility of established organizations (*liability of senescence*); an erosion of technology, products, business concepts, and management strategies over time (*liability of obsolescence*); or, particularly in the case of owner-managed firms, problems in finding a successor who is willing to take over the business.[1]

[1] Aldrich and Auster (1986), Brüderl and Schüssler (1990), Carroll and Hannan (2000), Jovanovic (2001), and Ranger-Moore (1997).

It is commonly assumed that survival rates should be higher in industries where the *minimum efficient size,* which has to be achieved in order to be profitable (Wagner, 1994; Audretsch, 1995, pp. 77–80), is relatively small (Audretsch et al. 2000; Tveterås and Eide, 2000). Accordingly, high-*capital intensity* in an industry may be expected to hinder the set-up and survival of new firms due to the relatively large amount of resources that is needed for attaining the minimum efficient size (Mayer and Chappell, 1992; Audretsch et al., 2000). This may explain the observation that the risk of failure is the lower the larger the initial size of the start-up. If new firms enter the market just barely below the minimum efficient size they may have less difficulty attaining the breakeven point than do smaller firms. 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 relationship between the level of entry barriers and new firm survival rates is a priori unclear (Table I).

While a high level of *labor unit cost* and high *user cost of capital* can be assumed to have a negative effect on the success of market entry (cf. Patch, 1995, p. 84), prospering *growth* in the national economy, in the particular region, or in the same industry may be conducive to economic success and survival (Rosenbaum and Lamort, 1992; Audretsch, 1995, pp. 70–73; Boeri and Bellmann, 1995). However, the relative importance of the different levels is unclear: Is regional prosperity more significant for survival than is national development, or vice versa?

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). However, new businesses, which are set up in close proximity to innovative firms of the same industry, could also benefit from knowledge spillovers that are conducive to their development (Krugman, 1991). For this reason, the effect of an industry's innovativeness at a certain location on the survival of new businesses is undetermined (Table I).

The nature of innovation activity in an industry as described by its *technological regime* may be more important than innovativeness itself (Winter, 1984; Audretsch, 1995, pp. 39–64; Marsili, 2002). At an early stage of the industry life cycle, the market is characterized by an "entrepreneurial" regime in which small firms have a high share of innovation activity; thus, entrants face a relatively good chance of competing successfully. A relatively high level of technological turbulence at this stage may, however, imply a high risk and correspondingly high failure rates. Under the conditions of a "routinized" regime – i.e., after the establishment of a dominant

Table I. Overview of hypotheses about the effect of different factors on new firm survival chances

Determinant	Expected sign for relationship with survival chances of start-ups
Age	–
– liability of newness	−/+
– liability of aging (of obsolescence, of senescence)	–
Minimum efficient size in industry	−/+
Capital intensity	−/+
Labor unit cost	−
Capital user cost	−
Demand growth – national, in specific industry or region	−/+
Innovativeness of industry and region	−/+
Entrepreneurial character of technological regime in specific industry and region	−/+
Early stage of industry life cycle	−/+
Market density	−
Agglomeration	+ (localization or urbanization economies resulting from density or size?)
Market concentration	−/+
Unemployment	−/+

design – the incumbent large firms have the innovative advantage. Therefore, the conditions for successful entry and survival in such a market can be assumed to be comparatively unfavorable (Table 1). The respective empirical evidence is, however, unclear.[2] In this context, it may be important to recognize that considerable differences can exist in regard to the technological regime of a certain industry between regions (see Saxenian, 1994, for an illustrative example).[3]

[2] While Audretsch (1995) found that new firms have lower survival chances under the conditions of an entrepreneurial technological regime, Agarwal and Audretsch (2001) identify relatively high survival rates in the early stage of the product life cycle. Better prospects of survival for start-ups under an entrepreneurial regime are also found by Klepper (2001), Klepper and Simon (2000), and Suárez and Utterback (1995).

[3] In an analysis of new firm formation in West Germany, Fritsch and Falck (2006) found that the indicator for the character of an industry's technological regime had a

Another factor that may affect the survival chances of new firms is the intensity of competition within an industry or region. This competition can be measured in a number of different ways. One indicator of the level of competition in an industry is the existing number of firms in relation to the volume of demand. The industrial ecology approach (Hannan and Carroll, 1992) argues that if the density of firms is relatively high upon a new firm's emergence, this will have a negative impact on the new firm's survival chances.[4] Another indicator of the intensity of competition is the entry rate in an industry or region. A relatively high entry rate indicates intensive competition, which may result in correspondingly high rates of new firm failure (MacDonald, 1986; Sterlacchini, 1994; Audretsch, 1995). It is, however, unclear whether entry at the national or at the regional level has the greater effect on survival.

The observation that economic activity tends to be clustered in space (Audretsch and Feldman, 1996; Porter, 1998; Cooke, 2002) suggests that certain agglomeration economies are relevant for the location of new businesses and that these advantages compensate for the negative effect of higher cost (e.g. rents, wages) and of competition from other firms located in the vicinity. Advantages of setting up a new business in a large agglomeration could include the availability of large, differentiated labor markets and specialized services, easy access to research institutions, the spatial proximity to large numbers of customers as well as to other firms in the industry that may facilitate knowledge spillovers. It is, however, unclear if 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). Moreover, such advantages may be more likely to result from the density or the size of a cluster or agglomeration.

The unemployment rate can be an indicator of at least three issues that may be relevant for new firm survival. First, high unemployment could reflect low growth rates, which may affect the success of start-ups in a positive or negative way (see above). Second, pronounced unemployment results in easy availability of labor and should, therefore, be conducive to

much stronger impact when differentiated by region than compared with figures at the national level.

