Survival Chances Of Start-Ups
Do Regional Conditions Matter?

Oliver Falck
University of Passau

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Address of correspondence:
Oliver Falck, University of Passau, Faculty of Economics and Business Administration, Innstraße 27, D-94032 Passau (Germany), Phone: **49-851-5092543, Fax: **49-851-5092542, E-mail: oliver.falck@uni-passau.de

Contents

Abstract

This paper analyses the effect of industry, regional and firm level characteristics on the post entry performance of newly founded businesses by means of an econometric survival time model. First preference is given to an accelerated failure time model assuming a log-logistic distribution. The dataset involves a representative sample of establishments in the private sector provided by the Institute for Employment Research (IAB). The data relates to West German states during 1993-2002 period. A start-up's The likelihood of failure tends to be relatively high in industries characterized by a high minimum efficient size and high numbers of entries. The regional dimension has a considerable impact upon improvements of estimation results. On the firm level, the size of the firm seems to be the best predictor for the likelihood of failure.

JEL classification: D21, C41, L10, M13, R10.

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1. Introduction[*]

The formation of a business is afflicted with many risks. Only a small part of the newly founded businesses survives a longer period. The knowledge in empirical research over the probability of survival of businesses can be classified as extensive. A large number of econometric studies about the determinants of the failure of newly founded businesses analyzing different data sets already exists. This analysis using western German establishment data provided by the Institute for Employment Research emphasizes the importance of regional conditions for the success of newly created businesses. While industry conditions find broad consideration in empirical studies, regional conditions have so far been largely neglected. In this study it can be shown that both the industry and the regional conditions are of central importance for the likelihood of survival of newly founded businesses. Thereby, the used data permits a view on the firm level. Regarding the probability of survival of newly founded businesses the size of a company has been confirmed as being the best predictor.

Chapter 2 gives a survey of empirical research in the determinants of failure of newly founded businesses is given. Chapter 3 describes the used data, whereas chapter 4 discusses the estimation procedure. In chapter 5, the results are presented. Finally, chapter 6 gives a short summary as well as an outlook on further research.

2. Determinants of the failure of newly founded businesses

The size of the establishment proves to be the main determinant of the failure of newly founded establishments in empirical studies. This is known as the liability of smallness. Newly founded businesses often lack sufficient economic resources to overcome economic problems.[1] Because newly founded establishments tend to be relatively small, the

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[1] Cf. Aldrich, Auster (1986).

liability of smallness is also a liability of newness.[2] Moreover, the liability of newness is also driven by the fact that newly founded businesses need time to establish a good organisational structure as well as relations to suppliers. The time needed to win suitable personnel and to acquire the first customers further contribute to the problems of young establishments. Therefore, profits are frequently made only after some time.[3] Geroski (1995) already finds out that both newly founded businesses and small businesses have a probability of survival below average.

Other empirical studies show that the probability of failure increases to a maximum during the first months after foundation and then begins to fall.[4] This liability of adolescence is usually explained by the fact that it requires a certain time to test and judge the chances of success of the project.

While the impact of firm size on its survival time is widely accepted, the question, whether the size of a business at its foundation or rather the current size of a business affects the probability of survival, is answered differently. Mata, Portugal, Guimaraes (1995) conclude that the current size has a stronger influence on the probability of survival than the size at the foundation time. They justify their result by the fact that the current size of a business considers implicitly the ability of adjustment to a changing environment. Also the firm's characteristics at the time of its foundation were found to have a long-term effect on the probability of survival.[5]

Technological conditions in an industry are closely connected with the impact of the business size.[6] Industries, in which the prevailing technology causes size advantages, will have a high minimum efficient size of establishment. Newly created establishments, which are frequently created below the minimum efficient firm size, are exposed to a strong competitive growth pressure in these industries. Therefore,

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[2] Cf. Aldrich, Auster (1986).
[3] Jovanovic (1982) and Nelson, Winter (1982) discuss the *liability of newness*.
[4] Cf. Audretsch, Mahmood (1994), Brüderl, Schüssler (1990), Brüderl, Preisendörfer, Ziegler (1992), Mahmood (2000) and Wagner (1994).
[5] Cf. Geroski, Mata, Portugal (2002).
[6] Cf. Audretsch (1995, 77-80) and Wagner (1994).

industries with a high minimum efficient size of establishment have a higher probability of failure of newly created establishments.[7] On the contrary, Dunne, Robert (1991) emphasize that high barriers to market entrance may cause firm foundations with above average chances of success due to a self selection process.

