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

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Contents

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. Regional growth has a rather pronounced positive influence on survival rates, while the relationship between the nationwide development of the particular industry and survival tends to be negative. We also find a remarkably high level of spatial autocorrelation.

JEL classification: D21, L10, M13, R10
Keywords: New-firm survival, hazard, entry, market selection

Zusammenfassung

„Der Einfluss von Branchenzugehörigkeit, Standort und Zeit auf das Überleben neuer Betriebe – Eine multi-dimensionale Analyse“

Wir analysieren den Einfluss von branchenspezifischen Faktoren und Standorteinflüssen über die Zeit auf die Überlebensraten neu gegründeter Betrieben mit einem multidimensionalen Ansatz. Die Untersuchung bezieht sich auf die Kreise Westdeutschland im Zeitraum 1983-2000. Die Überlebenschancen sind relativ niedrig in Branchen, die durch eine hohe mindesteffiziente Betriebsgröße und ein hohes Maß an Gründungen gekennzeichnet sind. Regionales Wachstum hat einen deutlich positiven Einfluss, während sich für die nationale Entwicklung der betreffenden Branche eher ein negativer Zusammenhang mit den Überlebenschancen zeigt. In den Analysen ergibt sich ein bemerkenswert hohes Maß an räumlicher Autokorrelation.

JEL-Klassifikation: D21, L10, M13, R10
Schlagworte: Überleben von Gründungen, Hazard, Marktzutritt, Marktselektion

1. 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 united in one single person. As a result, a considerable proportion of new firms have to leave the market relatively soon with the result that in many industries, regions or years 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 steer market processes and the development of firm populations. While considerable progress in our understanding of new-firm formation processes has been made in recent years (cf. Fritsch and Falck, 2003), 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.

In this paper we report about analyses of new business survival that are 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 2). Section 3 briefly describes the data and section 4 is devoted to the general survival pattern of the new establishments. The results of the multivariate analysis are reported in section 5. Finally, we summarize our main results and draw conclusions for policy as well as for further research (Section 6).

2. 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 work efficiently enough to keep pace with competitors. This includes establishing business relations with suppliers, acquiring suitable personnel as well as gaining customers. Another reason for the relatively high vulnerability of new firms to closure is that quite often a certain time period has to be survived until the first profit is realized. Because new firms tend to start relatively small, the liability of newness may also be a *liability of smallness* (Aldrich and Auster, 1986). Such a particular vulnerability of small units to closure could be explained by a rather limited endowment with spare resources in these firms, which does not allow them to survive economic problems.

A number of empirical analyses have found that the likelihood of failure rises during the initial few months following foundation and then, after having reached a maximum, decreases again (Audretsch and Mahmood, 1994; Brüderl and Schüssler, 1990; Mahmood, 2000; Wagner, 1994). The common explanation for this phenomenon, called the *liability of adolescence,* assumes that it takes some time to make a judgment about the prospects of a new venture. The main determinants of the time span until exit are the exhaustion of initial resource endowment, external resource owners' fading confidence in a venture's success (Brüderl and Schüssler, 1990) and the firm-specific threshold of what is deemed sufficient performance, which may be determined by factors such as the founders' employment alternatives, psychic income from entrepreneurship or the cost of switching to other occupations (Gimeno, Folta, Cooper and Woo, 1997). Some authors assume that also older firms 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] The notion of a liability of aging is not necessarily a contradiction to the liability of newness

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[1] Agarwal and Gort (1996), Aldrich and Auster (1986), Brüderl and Schüssler (1990), Carroll and Hannan (2000), Bojanovic (2001), Ranger-Moore (1997).

because both phenomena relate to quite different development stages of a firm, early "youth" and "maturity".

As a stylized fact of empirical research the risk of failure decreases with the larger the initial size of a new business is. One explanation for this finding is that large start-ups represent relatively serious attempts at market entry which are unlikely to be abandoned as soon as first complications arise. Due to a relatively large amount of initial resources, larger start-ups are also better endowed to weather environmental fluctuations than firms which begin relatively small (Mata and Portugal, 1994; Ranger-Moore, 1997). This may particularly hold if a considerable part of the investment is irreversible so that closure would lead to a high sunk cost. Another explanation for the higher survival chances of larger start-ups emphasizes that these new firms enter the market with a relatively small distance to the minimum efficient size which has to be achieved in order to be profitable (Audretsch, 1995, 77, 80; Wagner, 1994). Therefore, larger start-ups may have less difficulty attaining the breakeven point than smaller ones. Because the minimum efficient size varies from industry to industry, survival rates should be higher in industries where the minimum efficient size is relatively small (Audretsch, Houweling and Thurik, 2000; Tvetrås 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 (Audretsch, Houweling and Thurik, 2000; Mayer and Chappell, 1992). However, relatively 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.