[4] According to this "density delay" hypothesis, organizations that were set up when the industry was crowded have higher rates of exit than do organizations founded in other, less crowded time periods (Carroll and Hannan, 1989, 2000). Geroski et al. (2002, 5f.) provide two explanations for such a phenomenon. The first explanation, called the "liability of scarcity", assumes that organizations created in unfavorable circumstances are in relatively bad shape and less robust. The second explanation suggests that firms that have been set up under crowded market conditions may be pushed into such types of niche where prospects of success are relatively low ("tight niche packing").

the development of new firms. And third, high unemployment can lead to a large share of start-ups created by unemployed persons. This raises the question whether the survival chances of new businesses founded by formerly unemployed persons differ from those of other start-ups. One may, for instance, expect firms founded by unemployed persons to have fewer resources because without employment and regular income, the available amount of capital will be rather limited. Moreover, the qualification level of unemployed persons tends to be below average. On the other hand, if the opportunity cost of a formerly unemployed entrepreneur is relatively low, these founders will not give up a non-successful business easily but will tend to fight until the situation appears hopeless (for an empirical test, see Pfeiffer and Reize, 2000).

Table I provides an overview of the different determinants of new firm survival and the expected signs for the effect.

III. Data and Measurement Issues

Our information on start-ups and their survival is generated from the German Social Insurance Statistics (see Fritsch and Brixy, 2004, for a description of this data source), which covers the vast majority of the private sector in Germany. Since our data comprises only establishments with at least one employee other than the founder, those start-ups that remain very small without any employees are not included.[5] We exclude new businesses with more than 20 employees in the first or in the second year of their existence.[6] As a result, a considerable number of new subsidiaries of larger firms, which often begin as a rather large establishment, are not counted as start-ups.[7] Hence, although the data base is limited to the level of establishments, the focus is on entrepreneurship and new firm formation. A detailed analysis of our data base reveals that these data reflect new firm formation activity relatively well (see Fritsch and Brixy, 2004).

We analyze the information about the numbers of newly founded businesses that have been able to survive different time periods. This

[5] Start-ups are identified by new establishment numbers in the statistics at a yearly reporting date. If an establishment number disappears, this is regarded a closure. Those short-lived businesses that are set up and closed between two yearly reporting dates are not included in our data. If ownership changes lead to a change of the establishment number, this may be wrongfully identified as "exit" (= disappearance of an establishment number) and "start-up" (= new number) (see Fritsch and Brixy, 2004, for details).

[6] The main reason for excluding new establishments with more than 20 employees is that some of the large new establishments reported in our data are probably a result of the reorganization of larger firms and do not reflect the set-up of new establishments.

[7] In our data we are, however, not able to identify if a firm is a subsidiary of a larger enterprise, a headquarter, or a single-plant firm with only one location.

information is available for the years 1983–2000. Because survival rates and hazard rates are logically related, our investigation is equivalent to analyzing hazard rates, i.e. the probability of new business failure in a given time interval.[8] We include only those cohorts of new businesses for which a 2-year survival rate can be calculated. Therefore, our information relates to the start-ups from 1983 to 1998. We have this information for every year, differentiated by industry (52 private-sector industries) and region (326 districts or *Kreise*).

We restrict the analysis to West Germany for two reasons. First, information on East Germany, the former socialist GDR, is only available from 1992 onwards – i.e., for a much shorter-time period. And second, a number of empirical analyses have shown that economic conditions were rather divergent in eastern and western Germany in 1990s and that quite different factors governed market dynamics in the two regions (Brixy and Grotz, 2004; Fritsch, 2004). Information about employment and qualification was also taken from the Social Insurance Statistics. Other indicators are based on publications of the Federal Statistical Office (*Statistisches Bundesamt*).

The minimum efficient size of an establishment is computed as the 75th percentile of establishment size when establishments are ordered by size (number of employees). This measure goes back to Comanor and Wilson (1967, p. 428) and is used in other analyses (see, e.g., Audretsch 1995). Comanor and Wilson argue that large-scale establishments are efficient because otherwise, smaller units would have emerged. Accordingly, the smaller establishments are either newly founded or declining businesses that suffer from size disadvantages.

We measure innovativeness by the share of employees in Research and Development (R&D). The R&D employees are those with a degree in engineering or a natural science (source: Social Insurance Statistics). The indicator for the technological regime is the proportion of R&D employees in establishments with less than 50 employees over the share of R&D employment in total employment in the same region, industry, and year. This quotient measures the importance of small establishments for R&D

[8] The survivor function $S(t)$ reports the probability of surviving until time t. It gives the probability that failure does not occur before t. The hazard rate $h(t)$ – also known as the conditional failure rate or age-specific rate of failure – is the probability that the failure event occurs in a given time interval if the subject has survived until the beginning of this interval. The hazard rate is completely determined and vice-versa if the survival rate is given. Therefore, the survivor function is nothing else than $S(t)=\exp\{-H(t)\}$ with $H(t)=\int_0^t h(u)\mathrm{d}u$ being the cumulative hazard function.

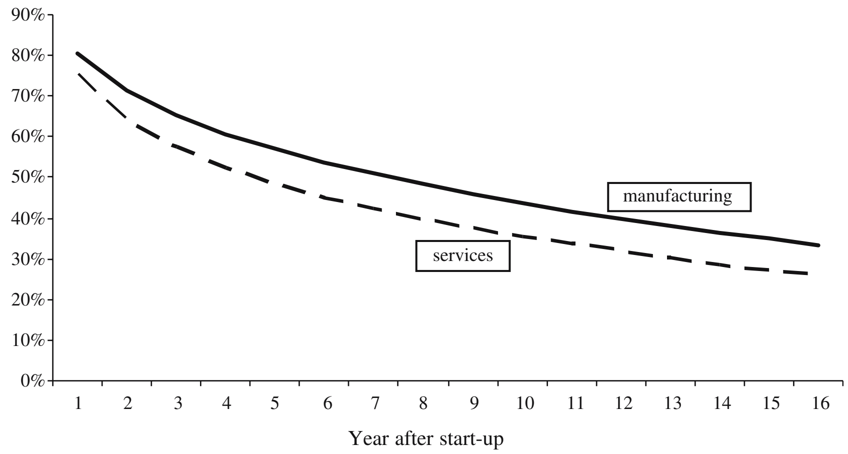

Figure 1. Survival rates in West Germany 1984–2000.