Apart from the minimum efficient size of the establishment, the phase of the industry's product life cycle is of importance. Audretsch, Houwelig, Thurik (2000) point out that in early phases of the product life cycle standardized products and/or production procedures play a subordinated role and that businesses therefore face a high risk. Audretsch, Houwelig, Thurik (2000) assume that due to the prevailing uncertainty the probability of survival of enterprises is below average. In contrast, Audretsch (1995, 65 - 122) finds a positive correlation between probability of survival and industry growth as an indicator for the phase in the product life cycle. The rationale for this positive correlation could be that particularly small firms enjoy innovation advantages compared to established large-scale enterprises.[8] Product innovations during the early phases of the product life cycle often occur in small firms which benefit from flat organizational structures.

While industry conditions are broadly taken into account in econometric survival time analyses, this does not apply to regional conditions. Usually, macro variables like unemployment ratio, interest rate or gross domestic product are considered.[9] However only Fritsch, Brixy, Falck (2004) broadly control for the regional conditions in a survival time analysis using a multidimensional approach.[10] Thus agglomeration advantages like access to a large differentiated job market, broad business services, proximity to research centers or the proximity to a

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[7] Cf. Audretsch, Houweling, Thurik (2000) and Tvetras, Eide (2000).

[8] Cf. Audretsch (1995, 36-64), Marsili (2002) and Winter (1984) for the concept of the technological regime with which innovation activities in industries can be described.

[9] Cf. e.g. Audretsch, Mahmood (1995) who take into consideration the national unemployment rate and the interest rate.

[10] However, there appear to be numerous articles discussing the impact of regional conditions on new firm formation – especially in Eastern Germany – as well as on the development of newly founded businesses. Cf. Steil (1999), Bellmann, Bernien, Kölling, Möller, Wahse (2002), Fritsch, Niese (2004) and Brixy, Niese (2004).

large number of consumers can compensate the negative effects of higher costs, respectively higher wages or leases.[11] This variables cannot only influence the foundation of new businesses, but also their probability of survival. In their multidimensional model Fritsch, Brixy, Falck (2004) find a significant impact of the regional growth rate of employees on the probability of survival.

Beyond this, the degree of competition in the market, in which businesses act, might be a key driver of the probability of survival of businesses. Besides classical measures of market concentration like the Herfindahl index, the number of establishments in the same industry and/or region is used in empirical studies as a degree for the competition intensity, too. A high competition pressure is expected to stem from a large number of competitive new businesses.[12]

Further characteristics of the firm are considered in empirical studies. Amongst those are legal form, foreign property, the affiliation of the establishment to a multi-plant firm and the receipt of national capital investment grants. The question whether the newly founded business is a spin-off of an existing business can also be relevant. Concerning the legal form Harhoff, Stahl, Woywode (1998) argue that firms with limited liability are more likely to go bankrupt, since the owner has only limited responsibility for the liabilities. Mata, Portugal (2002) share that view as they come to the conclusion that firms with limited liability have a higher failure probability than firms, in which the owner is fully liable. On the other hand the complex administrative procedures of the founding process mean that new firms with limited liabilities are more difficult to establish and hence could represent establishments which must be taken seriously than other foundations.

Likewise, little clarity prevails concerning the role of foreign capital for the probability of survival of businesses. Thus, on the one hand

[11] Cf. Audretsch, Feldman (1996), Cooke (2002) and Porter (1998).