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, 84), prospering growth in the national economy, in the particular region or industry may be conducive to economic success and survival (Audretsch, 1995, 70-73; Boeri and Bellmann, 1995; Rosenbaum and Lamort, 1992). However, the relative importance of the different levels is unclear: is regional prosperity more significant for survival than the national development or vice versa? And what impact may industry trends have? A negative relationship between industry growth and new-firm survival (Audretsch, Howeling and Thurik, 2000) could be explained by the conjecture that high-growth industries tend to be at a relatively early stage of the product life cycle, in which products as well as production processes have a low level of standardization. Therefore, setting up a new business in such an industry can be rather risky, particularly if the number of competing start-ups in young and strongly growing industries is relatively high. The empirical evidence is not entirely clear in this respect. In a cross-section analysis for US American industries, Audretsch (1995, 65-122) found that industry growth is conducive to survival but that the probability of new-firm failure is higher in the early stages of the product life-cycle under the conditions of an entrepreneurial regime, i.e. in a relatively young industry in which innovations by small firms play a significant role.

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 a high density of firms at the time when a new firm has emerged will have a negative impact on its survival chances. According to this "density delay" hypothesis, organizations that were set up when the industry was crowded have higher rates of exit than organizations founded in other, less crowded time periods (Carroll and Hannan, 1989; 2000). Geroski, Mata and Portugal (2002, 5f.) suggest 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.[2] The second explanation suggests that firms which have been set up under crowded market conditions may be pushed into

[2] "… organizations created in unfavourable circumstances are unlikely to be anywhere near their optimal structural configuration and, in addition, may not be able to find the right kinds of resources, make the correct organization specific investments, or design the right kinds of routines" (Geroski, Mata and Portugal, 2002, 5).

such types of niche where prospects of success are relatively low ("tight niche packing").[3]

A further type of measure of the intensity of competition is market concentration as indicated, for example, by the concentration ratio or the Herfindahl index. Significant market power of the incumbents may imply low prospects for successful entry (Ilmakunnas and Topi, 1999; Rosenbaum, 1993). It could, however, also be the case that market concentration and market power result in a relatively high price level that provides favorable economic conditions (Audretsch, Houweling and Thurik, 2000). Given the presence of such an 'umbrella effect', start-ups may have relatively good chances of survival. Any measurement of market density or concentration should account for minimum efficient size and it may not be easy to separate this influence empirically from the density or concentration effect. Provided that low market density/high concentration results from large minimum efficient size we may expect high failure rates or relatively low entry rates combined with low failure rates in the particular industries.

A third indicator of the intensity of competition is the entry rate in an industry or region. A relative high entry rate indicates intensive competition, which may result in correspondingly high rates of new-firm failure (MacDonald, 1986; Audretsch, 2001; Sterlacchini; 1994). It is, however, unclear whether it is entry at national or at regional level that has the greater effect on survival. Measures of the intensity of competition at regional level are regional entry and spatial proximity to other establishments, particularly to those in the same industry. The observation that economic activity tends to be clustered in space (Audretsch and Feldman, 1996; Cooke, 2002; Porter, 1998) suggests that certain agglomeration economies

[3] "'Tight niche packing', on the other hand is a story which suggests that the new firms founded in crowded markets conditions can get pushed into unpromising niches which may be transitory or may just lead them to develop knowledge and routines which are so specialized that they will never be able to reposition themselves into more favourable parts of the market later on. Another version of this same story says that the state of the environment at the time of birth largely determines the strategic choices of firms. As firms age and the environment changes, the initial choices of firms become less and less well suited to the new environment, but the routines developed by firms during their lives and that eased the task of dealing with the firms' daily operations, may create rigidities that make the firms ill-suited to cope with the changes in the firms' environments" (Geroski, Mata and Portugal, 2002, 5f.).

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 nearby. 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 etc. All these factors may facilitate new-firm survival. In particular spatial proximity to other actors can result in a high level of knowledge spillovers that are conducive to economic performance (cf. Krugman, 1991). Many other regional factors that may have an impact on the success of new firms are related to regional population density and the size of an agglomeration. This holds particularly for the availability of qualified labor and other resources. Provided that agglomerations provide relatively favorable conditions for innovation activity (see Fritsch, 2000, for a critical review), there should also be a positive statistical relationship with the share of employees in research and development (R&D), the number of patents per employee and with other indicators of regional innovation activity. However, innovative start-ups may be subject to relatively high risk and uncertainty and may be more likely to fail than non-innovative entries.