activity, thus indicating the entrepreneurial character of a certain industry in a region.[9]

IV. The General Survival Pattern

Figure 1 shows the average survival rates of newly founded businesses in the 1984–2000 period. According to the average for all private sector industries, only 80% of the start-ups continued to exist after 1 year. The survival rates are considerably lower in services than in manufacturing. Looking at the hazard rates (Figure 2), it becomes clear that this higher vulnerability of start-ups in the service sector lasts until the sixth year of their existence. When the first 6 years are over, the likelihood of going out of business is about the same in services and in manufacturing. About 46% of the start-ups in manufacturing survived the first 10 years compared with about 37% in the service industries. Only 25.85% of all new service establishments set up in 1984 survived until 2000. In manufacturing this share is about 33.42%.

There is some variation in the survival and hazard rates over time as shown in Table II. While the change in survival rates is somewhat cyclical, there appears to be an increase in the hazard rate after 2 years and particularly after 5 years. Pronounced variation in the survival and hazard rates can also be found within the manufacturing and the service sec-

[9] This indicator corresponds to the "small firm innovation rate/total innovation rate" used by Audretsch (1995) as a measure of the entrepreneurial character of an industry. In contrast to Audretsch's indicator, which is based on the number of innovations introduced, our measure refers to R&D input.

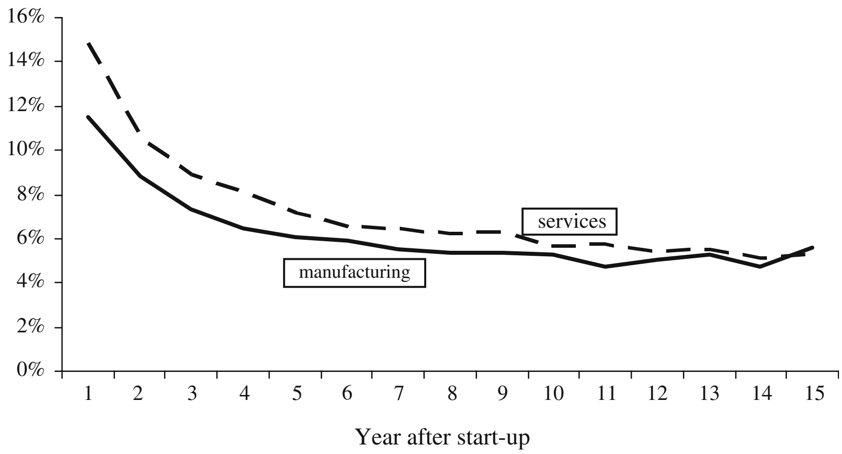

Figure 2. Hazard rates in West Germany 1984–2000.

Table II. Survival and hazard rates for yearly cohorts 1984–1998 after 2, 5, and 10 years

Year	Survival rate as % after			Hazard rate as % after		
	2 years	5 years	10 years	2 years	5 years	10 years
1984	60.23	46.56	35.29	10.00	5.17	5.24
1985	61.69	47.96	35.55	8.54	5.55	5.29
1986	64.41	49.33	35.92	12.57	5.97	5.73
1987	63.62	50.35	36.31	8.35	6.68	6.10
1988	63.99	49.58	35.44	8.79	7.01	5.15
1989	65.89	50.36	35.66	9.50	7.30	5.82
1990	65.61	49.24	34.86	10.05	7.71	
1991	64.24	47.56		10.73	7.83	
1992	64.18	46.73		11.51	7.74	
1993	64.44	46.72		11.82	7.09	
1994	63.70	46.29		12.15	7.26	
1995	62.58	45.81		12.13		
1996	62.98			11.41		
1997	63.08			11.91		
1998	63.72					
Average	63.62	48.04	35.58	10.68	6.85	5.56
Standard deviation	1.42	1.65	0.46	1.46	0.91	0.38

tor (Table III). The highest 10-year survival rates are in water and energy, precision engineering, and in health care; by contrast, survival rates are relatively low in hotels and restaurants, apparel, and in agriculture.

Table III. Average survival and hazard rates 1983–2000 in different industries after 2,5, and 10 years