[12] The best places in which to study the modelling of the market concentration are Mata, Portugal (1994), Andretsch, Houwelig, Thurik (2000), Görg (2003) and Fritsch, Brixy, Falck (2004). These models work with variables like the Herfindahl index, the number of start-ups or the start-up rate in an industry respectively. Fritsch, Brixy, Falck (2004) also implement regional differentiation.

problems of co-ordination in internationally operating enterprises as well as the better possibility of shifting production to other locations are stressed. On the other hand foreign financial participation could be an indicator for unobserved advantages of the business, which lead to a higher probability of survival. [13]

The influence of national subsidies on the survival of businesses is still rarely analysed by econometric methods. Diamara, Skuras, Tzelepis (2000) for example analyse the influence of national subsidies on the survival of businesses in the Greek food sector with the help of a hazard model and show a significantly negative influence on the probability of failure. For Germany, a first analysis of the effects of public assistance programs on the success of young firms goes back to Bruederl, Preisendörfer, Ziegler (1993). Using a statistic matching method Almus, Prantl (2001) find on the average a higher probability of survival. In terms of survival, they show a higher growth of employment in the group of young firms receiving assistance from the Deutsche Ausgleichsbank (DtA). Both, spin-offs and newly founded establishments belonging to an already existing multi-plant enterprise, might have an above average survival probability. In relation to independently founded businesses, these newly founded establishments have the advantage that they can fall back on existing knowledge concerning organization, supplier - and customer relations. Therefore, their probability of survival is above average.[14]

Table 1 gives an overview of the expected influences of different variables on the survival time of businesses.

<< Insert Table 1 about here >>

[13] For more on the influence of foreign ownership cf. Hymer (1976), Braconier, Ekholm (2000), Mata, Portugal (2002) and Bernard, Sjöholm (2003).

[14] Cf. Brüderl, Preisendörfer, Ziegler (1992).

3. Data

The establishment panel (Betriebspanel) of the Institute for Employment Research (Institut für Arbeitsmarkt- und Berufsforschung IAB) serves as data basis.[15] It contents the results of an annual questioning amongst establishments, which is carried out in West Germany since 1993. The drawing of the sample of the IAB establishment panel is based on the German Social Insurance Statistics of the Federal Employment Services. The Social Insurance Statistics is derived from the reporting procedure for the public health -, pension - and unemployment insurance. Thereby, each establishment with at least one employee operating under social security receives a code number, which is durably bound to the establishment. These establishments represent the population. Thus, for the drawing of the sample for the IAB establishment panel, the code number serves as crucial defining criterion for the establishment. The drawing of the sample takes place according to the principle of the optimal layering. The resulting sample corresponds approximately to an employee-proportionally drawn sample. The layering cells are defined by ten establishment size classes and sixteen industries. The probability of selecting the establishment rises with its size, thus the IAB establishment panel contains relatively more large-scale establishments than the population of the establishments with at least one employee operating under social security. Illustration 1 represents the number of establishments included in the sample each year. An annually returning catalogue of questions covering establishment characteristics such as occupation, revenue and investments is asked. This catalogue guarantees the panel character of the questioning. Additional complexes of questions are included in the rotation of several years and cover issues of working time flexibility, overtime or working time accounts.

<< Insert Illustration 1 about here >>

[15] For more detailed information cf. Bellmann (1997 and 2002) and Bellmann, Kohaut, Lahner (2002).

Analysing the probability of failure of newly founded establishments in the private sector, only those establishments are selected from the IAB establishment panel, which were not older than ten years at the time of the first questioning and which belong to the private sector. The time of the first questioning of an establishment does not have to be the beginning of the questionings in the year 1993. Due to the balancing of the mortality in a sample and the expansion of the sample, establishments might also be observed for the first time after 1993. The data is, thus, left truncated and also right censored. Establishments are exposed to the risk of failure since their foundation. Regarding the IAB establishment panel the establishment and its characteristics are, however, only observed when starting the first questioning. This characterizes left truncated observation units. Furthermore, not all establishments will survive up to the last considered panel wave. Only establishments still existing in the last considered wave are exposed to the risk of failure for the whole observation period. In the case of establishments, which close before the last considered panel wave, one speaks of right censored observation units. Both, left truncation and right cencoring, are to be taken into account in hazard function estimation, which describes the conditioned probability of failure of an establishment in a time span $t + \Delta t$.[16] The finally used sample consists of 9273 establishments. Out of those 9273 establishments 334 closed during the observation period. An establishment is assumed to be closed, if it does not answer in the panel questioning for two consecutive years. Due to the high participation of the establishments in the questioning this approach seems to be justifiable: In the first year of the panel 71% of the included establishments voiced their willingness to participate in the interviews; even up to 85% of the repeatedly surveyed establishments provided answers to the IAB's questions.[17] Illustration 2 represents the Kaplan-Meier hazard function computed on basis of a not parametric estimation.