Literature suggests that the characteristics of the technological regime that holds sway in an industry may have a considerable effect on entry and survival. The concept of technological regime characterizes the nature of innovation activity in an industry, particularly the role of small and large firms (Audretsch, 1995, 39-64; Marsili, 2002; Winter, 1984). A technological regime is called “entrepreneurial” if small firms have a high share of innovation activity so that entrants face a relatively good chance of competing successfully. In an entrepreneurial regime a dominant design has not yet emerged. Under the conditions of a “routinized” regime, i.e. after the establishment of a dominant design, the innovative advantage is on the side of the incumbent large firms, so small firms play only a minor role. Therefore, the conditions for successful entry and survival in such a market can be assumed to be comparatively unfavorable. The empirical evidence with regard to the survival chances in different technological regimes, however, is not at all

Table 1: 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 adolescence	– / +
- liability of aging (of obsolescence, of senescence)	–
Initial size (liability of smallness)	+
Minimum efficient size in industry	– / +
Capital intensity	– / +
Labor unit cost	–
Capital user cost	–
Demand growth – national, in particular industry or region	– / +
Market density (liability of scarcity)	–
Agglomeration, density and size	+
Market concentration	– / +
Entry rate in particular industry and region	–
Availability of resources (personnel etc.)	+
Regional innovativeness	– / +
Entrepreneurial character of technological regime in particular industry and region	– / +
Unemployment	– / +

clear. While Audretsch (1995; 65-122) found that new firms have lower survival chances under the conditions of an entrepreneurial regime, Klepper 2001, Klepper and Simons (2000) as well as Suárez and Utterback (1995) show that prospects for successful start-ups are better before a dominant design is established. The technological regime of an industry may have a pronounced regional dimension (see Saxenian, 1994, for an illustrative example). This is confirmed in an analysis of new-firm formation in West Germany conducted by Fritsch and Falck (2003), who found that the indicator for the character of an industry's technological regime had a much stronger impact when differentiated by region than compared with figures at national level.

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 the development of new firms. And third, it can lead to a large share of start-ups out of unemployment. This raises the question whether the survival chances of new businesses founded by formerly unemployed people differ from those of other start-ups. One may, for instance, expect firms founded by unemployed people to have fewer resources because without employment and regular income, the available amount of capital will be rather limited. Moreover, unemployment tends to be selective in that the qualification level of unemployed people tends to be below average. On the other hand, the opportunity cost of a formerly unemployed entrepreneur is relatively low, so 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). A founder's attitude towards the goals he or she wants to achieve may be of great importance for survival. While some founders primarily want to maximize their profits, others may be quite content with a relatively moderate income. The latter can hold particularly for founders out of unemployment (Love, 1996). If setting up one's own business is the only way of realizing an idea, as may be the case in particular under an entrepreneurial regime (Audretsch, 1995), this could also motivate an owner not to give up easily. Table 1 provides an overview of the different determinants of new-firm survival and the expected signs for the relationship with new-firm survival.

3. Data and measurement issues

Our information on start-ups and their survival is generated from the German Social Insurance Statistics (see Fritsch and Brixy, 2003, for a description of this data source), which covers the vast majority of the private sector in Germany. Since our data cover only establishments with at least one employee other than the founder, the start-ups of firms that remain very small without any employees are not included. We exclude new businesses with more than 20 employees in the first or in second year of their existence.[4] As a result, a considerable number of new subsidiaries of large firms are not counted as start-ups. 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 the 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 information is available for the years 1983 to 2000. Because the shortest survival period analyzed is two years, we include only those cohorts of new businesses for which a two-year survival rate can be calculated. Our information therefore relates to the start-ups of the years 1983-1998. 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 the 1990s and that quite different factors governed market dynamics in the two regions (Brixy and Grotz, 2004; Fritsch, 2004). Information for the explanatory variables was taken from different sources, particularly the Social Insurance Statistics and publications of the Federal Statistical Office (Statistisches Bundesamt)

4. 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 percent of the start-ups still exist after one year. The survival rates are considerably lower in services than in manufacturing. Looking at the hazard rates

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[4] A 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.