Industry	Survival rate as % after			Hazard rate as % after		
	2 years	5 years	10 years	2 years	5 years	10 years
Agriculture	49.51	35.39	23.16	12.94	6.33	7.90
Water, energy	77.49	64.16	56.31	4.59	3.68	12.13
Coal mining	52.00	40.28	33.33	4.17	20.00	20.00
Other mining	65.13	42.67	28.09	11.71	8.72	10.90
Chemicals	73.49	55.39	41.74	10.58	6.99	7.43
Mineral oil processing	70.42	56.12	47.57	2.98	9.09	13.89
Plastics	70.70	55.43	44.07	8.36	5.68	6.63
Rubber	72.97	60.64	49.63	7.67	4.50	5.93
Stone and clay	73.61	61.35	48.98	7.18	4.04	3.57
Ceramics	68.74	49.94	38.11	12.94	7.29	8.22
Glass	67.64	52.40	36.44	8.72	8.79	1.33
Iron and steel	74.54	58.02	33.68	9.59	4.87	0.00
Non-ferrous metals	75.26	59.90	43.97	9.54	2.73	5.56
Foundries	71.28	55.32	42.07	9.70	3.58	4.88
Steel processing	71.70	59.55	47.29	7.52	5.09	4.06
Steel and light metal construction	66.08	49.44	36.66	11.63	7.35	6.01
Machinery (non-electrical)	75.26	60.58	48.48	9.79	6.24	5.24
Gears, drive units other machine parts	74.20	60.39	47.18	8.19	6.02	2.85
Office machinery	71.22	54.80	41.02	10.70	4.40	2.02
Computers	70.10	52.69	35.01	10.66	8.63	6.80
Motor vehicles	74.46	60.74	47.37	7.97	5.58	4.13
Shipbuilding	65.49	47.93	34.96	8.71	9.62	8.09
Aerospace	72.90	54.44	36.17	10.59	10.14	5.71
Electronics	73.22	58.15	45.06	9.01	5.96	5.41
Precision engineering	82.28	72.00	58.22	5.23	4.05	4.24
Watches and gauges	69.88	52.95	43.49	14.43	3.74	6.55
Iron and metal goods	72.17	58.04	46.29	7.76	5.15	6.56
Jewelry, musical instruments, and toys	68.97	54.51	40.86	9.70	7.02	7.94
Wood (excluding furniture)	68.01	54.16	43.36	9.79	9.10	4.50
Furniture	70.23	56.87	44.51	8.06	5.96	5.71
Paper-making	65.47	49.56	30.35	11.75	5.91	11.67
Paper processing and board	70.75	56.05	41.72	9.16	6.76	5.40
Printing	70.96	57.36	43.16	8.98	6.01	5.96
Textiles	64.33	45.49	31.57	13.91	7.25	8.85

Table III. Continued

Industry	Survival rate as % after			Hazard rate as % after		
	2 years	5 years	10 years	2 years	5 years	10 years
Leather	63.99	47.56	34.14	10.76	7.58	7.17
Apparel	54.48	34.64	19.20	16.91	13.63	8.19
Food	72.37	56.76	42.99	9.41	6.78	5.83
Beverages	69.07	53.47	41.65	10.13	6.42	5.71
Tobacco	43.11	15.56	4.76	0.00	10.00	0.00
Construction	57.33	40.99	30.60	14.05	8.17	6.62
Installation	73.43	60.86	48.98	7.72	5.24	4.81
Wholesale trade	64.22	46.87	33.01	11.43	8.53	7.21
Resale trade	63.92	47.14	33.55	11.37	7.81	6.46
Shipping	69.30	50.18	31.11	9.96	8.41	7.31
Traffic and freight	62.25	45.70	32.85	11.02	7.82	6.67
Postal services	68.89	53.98	42.38	15.71	18.93	16.30
Banking and credits	65.77	48.92	36.72	11.04	7.58	5.69
Insurance	61.76	47.50	36.91	10.09	6.22	6.14
Real estate and housing	60.09	42.83	30.85	12.34	7.92	7.10
Hotels, restaurants, etc.	53.15	35.40	22.18	14.74	10.01	7.83
Science, publishing, etc.	60.46	43.29	29.98	11.30	7.31	4.82
Health care	85.06	77.85	68.97	3.32	2.75	2.65
Other private services	68.46	53.65	41.64	9.33	6.21	4.88
All private industries	64.13	48.53	35.87	10.62	6.92	5.75

The regional distribution of the average 5-year survival rate shows a rather mixed picture (Figure 3). Regions with relatively high survival rates are concentrated in the northern part of Bavaria and Baden-Wurttemberg as well as in the south-east portion of Hesse. The larger cities seem to have low survival rates. This result could be caused by the relatively high share of start-ups in the service sector, which generally tends to have a higher hazard rate (cf. Fritsch and Falck, 2006) in these regions. Also, the 2-year and the 10-year survival rates tend to be relatively low in agglomerations, while the respective hazard rates are comparatively high (Table IV). Survival rates are the highest in the moderately congested regions, which represent the middle category between the agglomerations and the rural areas (Table IV).

V. Multivariate Analysis

1. VARIABLES AND ESTIMATION PROCEDURE

In order to explain the survival rates, we estimated ordinary least square (OLS) regressions applying the Huber-White-sandwich procedure to gain

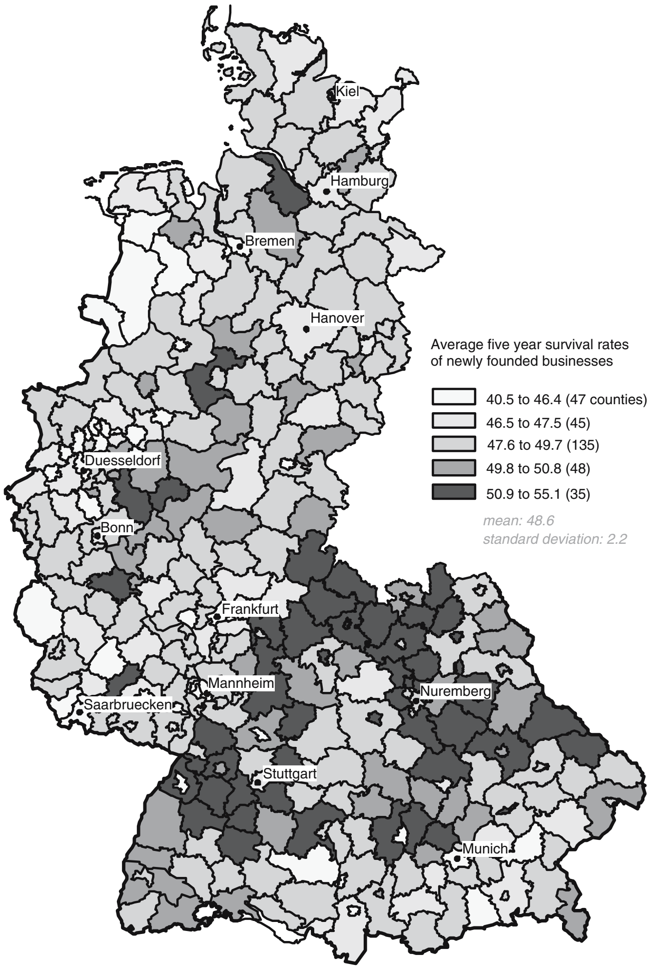

Figure 3. Average 5-year survival rates in western Germany 1983–2000 (%).