<< Insert Illustration 2 about here >>

[16] Cf. Hosmer, Lemeshow (1999, 253-269) and Jenkins (2004, 106-107).
[17] Cf. Bellmann, Kohaut, Lahmer (2002, 15).

A bell-shaped hazard function shows up. In contrast, Fritsch, Brixy, Falck (2004, 10) find hazard rates falling monotonously with the establishment age on the basis of.[18] This discrepancy could arise as a result of the sample drawing process in the IAB establishment panel. While in the Social Insurance Statistics small establishments prevail, large-scale establishments are over-represented in the IAB establishment panel.[19] In the case of large-scaled foundations, on the one hand, one might assume behind this new foundation a long-term intention, which can be taken seriously. On the other hand, these newly founded establishment might have sufficient resources, in order to overcome the first problems.

4. Estimation procedure

A usual concept in econometric survival time analysis is the hazard function already introduced.[20] The hazard function represents the probability of failure of an establishment during $t+\Delta t$ under the condition that the enterprise is active up to the time t:

$$h(t) = \lim_{\Delta t \to 0} \frac{P(t \leq T < t + \Delta t \mid T \geq t)}{\Delta t} = \frac{f(t)}{1 - F(t)} = \frac{f(t)}{S(t)} \qquad (1)$$

$f(t)$ represents the density function, $F(t)$ is the distribution function and $S(t)$ the survival function. The survival function is $S(t) = \exp(-\Lambda(t))$ with $\Lambda(t) = \int_0^t h(u)du$ as cumulative hazard function.

[18] Perez, Castillejo (2004) recently presented a study based on Spanish data similar to the IAB establishment panel. They also identified a bell-shaped function of the non-parametric Kaplan-Meier hazard function.
[19] Those establishments, that are questioned for the first time in their year of foundation, have an average number of employees operating under social security of about 200. In contrast, the average initial size of start-ups in the establishment file of the Social Insurance Statistics is 2.28 employees (cf. Fritsch, Weyh (2004, 7-8)).
[20] Cf. Lancaster (1990, 6-10).

In the case of left truncated and right censored observations the Likelihood function in general form reads[21]:

$$L = \prod_{i=1}^{N} \left[\left[\frac{f(T_i)}{S(E_i)} \right]^{c_i} \left[\frac{S(T_i)}{S(E_i)} \right]^{1-c_i} \right] = \prod_{i=1}^{N} \left[h(T_i)^{c_i} \left[\frac{S(T_i)}{S(E_i)} \right] \right] \qquad (2)$$

c_i is the censoring variable. c_i takes the value one for observation units, which fail during the observation period and the value zero for observation units, which are still going concern at the end of the observation period. E_i gives the time of first questioning in the sample. After taking logarithm, the log Likelihood function results:

$$\ln L = \sum_{i=1}^{N} \left[c_i \ln h(T_i) + \ln \left[\frac{S(T_i)}{S(E_i)} \right] \right] \qquad (3)$$

A semi parametric hazard model, which was first suggested by Cox (1972), is mainly used. The co-variables X shift the baseline hazard function $h_0(t)$ at each time t proportionally upward or downward depending upon influence.[22]

$$\begin{aligned} h_i(t, X_i) &= h_0(t) \cdot \lambda_i,\ \lambda_i \equiv \exp(X_i \beta) \\ \ln(h_i(t, X_i)) &= \ln(h_0(t)) + X_i \beta \end{aligned} \qquad (4)$$