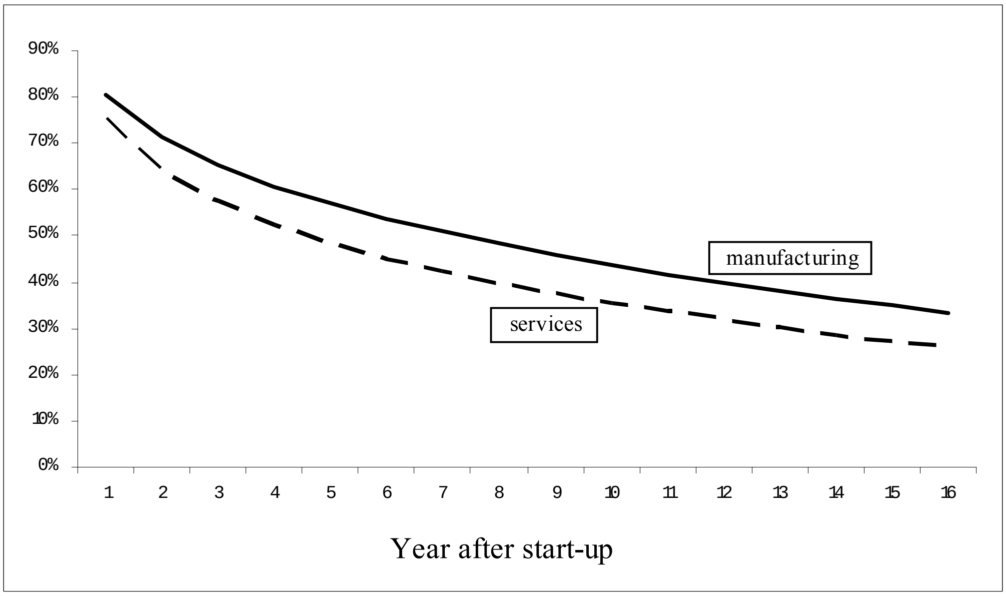

Figure 1: Survival rates in West Germany 1984-2000

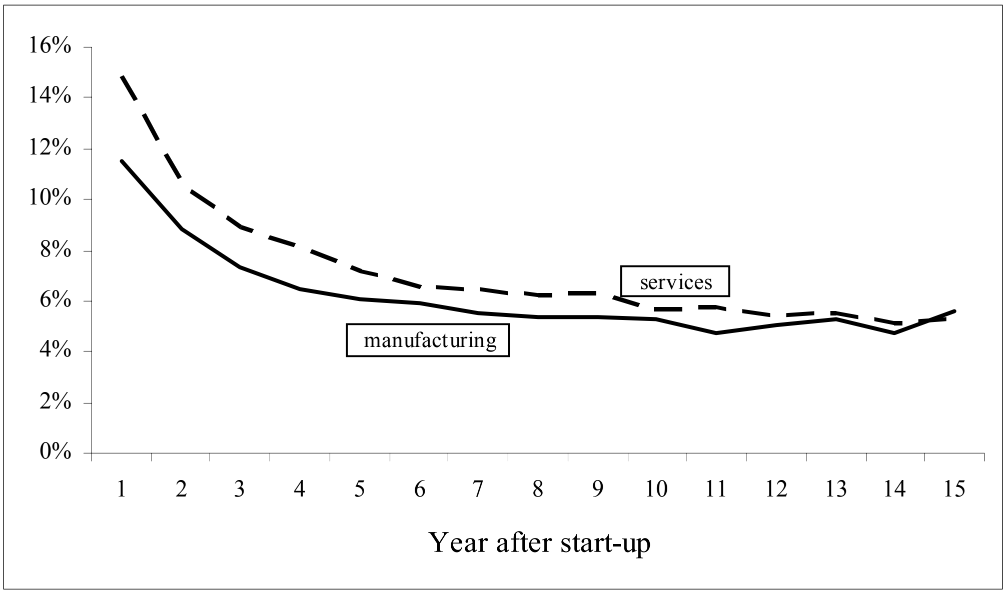

Figure 2: Hazard rates in West Germany 1984-2000

Table 2: Survival and hazard rates for yearly cohorts 1984-1998 after two, five and ten years

Year	Survival rate as % after			Hazard rate as % after		
	two years	five years	ten years	two years	five years	ten 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

(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 six years are over, the likelihood of going out of business is about the same in services and in manufacturing. About 46 percent of the start-ups in manufacturing survive the first ten years compared with about 37 percent in the service industries. Only 25.85 percent of all new service establishments set up in 1984 survived until 2000. In manufacturing this share is about 33.42 percent.

There is some variation in the survival and hazard rates over time as shown in Table 2. While the change in survival rates is somewhat cyclical, there appears to be an increase in the hazard rate after two years and particularly after five years. Pronounced variation in the survival and hazard rates can also be found within the manufacturing and the service sector (Table 3). The highest ten-year survival rates are in “water & energy”, “fine mechanics” and in “health care” while survival rates are relatively low in “apparel”, “hotels & restaurants” and in “agriculture”.

Table 3: Average survival and hazard rates 1983-2000 in different industries after two, five and ten years

Industry	Survival rate as % after			Hazard rate as % after		
	two years	five years	Ten years	two years	five years	ten 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
Fine mechanics	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
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