Table IV. Average survival and hazard rates for cohorts 1984–1998 in different regions after 2, 5, and 10 years

Type of region	Survival rate as % after			Hazard rate as % after		
	2 years	5 years	10 years	2 years	5 years	10 years
Agglomerations	63.42	47.49	34.83	10.87	7.11	5.78
Moderately congested regions	64.07	48.90	36.75	10.38	6.47	5.34
Rural areas	63.31	48.25	35.83	10.55	6.69	5.11
All regions	63.62	48.04	35.58	10.68	6.85	5.56

estimates that are robust in regard to autocorrelation over time and heteroscedasticity between clusters. Heteroscedasticity could particularly occur for the survival rates as a result of differences in the number of start-ups per cell. A Tobit analysis may be more suitable because our dependent variables are rates that have only a limited range of values. This procedure, however, led to almost identical results; hence, we abstain from presenting the respective estimates here. In several cases, there were no start-ups in a certain industry, region, and year; thus, these cases could not be included into the analysis because no survival rate could be calculated.

As we mentioned above (Section II), density effects could be relevant, and the chances of new firm survival may not be independent of the level of start-ups in the particular region, in neighboring regions, or in the industry, respectively. Thus, we include the number of new firm entries. Because the number of start-ups may not only be a determinant of survival chances but could also be influenced by the probability of surviving in a certain industry and region, this variable may be correlated with the error term, resulting in biased and inconsistent estimates.

To avoid this problem, we applied an instrumental variables approach, which substitutes the number of start-ups with a variable (the instrument) that is correlated with the number of start-ups but not with the error term. We used the number of employees in the respective industry and region as an instrumental variable for the number of new firms, which has a strong impact on the number of new businesses (Fritsch and Falck, 2006). A Durbin–Wu–Hausman test indicated that this instrumental variable approach is not more efficient than including the number of start-ups, and, therefore, the OLS regression is appropriate. We cannot completely exclude that there is also an endogeneity problem with regard to the change of gross value added or with regional and industry employment change in the sense that high survival rates cause correspondingly high growth rates. While it can be regarded unlikely that a regional survival rate has an effect on the change of national GDP or overall employment in the respective industry, it could particularly be relevant in regard to regional employment change. However, we are not aware of any variable that would be suitable to serve as an instrument for these regressors.

If not explicitly noted otherwise, all the values of the explanatory variables relate to the period in which the new establishments started or – in the case of rates of change – to the entire time period under inspection, respectively. Such an approach produced considerably better results than the inclusion of values that relate to a later period of time – e.g., the years shortly before a new establishment closed down. This confirms the analysis of Geroski et al. (2002), who found that the conditions prevailing at the time when new businesses are established have a longer-lasting effect on the firms' survival prospects.

Table V. Descriptive statistics of independent variables

Variable	Mean	Standard deviation	Minimum	Maximum
All private sector industries				
Minimum efficient size (i)	153.22	328.94	9.43	2,255.41
Share of R&D employees (ir)	0.02	0.04	0 (4,222 cases)	1 (6 cases)
Technological regime (ir)	1.28	5.3	0 (2,027 cases)	121
Sum of start-ups in region and adjacent regions (ir)	45.07	118.23	0 (819 cases)	2,058.73
Population density (r)	560.67	700.18	41.35	3984.87
Growth rate of gross value added	0.026	0.022	−0.022 (1993)	0.064 (1990)
Industry employment change (i)	−0.02	0.04	−0.12	0.08
Regional employment change (r)	0.01	0.01	−0.03	0.06
Regional unemployment rate (r)	0.14	0.05	0.05	0.30
Manufacturing				
Minimum efficient size (i)	144.21	176.70	20.51	904.89
Share of R&D employees (ir)	0.02	0.04	0 (3,164 cases)	1 (4 cases)
Technological regime (ir)	0.36	0.86	0 (1,570 cases)	25.41
Sum of start-ups in region and adjacent regions (ir)	8.13	13.86	0 (706 cases)	131.53
Industry employment change (i)	−0.03	0.03	−0.12	0.02
Services				
Minimum efficient size (i)	36.69	45.53	9.49	172.49
Share of R&D employees (ir)	0.01	0.02	0 (992 cases)	0.30
Technological regime (ir)	4.03	10.53	0 (385 cases)	121
Sum of start-ups in region and adjacent regions (ir)	148.59	204.36	0 (28 cases)	2,058.73
Industry employment change (i)	0.02	0.04	−0.04	0.08

Mean, minimum, and maximum of the mean over time for the dimension in parentheses. i: industry, r: region.

We performed the analysis for manufacturing industries, for service industries, and for the overall private sector, respectively.[10] Table V shows descriptive statistics for those variables that have been included in the final

[10] Note that the overall private sector comprises industries that were not assigned to manufacturing and services such as agriculture, forestry, fishery, energy and water supply, mining, and construction. Therefore, the number of observations in the estimates for manufacturing and services do not add up to the number of observations in models for the whole private sector.

model. For all private sector industries, we found the highest minimum efficient size in coal mining and the lowest value in agriculture. Within the manufacturing sector, the maximum value was in the iron and steel industry and the minimum in furniture industry. In the service sector, the minimum value was in health care and the maximum value in the shipping industry.

Considerable variation could also be found for the other indicators. There were several cases where an industry did not exist in a certain district or in which the number of employees in the respective industry was rather small. A small number of employees in a certain industry may explain those observations that may appear extreme, such as a 100% share of R&D employment. Large differences can particularly be found with regard to the number of start-ups in the industry that occur in a certain region and the adjacent districts. However, such observations are in no way 'outliers' that have any significant effect on the results.