The model is very popular in econometric survival time analyses due to the fact that the baseline hazard function $h_0(t)$ does not have to be specified. However, the strong assumption of the proportional influence at each time of the co-variables is frequently hurt. To test, if the proportionality assumption holds for individual variables in the model or for the entire model Grambsch, Therneau (1994) suggest to compute a test statistic using the Schoenfeld- or the scaled-Schoenfeld-residuals.[23] If the value of the test statistics is not significant, the

[21] Cf. Perez, Castillejo (2004, 5) and Kim (2003, 521-522).
[22] Cf. Jenkins (2004, 41-44); Hosmer, Lemeshow (1999, 113-115).
[23] Cf. Hosmer, Lemeshow (1999, 205-216).

proportionality acceptance cannot be rejected. For the entire model, a value of 18.65 results in the presented specification for the test statistic (p-value 0,0169), which suggests that the proportionality assumption is hurt. Alternatively, an accelerated failure time model is applied.[24] This is characterised by the fact that it can be linearized by taking logarithms.

$$\begin{aligned} \ln(t_i) &= X_i\beta + z_i \\ \ln(t_i\psi_i) &= z_i \end{aligned} \qquad (5)$$

Looking at the second representation of equation 5, it is obvious that $\psi_i = \exp(-X_i\beta)$ is a time scaling factor, which increases the probability of failure and therefore decreases survival time for values more than one. For values less than one, the probability of failure decreases and therefore increases survival time. To understand this model Allison (1995, 62) states the following illustration: A rule of thumb says that one dog life year corresponds to seven human life years. In calendar years therefore it means that dogs age faster than humans. Now if $h(t, X)$ is the hazard function of dogs, then $h(t, X = 0)$ describes the hazard function of humans. ψ has the value seven. Thus for $\psi > 1$ the clock ticks faster, for $\psi < 1$ it ticks slower. By differentiating $\beta_k = \frac{\delta \ln(t_i)}{\delta X_k}$ it can be shown that the coefficients β_k indicate the proportional changes of survival time by changing the value of one regressor by one unit and holding the other regressors constant.[25] z_i is a scaled error term.

Regarding the accelerated failure time model, the underlying distribution has to be further specified. The bell-shaped form of the hazard function found in the non-parametric estimation suggests a log-logistic distribution for the hazard function in the accelerated failure time model. In contrast to the frequently applied exponential

[24] Cf. Jenkins (2004, 44-47), Hosmer, Lemeshow (1999, 271-273).

[25] Regression coefficients are interpreted in another way compared to the proportional hazard model. In the proportional hazard model regression coefficients proportionally shift the hazard rate as the value of one regressor increases by one unit all other regressors being constant.

distribution, this distribution has the advantage that apart from monotonous functional forms, it permits also functional forms like the bell-shaped one found above.[26]

$$h(t, X_i) = \frac{\psi_i^{1/\gamma} t^{(1/\gamma - 1)}}{\gamma[1 + (\psi_i t)^{1/\gamma}]} \qquad (6)$$

ψ_i is thereby the already described scaling factor and $\gamma > 0$ determines the shape of the function. For $\gamma \geq 1$, a monotonous falling function results. For $\gamma < 1$, a bell-shaped functional form results. In the presented model specification a significant value of 0.5430 results for γ. Further, a graphic examination, in which the Kaplan Meier estimated values of the cumulative hazard function are plotted against the cumulative Cox Snell residuals from the presented model, shows that the values are very near the 45° line. This indicates that the model represents the data well.[27] Only for great values of t a certain deviation is found, quite usual for models with right censored data.

5. Multivariate analysis

5.1. Variable selection

In order to make a first guess on the variables, which should be taken into account in the multivariate survival time analysis, non-parametric tests are conducted in accordance to the examination of the equality of the survival function in different groups. If the survival functions for groups differ, this suggests that the variables separating the groups have a substantial influence on the probability of survival of establishments. Thus, they should be included into the multivariate analysis. Table 2 shows the results for the variables federal states (Bundesland), industry, large-scale enterprise (= 1 for enterprises with more than 200 employees), public investment assistance (= 1 for receiving public assistance), research and development department (=

[26] Cf. Jenkins (2004, 39); Hosmer, Lemeshow (1999, 299-304).
[27] Cf. Hosmer, Lemeshow (1999, 303).