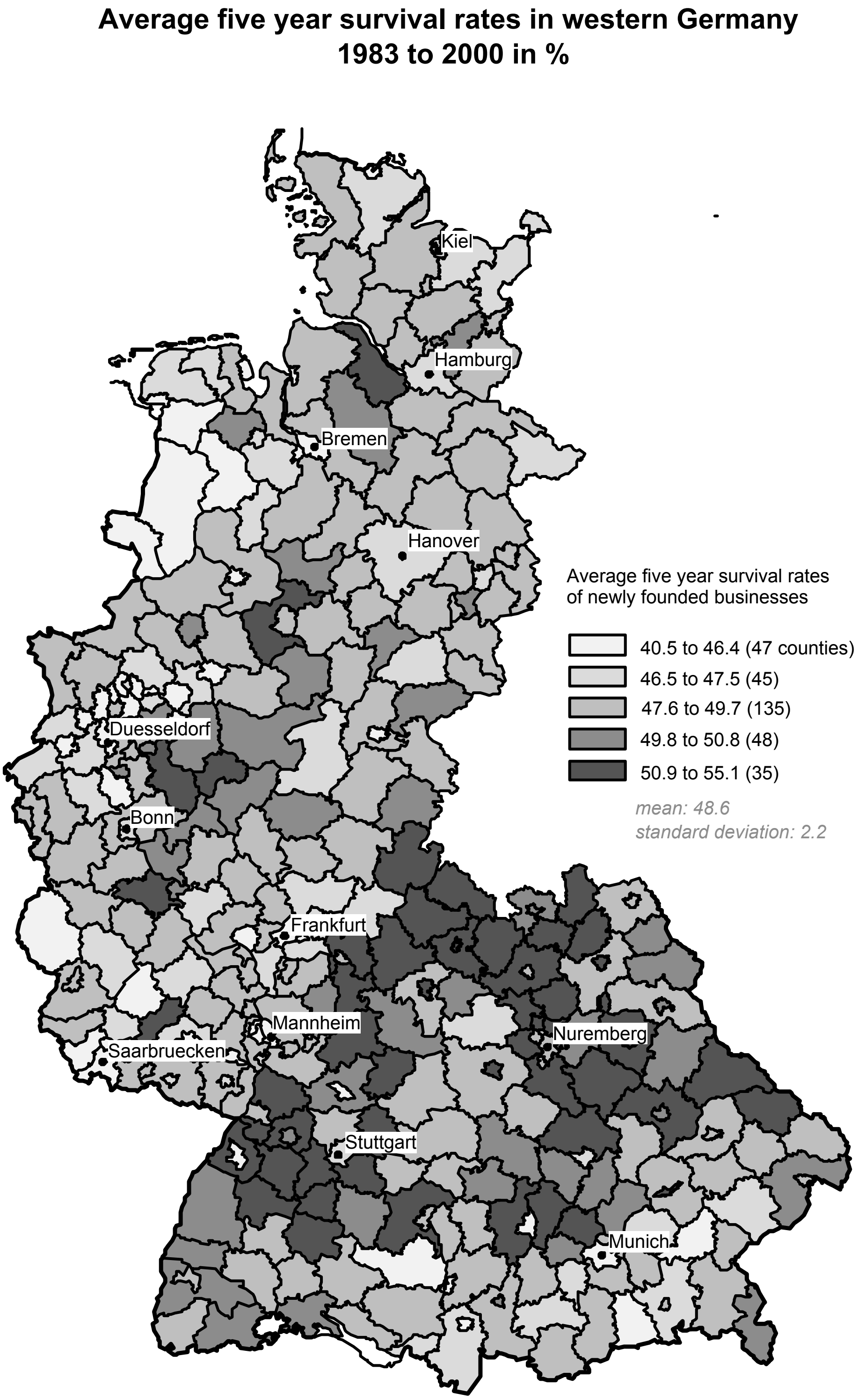

Figure 3: Average five year survival rates in western Germany 1983 to 2000 (%)

Table 4: Average survival and hazard rates for cohorts 1984-1998 in different regions after two, five and ten years

Type of region	Survival rate as % after			Hazard rate as % after		
	two years	five years	ten years	two years	five years	ten 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

The regional distribution of the average five-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-Wuerttemberg as well as in the south-east 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 (cf. Fritsch and Falck, 2003) in these regions, due to the generally higher hazard rates in services. Also the two-year and the ten-year survival rates tend to be relatively low in agglomerations while the respective hazard rates are comparatively high (Table 4). Survival rates are highest in the moderately congested regions, which represent the middle category between the agglomerations and the rural areas (Table 4).

5. Multivariate analysis

5.1 Variables and estimation procedure

For explaining the survival rates we estimated ordinary least square (OLS) regressions applying the Huber-White-sandwich procedure to gain estimates which are robust with regard to autocorrelation and heteroscedasticity over time. In our models we also explicitly accounted for spatial autocorrelation, which proves to be highly significant. Because our dependent variables are rates that have only a limited range of values, Tobit analysis may be more suitable. This procedure, however, led to almost identical results, so we abstain from presenting the respective estimates here. As we argued above (Section 2), density effects may be relevant so that the chances of new-firm survival may not be independent of the level of start-ups in the particular region or industry.

Thus we include the number of new firm entries.[5] 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 by 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 as an instrumental variable for the number of new firms, which has a strong impact on the number of new businesses (Fritsch and Falck, 2003). To test if the instrumental variable approach is more efficient than OLS regression we ran a Durbin-Wu-Hausman test, which in many cases indicates that OLS estimators are inconsistent and is in favour of the instrumental variable approach (Table 6). However, comparing the estimation results for both types of models we find that the differences are rather minor.

If not explicitly noted otherwise, all the values of the explanatory variables relate to the period in which the surviving new establishments started. This approach gave largely better results than the inclusion of values relating to a later point in time, e.g. the years shortly before a new establishment closed down. This confirms the analysis of Geroski, Mata and Portugal (2002), who found that the conditions prevailing at the time when new businesses are set up have a longer-lasting effect on the firms' survival prospects.