2. RESULTS

Table VI displays the results of our final regression model for explaining the 2-, 5-, and 10-year survival rates. The estimations show that spatial autocorrelation is an important issue in explaining new firm survival. We found that the best way of accounting for such neighborhood effects in the model was not only to use the number of start-ups in the respective region as explanatory variable but also to include the number of new businesses that have been set up in the adjacent regions.[11] When start-ups in adjacent regions are included, no other type of exogenous variables for spatial autocorrelation proved to be statistically significant. Running the regressions without border territories where neighboring regions do not exist or are not included in the data set did not lead to any significant changes in the results.

A high minimum efficient establishment size in the industry has a negative impact on new firm survival in the services sector. Apparently, relatively high hurdles for successful entry into services lead to correspondingly low survival rates. This negative effect of minimum efficient size on new firm survival is particularly pronounced in the estimates for the 5-year and the 10-year rates. It takes some considerable time until many of the new businesses attain a competitive size. For start-ups in manufacturing, however, this effect is not statistically significant. This result is surprising given the relatively high values of minimum efficient size in manufacturing

[11] The regional number of start-ups and the number of start-ups in adjacent regions are not included as separate variables here but are aggregated to one variable because of a high level of correlation of the values for neighboring regions.

Table VI. Regression analysis of survival rates

	OLS regressions with robust standard errors								
	All private industries			Services			Manufacturing		
	2 year survival rate	5 year survival rate	10 year survival rate	2 year survival rate	5 year survival rate	10 year survival rate	2 year survival rate	5 year survival rate	10 year survival rate
Minimum efficient size (it)	0.0044*	−0.0101**	−0.0156**	−0.0370**	−0.0860**	−0.1001**	0.0039	−0.0045	−0.0062
	(2.15)	(−3.95)	(−5.26)	(−7.89)	(−14.09)	(−13.84)	(1.62)	(−1.54)	(−1.71)
Share of R&D employees (irt)	0.1846**	0.1046	0.1219	0.0842	−0.2572**	−0.4474**	0.2024**	0.1561*	−0.0079
	(4.11)	(1.82)	(1.49)	(1.22)	(−2.79)	(−3.42)	(3.62)	(2.07)	(−0.08)
Sum (ln) of start-ups in region and adjacent regions (irt)	−0.0140**	−0.0186**	−0.0179**	0.0080**	0.0191**	−0.0250**	−0.0057**	−0.0051*	−0.0079**
	(−13.98)	(−14.97)	(−11.79)	(−5.10)	(−9.60)	(−10.39)	(−3.39)	(−2.47)	(−3.05)
Population density (r, average over several years)	−0.0161**	−0.0284**	−0.0326**	0.0083**	−0.0136**	−0.0208**	−0.0183**	−0.0302**	−0.0340**
	(−10.29)	(−14.38)	(−14.58)	(−3.60)	(−4.63)	(−6.20)	(−8.80)	(−11.77)	(−11.15)
Yearly growth rate of gross value added (average over the period under inspection)	0.1531**	0.2712**	0.1036**	0.5372**	0.6633**	0.2902**	0.1034**	0.2194**	0.1835**
	(7.80)	(11.97)	(3.05)	(17.76)	(19.44)	(6.49)	(4.04)	(7.30)	(3.71)
Regional employment change (r, average over the period under inspection)	0.0387	0.1260**	0.1254**	0.1164**	0.0386	0.1082**	0.1943**	0.1622**	0.1608**
	(1.53)	(6.16)	(4.95)	(3.81)	(1.52)	(4.67)	(4.75)	(5.33)	(5.13)

Industry employment change (i, average over the period under inspection)	0.1232** (5.51)	0.0066 (0.50)	0.1132** (3.11)	0.1287** (4.79)	0.0921** (6.57)	0.0876** (3.93)	0.3592** (10.87)	0.2760** (10.73)	0.2240** (7.33)
Number of observations	117,448	100,386	58,466	45,921	39,012	22,681	61,441	52,769	30,777
R^2	0.184	0.208	0.203	0.277	0.445	0.426	0.164	0.193	0.156
Durbin–Wu–Hausman test	6.37	−0.29°	−2.04°	7.87	0.01	3.25	0.07	9.34	−22.85°

i: values per industry, r: values per region, t: per year,**: statistically significant at the 1% level,*: statistically significant at the 5% level, °: The Durbin–Wu–Hausman test is asymptotically valid in conjunction with the robust covariance estimator, but a problem of a negative test statistics may occur.

(Table V). An explanation could be that the higher hurdles for entry in manufacturing induce relatively strong self-selection of entrants and that this positive impact compensates for the higher problems of attaining a competitive size in this sector. Due to the high share of services sector start-ups, minimum efficient size is also significant with a negative sign in the estimations for all private sector industries.

The share of R&D employment in the particular industry, region, and year has a significantly negative impact on the survival chances of new businesses in services but proves to be significantly positive for the 2-year and for the 5-year survival rate in the manufacturing sector. In the estimates for all private sector industries, the respective coefficient is statistically significant only for the 2-year survival rate and with a positive sign. The negative coefficients that we find for the share of R&D employment in services industries confirm the hypothesis that entry into innovative industries is relatively risky. We find a significantly positive coefficient for the share of regional R&D employment in the estimates limited to manufacturing start-ups, which demonstrates that there are differences between the large economic sectors. This positive effect may result from the relative prosperity of innovative manufacturing industries that is not perfectly controlled for by the employment change variables in the model. Including the share of R&D employment by year and industry without regional variation leads to considerably lower t-values. This clearly indicates that the regional variation has an effect. Due to high correlation between the share of R&D employment and our measure for the entrepreneurial character of an industry's technological regime, we do not include both variables into the same model. If we substitute the technological regime indicator for the share of R&D employment, it is only statistically significant for the 10-year survival rate in the estimates for all sectors. The respective coefficient shows a positive sign indicating that an entrepreneurial regime is conducive to survival.