1, if RaD department available), part of multi-plant enterprise (= 1, if establishment is part of a multi-plant enterprise), legal form (= 1, if limited liability company), spin-off (= 1, if establishment is a spin-off). Both, a log-rank and a Wilcoxon test are accomplished for the examination of the equality of the survival functions.

<< Insert Table 2 about here >>

It shows that, apart from the size of company as central characteristic of the establishment, the environment of the establishment has a substantial influence. It seems therefore important to consider region and industry characteristics. Many of the mentioned variables are however closely connected to the size of establishment. For example, RaD departments are mainly present in large-scale establishments. Large-scale establishments often choose a legal form with limited liability. Newly created establishments in multi-plant enterprises are already founded with minimum efficient size. Likewise, industries can be characterized in particular by their size of establishment structure. In order to make sure that the specified group differences are not only driven by differences in the size of establishment structure the log-rank test is again done controlling for firm size.

<< Insert Table 3 about here >>

Industry conditions and regional environment still play an important role. On the establishment level, the size of the establishment remains the central characteristic. Due to the data provided by the IAB establishment panel, only the size of the establishment in the examined year can be taken into account, because the panel lacks information on the size of the establishment at the time of foundation. As pointed out in chapter 2 different statements can be found in literature rating the degree of importance of these variables. No contribution can be made to this debate.

Additionally, the multivariate analysis considers the growth rate of employment in the establishment as indicator for the adaptability of the establishment.

For the characterisation of industry and regional conditions, the following variables are used at the observation time:

- growth rate of employment under social security in the industry (source: Social Insurance Statistics).
- growth rate of employment under social security in the federal state (Bundesland) (source: Social Insurance Statistics).
- type of region (source: IAB establishment panel): The type of region categorizes the region by its size, in which the establishment is settled. The variable can take the values 0, 1, 2..., 9 whereby the most populated regions over 500.000 inhabitants are coded with 0 and regions under 2.000 inhabitants with 9.
- growth rate of the price deflated national gross domestic product (source: Federal Statistical Office).
- Logarithm of the number of newly founded establishments in the regarded industry of the respective federal state (source: Social Insurance Statistics).
- Minimum efficient size of establishments in the respective industry (source: Social Insurance Statistics). The size of an establishment refers to the number of persons employed under social security. The minimum efficient size of an establishment is computed as the average value of the 50% largest establishment. This measure using the size distribution in the industry goes back to Comanor, Wilson (1967, 428). They argue that large-scale establishments are efficient business units, which profit from size advantages. On the contrary, with no size advantages, multi-plant enterprises with smaller units would have developed. At the same time there exist establishments in the industry, which operate under the minimum efficient size. According to Comanor, Wilson (1967, 428), these

establishments are either newly founded establishments or establishments, which were built up in a time, when industry demand was still smaller or technical conditions did not require large business units. In addition, smaller enterprises can concentrate on niches.

5.2. Results

Table 4 presents the results of the accelerated failure time model with log-logistic distribution. The co-variables in the model are time-variant.[28,29]

<< Insert Table 4 about here >>

Both, employment in the establishment and its employment growth, have a significantly positive impact on the survival time of the establishment. Thus, the liability of smallness plays an important role in the sample. Furthermore, the growth rate of employment in the industry being indicator for the phase of the industry's product life cycle has a significantly positive influence. The innovation advantages of small establishments probably compensate the high risk in early phases of the product life cycle. The regional conditions have important influence on the survival time of the establishment. A significant influence results for the type of region and for the growth rate of employment in the federal state. The regional dynamics as well as the access to differentiated labour markets, the proximity to research establishments, suppliers and a large number of consumers lower the probability of failure. Thereby, they significantly increase the time of survival of the establishments. The

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[28] In the case of time-varying co-variables the hazard function is $h(t, X_{it}) = \frac{\psi_{it}^{1/\gamma} t^{(1/\gamma - 1)}}{\gamma[1 + (\psi_{it} t)^{1/\gamma}]}$ with $\psi_i t = \exp(-X_{it}\beta)$.