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[5] We chose the log of the number of start-ups and not a start-up rate here because the interpretation of the results for the start-up rate could problematic. A start-up rate calculated as the number of start-ups over the number of employees ("labor market approach") may be systematically lower in industries and regions where the average establishment size is relatively high. Calculating an "ecological" start-up rate by relating the number of new firms to the number of incumbents in the industry and region would yield relatively high rates in regions and industries with above average establishment size and relatively low rates if the average establishment size were small (see Audretsch and Fritsch, 1994, for different approaches of calculating a start-up rate).

5.2 Results

Tables 5 and 6 display the results of the two types of regression model for explaining the two-, five- and ten-year survival rates. The models were run for manufacturing industries, for service industries and for the overall private sector respectively. While in the estimations reported in Table 5 the number of start-ups in the particular region and industry was included directly, Table 6 reports the estimates of the instrumental variable models, which contain the number of employees (log) instead.

A high minimum efficient plant size in the industry has a negative impact on new-firm survival in all three sector delineations. Apparently, relatively high hurdles for successful entry lead to correspondingly low survival rates. The impact of minimum efficient size becomes weaker with longer time periods. It tends to be strongest in the estimates for the two-year survival rate and is always least significant in the estimates for the ten-year period. We also find a negative impact of the share of R&D employment (employees with a degree in engineering or a natural science) in the particular industry, region and year on the survival chances of new businesses in many of the models. This confirms the findings of Brüderl, Preisendörfer and Ziegler (1996), Grotz and Brixy (2002) as well as of Audretsch (1995) and Audretsch, Houweling and Thurik (2000). There are three possible explanations for the negative sign of the regression coefficient. First, if the new businesses that are started in the particular industry and region tend to be highly innovative they may be faced with a relatively high risk and are therefore likely to fail. Second, if the founders have a relatively high qualification level they face correspondingly high opportunity costs that could make them give up rather easily ("liability of qualification"). And third, the coefficient for the impact of R&D employment on new-firm survival may be shaped by the fact that many of the large agglomerations have high shares of R&D employment and low survival rates. We tried to control for such agglomeration effects in our model by including a variable for the resident population figure, but this control may not be perfect.

Table 5: Regression analysis of survival rates

	OLS Regressions with robust standard errors								
	All private industries			Services			Manufacturing		
	Two-year survival rate	Five-year survival rate	Ten-year survival rate	Two-year survival rate	Five-year survival rate	Ten-year survival rate	Two-year survival rate	Five-year survival rate	Ten-year survival rate
Minimum efficient size (ij)	-0.0013** (36.40)	-0.0009** (23.93)	-0.0007** (11.15)	-0.0027** (13.19)	-0.0031** (14.24)	-0.0028** (8.26)	-0.0013** (31.71)	-0.0009** (21.46)	-0.0007** (10.97)
Share of R&D employees (ijk)	-0.0465 (0.97)	-0.1426* (2.42)	-0.2662** (3.12)	-0.1116* (2.11)	-0.2216** (3.54)	-0.4004** (3.54)	-0.1113 (1.75)	-0.2731** (3.68)	-0.3561** (3.23)
Yearly growth rate of gross value added (j)	-0.1407** (7.66)	-0.1426** (6.47)	-0.3504** (7.40)	-0.1798** (6.94)	-0.2007** (6.92)	-0.3663** (5.23)	-0.1089** (4.41)	-0.0860** (2.87)	-0.2022** (2.67)
Number (ln) of start-ups (ijk)	-0.0129** (14.02)	-0.0181** (15.52)	-0.0221** (11.15)	-0.0138** (7.00)	-0.0192** (8.90)	-0.2590** (7.26)	-0.0313** (15.07)	-0.0380** (14.55)	-0.0382** (8.11)
Resident population figure (ln) (k, average over several years)	0.0102** (5.81)	0.0160** (7.39)	0.0176** (4.90)	0.0171** (6.34)	0.0201** (6.83)	0.0280** (5.90)	0.0129** (4.30)	0.0226** (5.90)	0.0199** (3.04)
Regional employment change (%) (ik)	0.2961** (8.22)	0.4222** (7.18)	0.8949** (4.66)	0.2018** (4.89)	0.3019** (4.60)	0.7265** (3.58)	0.3277** (5.21)	0.3971** (3.96)	0.8093* (2.37)
Average survival rate in adjacent regions (ijk)	4.2545** (72.10)	3.4810** (84.81)	3.4780** (60.62)	4.2060** (39.52)	3.3711** (46.82)	3.2426** (30.63)	4.3130** (54.75)	3.5567** (63.00)	3.5756** (45.19)
Average residuals in adjacent regions (ijk)	-4.3930** (68.76)	-3.6340** (78.33)	-3.6663** (55.31)	-4.3961** (34.67)	-3.5848** (38.05)	-3.4814** (24.80)	-4.4422** (53.72)	-3.7052** (60.94)	-3.7559** (43.59)
R^2	0.3259	0.3595	0.3790	0.3335	0.4048	0.4378	0.3128	0.3383	0.3608
F-value	1005.37**	1245.43**	531.82**	527.69**	842.11**	305.46**	409.41**	543.66**	264.58**

i : per year. j: values per industry. k: values per region. **: statistically significant at the 1 percent level. *: statistically significant at the 5 percent level.