The number of start-ups in the respective industry and region has a negative impact on new firm survival. As already mentioned above, we also include the number of start-ups in the adjacent regions in this variable, which proves to have an important effect. The highly significant negative sign of the respective regression coefficient obviously reflects the strong competition between a large number of entries and confirms the market density-hypothesis (Section II). The start-ups in adjacent regions are obviously the main source of spatial autocorrelation. If start-ups in adjacent regions are included, no other indicator for spatial autocorrelation is statistically significant.[12]

[12] Substituting the regional number of start-ups in the particular industry by the national figure leads to a reduction of the value of regression coefficients to about a half.

The negative relationship between population density and the survival rate of newly founded businesses points toward the relevance of urbanization diseconomies – i.e., negative effects of spatial proximity to economic units affiliated with various industries. This result may also be regarded as an indication of the effect of market density. In order to test for the relevance of localization economies that emerge from the spatial proximity of similar activities, one could include the number of employees in the same industry. Such an approach results in coefficients with a highly significant negative sign. An interpretation of this result is difficult given the considerable statistical relationship between employment and the number of start-ups in an industry (coefficient of correlation of 0.65). The least we can say is that there is no positive net-impact of localization economies on new firm survival. If spatial proximity to other establishments in the same industry has positive effects on the development of newly founded businesses, these effects may be offset by stronger competition for customers and for resources due to the presence of other suppliers of the same kind in the region.

Change of national gross value added and employment change in the particular industry or region are indicators for the development of demand. We found positive effects for these variables that turned out to be the most pronounced when the change rates were not calculated for single years but for the total life-span of the new businesses.[13] All three indicators show a positive sign, thus indicating that the three dimensions are of some importance. Particularly, the pronounced positive effect of regional employment change indicates that local conditions have an important impact on new business survival even when the national and the industry specific developments are controlled for.[14] The regional unemployment rate in the year when a new business was set up can be regarded as an indicator of two things: the regional economic conditions such as growth rates and availability of labor in that year and the share of new businesses that were founded by unemployed people. Including this indicator in the year when a new business was set up or as an average over the period under inspection in our models did not show any significant effect. We also did not find a stable impact of capital intensity, unit labor cost, and user cost of capital on the survival chances of newly founded businesses.

Footnote 12 continued
This result indicates that market density has some regional dimension and that a considerable part of the relevant competition is within the region.

[13] We did not find any statistically significant impact of growth rates in the year(s) before the particular business was set up.

[14] Including regional employment change in the respective industry instead of the figure for all industries results also in a pronounced positive effect. However, the coefficient is somewhat smaller.

Dummy variables for industries and years were not included because of their high correlation with many of the explanatory variables. Including dummy variables for certain spatial categories (e.g., high density agglomeration, rural area) or interacting certain variables with indicators of population density did not result in any significant effects. Conducting the same type of analysis for East Germany leads to a much lower share of explained variance. In contrast to West Germany, we find some considerable variation in new firm survival rates over time in East Germany (cf. Brixy and Grotz, 2004; Fritsch, 2004). In addition, there are fewer factors that have a statistically significant impact on the survival of new firms, suggesting that survival of new businesses in East Germany is subject to erratic influences to a greater extent than is true in the West. These differences also strongly indicate the importance of regional conditions for the survival of newly founded businesses.

VI. Conclusions

We identified a set of variables that have an impact on the survival chances of new businesses. By simultaneously accounting for the spatial dimension, we were able to show that the regional economic environment is of considerable importance for the success of newly founded businesses. This impact of regional conditions is particularly clear for the number of start-ups in a region, regional innovation activity, regional employment growth, and population density. Moreover, we find pronounced spatial autocorrelation, which also emphasizes the importance of location in terms of "neighborhood effects". The impact of a variable always became stronger when it could be disaggregated by region as compared to including the variable without regional differentiation. These findings clearly suggest that empirical analyses of new firm survival should try to account for the regional level.

If regional factors have an important effect on new business survival, founders are faced with the decision to choose the appropriate location for their start-up. We know, however, from empirical research that founders of new businesses nearly always set up their business close to the place where they reside (Mueller and Morgan, 1962; Sorensen and Audia, 2000). However, this could also mean that they first settle down in a certain region and then consider whether or not to start a business on their own, often after a considerable amount of time has passed and, perhaps, stimulated by the regional conditions. Given the heterogeneity of industries and new businesses within industries one should be careful in deriving general recommendations for the choice of location from our results. Our results are general trends that should be adjusted to the specific characteristics of a certain project.

There are a number of issues in the analysis that deserve further investigation. First, we should further investigate the ways in which the spatial autocorrelation, which was found in our data, is produced. What are the forces behind these effects? Second, the diverse results that we found for the effect of an industry's minimum efficient size on new firm survival over different time-spans should be further investigated and better understood. Third, the positive relationship between survival in manufacturing industries and the share of R&D employment is still unclear. Finally, it would be desirable to find out the relative importance of the environmental factors as compared to firm specific characteristics. This, however, requires the availability of micro data and information at the level of the respective region and industry.

References

Agarwal, R., and D. B. Audretsch (2001) 'Does Entry Size Matter? The Impact of the Life Cycle and Technology on Firm Survival', *Journal of Industrial Economics* **49**, 21–43.

Aldrich, H. E., and E. R. Auster (1986) 'Even Dwarfs Started Small: Liabilities of Size and Age and their Strategic Implications', *Research in Organizational Behavior* **8**, 165–198.

Audretsch, D. B. (1995) *Innovation and Industry Evolution*. Cambridge, MA: MIT Press.