Table 6: Regression analysis of survival rates – models with instrumental variables

	Instrumental variables regressions with robust standard errors								
	All private industries			Services			Manufacturing		
	Two-year survival rate	Five-year survival rate	Ten-year survival rate	Two-year survival rate	Five-year survival rate	Ten-year survival rate	Two-year survival rate	Five-year survival rate	Ten-year survival rate
Minimum efficient size (ij)	-0.0018** (36.01)	-0.0014** (26.22)	-0.0011 (15.16)**	-0.0035** (15.53)	-0.0040** (16.54)	-0.0040** (10.19)	-0.0016** (31.22)	-0.0012** (22.67)	-0.0009** (12.69)
Share of R&D employees (ijk)	0.1354** (2.79)	0.0659 (1.06)	-0.1022 (1.02)	-0.0323 (0.60)	-0.1795** (2.79)	-0.4138** (3.56)	0.0025 (0.04)	-0.1354 (1.65)	-0.2553* (2.03)
Yearly growth rate of gross value added (j)	-0.0060 (0.31)	0.0028 (0.12)	-0.2228** (4.66)	-0.1733** (6.78)	-0.1573** (5.50)	-0.3664** (5.32)	-0.0614* (2.43)	-0.0729* (2.39)	-0.2735** (3.53)
Number (ln) of employees (ijk) as an instrument for the number of start-ups	-0.0473** (24.26)	-0.0550** (22.30)	-0.0599** (14.26)	-0.0318** (13.84)	-0.0387** (14.60)	-0.0498** (10.67)	-0.1147** (18.95)	-0.1192** (16.70)	-0.1168** (9.45)
Resident population figure (ln) (k, average over several years)	0.0313** (14.29)	0.0390** (14.54)	0.0414** (9.52)	0.0346** (11.29)	0.0391** (11.96)	0.0516** (8.85)	0.0547** (12.74)	0.0637** (12.05)	0.0603** (6.85)
Regional employment change (%) (ik)	0.2034** (5.47)	0.2749** (4.48)	0.7458** (3.79)	0.1393** (3.33)	0.17455** (2.60)	0.5269* (2.56)	0.3044** (4.80)	0.3018** (2.92)	0.6996* (2.00)
Average survival rate in adjacent regions (ijk)	4.2378** (71.55)	3.4743** (83.49)	3.5055** (59.79)	4.2564** (38.93)	3.3957** (46.52)	3.2675** (30.07)	4.5218** (52.41)	3.6971** (59.82)	3.7042** (43.50)
Average residuals in adjacent regions (ijk)	-4.3936** (68.29)	-3.6468** (77.26)	-3.7112** (54.67)	-4.552** (34.26)	-3.6234** (37.97)	-3.5270** (24.44)	-4.6481** (51.50)	-3.8464** (58.04)	-3.8814** (42.12)
R^2	0.3079	0.3429	0.3622	0.3278	0.3996	0.4301	0.2822	0.3144	0.3392
F-value	857.13**	1145.04**	515.63**	477.96**	789.57**	305.46**	372.13**	507.42**	249.63**
Durbin-Wu-Hausman test	188.34**	165.01**	77.43**	-10.17†	-123.14†	18.69*	-512.52†	-205.77†	50.02**

i : per year. j: values per industry. k: values per region. **: statistically significant at the 1 percent level. *: statistically significant at the 5 percent level.

Including the share of R&D employment differentiated by year and industry but not by region still results in significantly negative coefficients, but the t-values are considerably lower. This indicates that the regional variation has an effect. In the instrumental variables models, however, the share of R&D employment has a significant impact in only two of the models, showing a positive as well as a negative sign.

We found no significant impact of the national growth rate of gross value added over the survival period on new-firm survival chances. However, if we include the yearly growth rate of the particular industry, we find a significantly negative sign.[6] The standard explanation for this result, which has also been found in other studies (Brüderl, Preisendörfer and Ziegler, 1996; Audretsch, Howeling and Thurik, 2000), is that high-growth industries tend to be at a relatively early stage of the product life cycle in which products as well as production processes possess a low level of standardization. Therefore, setting up a new business in such an industry may be relatively risky, particularly if the number of competing start-ups in such young and strongly growing industries is rather high.

The number of start-ups in the particular industry and region has a pronounced negative impact on new-firm survival. Obviously this reflects the effect of strong competition between a large number of entries and confirms the density hypothesis (Section 2). If the regional number of start-ups in the particular industry is substituted by the national figure the effect is also significantly negative but slightly weaker. This result indicates that density has a regional dimension to some extent and that a considerable part of the relevant competition is within the region.

Including population density in the model as an indicator of agglomeration effects showed no statistically significant impact. This need not necessarily mean that concentration of economic activity does not matter, since population

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

density in such small spatial units as we used in our analysis ('Kreise') may not be an appropriate indicator. A particular weakness of population density at district level as an indicator of agglomeration effects is that the size and the character of the districts differ considerably. Some are core cities, others are part of a larger agglomeration's suburban ring and some are functional units that comprise a smaller town as well as the surrounding area. However, if we include the regional population figure in the model we find a pronounced positive relationship indicating that location in a large agglomeration is conducive to survival. This result suggests that it is not the density but the size of an agglomeration that is important. Testing different linear and non-linear forms of this indicator we found that the logarithm of the regional population figure fits the data best. We may therefore conclude that agglomeration economies rise less than proportional to the population figure. Because our spatial units are relatively small and probably do not cover the entire relevant agglomeration it would be desirable to include information on the population in adjacent districts in the models, too. However, if the population figure has a significant effect on survival as indicated by our results, there is also a direct relationship between population and the survival rate in the adjacent districts, which is included as a control for spatial autocorrelation. Hence, the effect of population in adjacent regions is included indirectly via their survival rate.

The positive relationship between population and the survival of newly founded businesses points towards the relevance of urbanization economies, i.e. the spatial proximity of economic units affiliated to various industries. 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. Due to the close statistical relationship between employment and the number of start-ups in an industry, this result is difficult to interpret. 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 due to the presence of other suppliers of the same kind in the region.

Average regional employment growth during the life-span of the new firms can be regarded as an indicator of regional demand. Including this variable in our model shows a strong positive impact. In contrast to this, employment change at national level, overall employment as well as employment change in the particular industry, were insignificant, indicating a substantial role of regional conditions for the success of a new business. The average regional employment change in the years before the businesses were set up shows no significant effect on new-firm survival. 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 in that year and the share of new businesses that were founded by unemployed people. Including this indicator in our models does not show any significant effect. A measure for the entrepreneurial character of an industry's technological regime in a certain year and region also revealed no strong effects.[7] There is, however, a quite significant negative relationship between this indicator and the minimum efficient size, but the impact of the minimum efficient size was generally much stronger. 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.

We find a quite pronounced degree of spatial autocorrelation in our data, i.e. new-firm survival in adjacent regions is not independent but related in some way. Not surprisingly, this level of spatial autocorrelation is considerably lower when conducting the analysis at the level of planning regions ('Raumordnungsregionen'), which are much larger than the districts that we use here. There are two possible reasons for such spatial autocorrelation. First,

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[7] Our indicator of the entrepreneurial character of the technological regime in an industry and region is the proportion of R&D employees in establishments with fewer than 50 employees over the share of R&D employment in total employment in the same region, industry and year (source: Social Insurance Statistics). 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. We calculate the technological regime indicator for each industry in each region separately so that the character of the technological regime in that industry may differ across regions as is suggested by some authors (Saxenian, 1994).

the effect of the factors that are responsible for new-firm survival may not be limited to the particular region but may spill over to other regions. We accounted for this type of spatial autocorrelation by including a weighted average of the industries' new-firm survival rates in the adjacent regions. A second type of spatial autocorrelation of new-firm survival rates could be caused by influences that affect larger geographical entities than districts and which are not fully reflected in the explanatory variables of the model. In fact, Audretsch and Fritsch (2002) and Fritsch and Falck (2003) found that a certain type of growth regime tends to apply to geographical areas that are considerably larger than districts or even planning regions.[8] We accounted for this type of spatial autocorrelation by including a weighted average of the residuals in the adjacent regions in our models. Remarkably, we arrive at diverging signs for the two types of spatial autocorrelation. While the spillovers from the adjacent regions have a positive effect on new-firm survival are, the effect of the residuals in the adjacent regions is strongly negative. Judged by the t-values of the respective coefficients both types of effect are relatively strong, indicating a high relevance of spatial autocorrelation. The spillover effect tends to be a little more pronounced, but this difference appears negligible.

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). And there are fewer factors that have a statistically significant impact on the survival of new firms, i.e. survival is subject to erratic influences to a greater extent than in the West. These differences obviously reflect the ongoing process of transformation to a market economy in the East.

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[8] German planning regions are functional spatial units somewhat larger than labor-market areas consisting of several districts, in most cases a city and the surrounding districts.

6. Conclusions

In our analysis we were able to identify a set of variables that have an impact on the survival chances of new businesses. In particular, we were able to show that the regional level matters for the success of newly founded businesses. This impact of regional conditions is particularly clear for the number of new firms in a region, regional employment growth and the degree of agglomeration. Moreover, we find a rather high level of spatial autocorrelation, which also emphasizes the importance of location. Factors at industry level tend to be of lesser importance. The impact of a variable always became stronger when it could be disaggregated by industry *and* region as compared to including the variable disaggregated by industry only. Empirical analysis of new-firm survival should, therefore, try to account for the regional level. This demonstrates the progress that can be achieved if differentiated data are available.

There are a number of issues in the analysis that deserve further investigation. In particular, we should be better able to understand the negative relationship that we found between industry growth and survival as well as the negative relationship between survival and R&D employment in the particular industry and region. And we need to know more about the way in which the different types of spatial autocorrelation come about.

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