Audretsch, D. B., and M. P. Feldman (1996) 'Knowledge Spillovers and the Geography of Innovation and Production, *American Economic Review* **86**, 630–640.

Audretsch, D. B., P. Houweling and A. R. Thurik (2000) Firm Survival in the Netherlands', *Review of Industrial Organization* **16**, 1–11.

Boeri, T., and L. Bellmann (1995) 'Post-entry Behaviour and the Cycle: Evidence from Germany', *International Journal of Industrial Organization* **13**, 483–500.

Brixy, U., and R. Grotz (2004) 'Differences of the Economic Performance of Newly Founded Firms in West- and East Germany', in M. Dowling, J. Schmude and D. Knyphausen-Aufsess (eds), *Advances in Interdisciplinary European Entrepreneurship Research*, Muenster: Lit, pp. 143–152.

Brüderl, J., and R. Schüssler (1990) 'Organizational Mortality: The Liabilities of Newness and Adolescence', *Administrative Science Quarterly* **35**, 530–547.

Brüderl, J., P. Preisendörfer, and R. Ziegler (1992) 'Survival Chances of Newly Founded Business Organizations', *American Sociological Review* **57**, 227–242.

Carroll, G., and M. Hannan (1989) 'Density Delay in the Evolution of Organizational Populations', *Administrative Science Quarterly* **34**, 411–430.

Carroll, G. R., and M. Hannan (2000) *The Demography of Corporations and Industries*. Princeton, NJ: Princeton University Press.

Comanor, W. S., and T. A. Wilson (1967) 'Advertising Market Structure and Performance', *Review of Economics and Statistics* **44**, 423–440.

Cooke, P. (2002) *Knowledge Economies – Clusters, Learning and Cooperative Advantage*. London: Routledge.

Dunne, T., and M. J. Roberts (1991) 'Variation in Producer Turnover Across US Manufacturing Industries, in P. A. Geroski and J. Schwalbach (eds), *Entry and Market Contestability: An International Comparison*, Oxford: Basil Blackwell, pp. 187–203.

Fritsch, M. (2004) 'Entrepreneurship, Entry and Performance of New Businesses Compared in Two Growth Regimes: East and West Germany', *Journal of Evolutionary Economics* **14**, 525–542.

Fritsch, M., and U. Brixy (2004) 'The Establishment File of the German Social Insurance Statistics', *Schmollers Jahrbuch/Journal of Applied Social Science Studies* **124**, 183–190.

Fritsch, M., and O. Falck (2006) 'New Business Formation by Industry over Space and Time: A Multi-Dimensional Analysis', *Regional Studies* **40** (forthcoming).

Geroski, P. A., J. Mata, and P. Portugal (2002) *Founding Conditions and the Survival of New Firms*. Portugal (mimeo): Lisboa.

Hannan, M., and G. Carroll (1992) *Dynamics of Organizational Populations*. Oxford: Oxford University Press.

Jovanovic, B. (2001) 'Fitness and Age: Review of Carroll and Hannan's Demography of Corporations and Industries', *Journal of Economic Literature* **39**, 105–119.

Klepper, S., and K. L. Simon (2000) 'The Making of an Oligopoly: Firm Survival and Technological Change in the Evolution of the U.S. Tire Industry', *Journal of Political Economy* **108**, 728–760.

Klepper, S. (2001) *The Evolution of the U.S. Automobile Industry and Detroit as its Capital*. Pittsburgh: Carnegie Mellon University (mimeo).

Krugman, P. (1991) *Geography and Trade*. Cambridge, MA: MIT Press.

MacDonald, J. M. (1986) 'Entry and Exit on the Competitive Fringe', *Southern Economic Journal* **52**, 640–652.

Marsili, O. (2002) 'Technological Regimes and Sources of Entrepreneurship', *Small Business Economics* **19**, 217–215.

Mayer, W. J., and W. F. Chappell (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.

Mueller, E., and J. N. Morgan (1962) 'Location Decisions of Manufacturers', *American Economic Review* **52**, 204–217.

Patch, E. P. (1995) *Plant Closings and Employment Loss in Manufacturing*. New York: Garland Publishing.

Pfeiffer, F., and F. Reize (2000) 'Business Start-ups by the Unemployed – An Econometric Analysis Based on Firm Data', *Labour Economics* **7**, 629–663.

Porter, M. (1998) 'Clusters and the new economics of competition', *Harvard Business Review* **November–December**, 77–90.

Ranger-Moore, J. (1997) 'Bigger May be Better, But is Older Wiser?' *American Sociological Review* **62**, 903–920.

Rosenbaum, D. I., and F. Lamort (1992) 'Entry, Barriers, Exit, and Sunk Costs: An Analysis', *Applied Economics*, **24**, 297–304.

Saxenian, A. (1994) *Regional Advantage*. Cambridge, MA: Harvard University Press.

Sorensen, O., and P. G. Audia (2000) 'The Social Structure of Entrepreneurial Activity: Geographic Concentration of Footwear Production in the United States 1940–1989', *American Journal of Sociology* **106**, 224–262.

Sterlacchini, A. (1994) 'The Birth of New Firms in Italian Manufacturing', *Journal of Industry Studies* **1**, 77–90.

Suárez, F. F., and J. M. Utterback (1995) 'Dominant Design and the Survival of Firms', *Strategic Management Journal* **16**, 415–430.

Tveterås, R., and G. E. Eide (2000) 'Survival of New Plants in Different Industry Environment in Norwegian Manufacturing: A Semi-Proportional Cox Model Approach, *Small Business Economics* **14**, 65–82.

Wagner, J. (1994) 'The Post-Entry Performance of New Small Firms in German Manufacturing Industries', *Journal of Industrial Economics* **42**, 141–154.

Winter, S. G. (1984) 'Schumpeterian Competition in Alternative Technological Regimes', *Journal of Economic Behavior and Organization* **5**, 287–320.