[29] Alternatively, a model with unobserved individual γ-distributed heterogeneity was estimated. However, the likelihood ratio test proposed by Nielson, Gill, Andersen, Sorensen (1992) in order to test whether or not the γ-variance parameter shall be considered is not significant at a p-value of 1.000. In this case, the value of the $\chi^2(1)$-distributed test statistic equals 0.00.

overall economic development has also a significantly positive effect on the survival time of establishments. Establishments in a competitive environment measured as the number of newly founded establishments in an industry of the respective federal state have - as expected - a significantly higher risk of failure. Establishments in industries with a high minimum efficient size are likewise exposed to a higher risk of failure. The competitive pressure on newly created establishments to achieve the minimum efficient size dominates.

Interaction terms between industry and regional variables as well as between establishment characteristics and industry variables were taken up likewise by way of trial. However, these have been proved being insignificant. Apart from the size of the establishment and the growth of employment in the respective establishment the characteristics of the establishment discussed in chapter 5.1 were as expected insignificant. It is confirmed that the size of the establishment as well as the employment growth in the establishment are the best predictors on the establishment level of firm survival.

6. Conclusions

This analysis of the failure of newly founded establishments on the basis of the IAB establishment panel has confirmed results found in various empirical literature treating this field. Beyond, it could be proven that apart from the industry conditions particularly the regional environment has a substantial influence on the probability of survival of newly created establishments. Literature has taken this into account only insufficiently, although the fundamental importance of the regional dimension in the economic science is recognized and has a long tradition.

A further confirmation of these results can be achieved with the analysis of the establishment file of the Social Insurance Statistics of the Federal Agency for Employment. This file could depict the history of an establishment.[30] The establishment file doesn't contain a large set of establishment characteristics, but it predominantly contains small establishments, on which political debate frequently focus. Due to the kind of the drawing of the sample, small establishments do not sufficiently find consideration in the IAB establishment panel.

[30] For more on the analysis potential of the establishment file cf. Brixy, Fritsch (2002).

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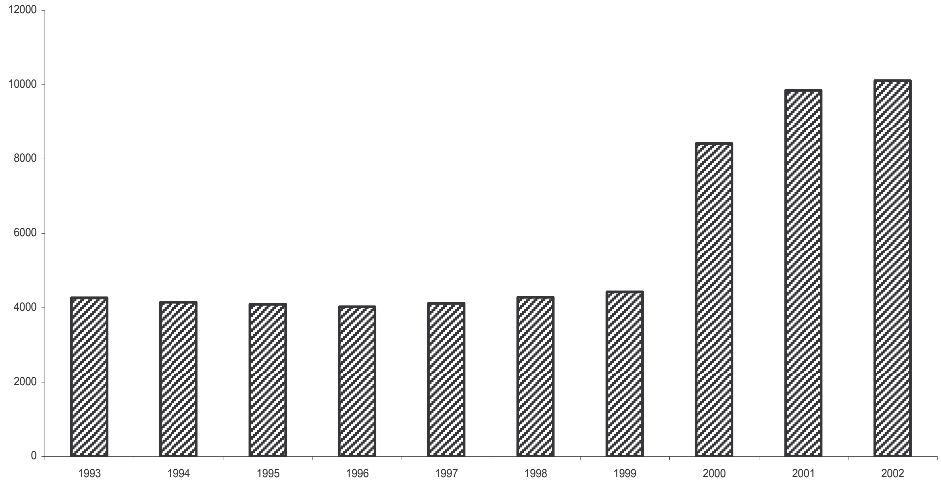
Table 1: Expected influence of different variables on the survival time of businesses

variable	Expected influence on the survival time of businesses
firm size	+
growth rate of employment in firm	+
minimum efficient size in industry	-/+
growth rate of employment in industry	-/+
technological regime (innovation advantage in small businesses)	+
growth rate of the price deflated national gross domestic product	+
growth rate of employment in region	+
agglomeration	+
number of start-ups in industry / region	-
legal form	-/+
foreign ownership	-/+
public assistance	+
spin-off	+
newly founded establishment in multi-plant firm	+

Illustration 1: Number of establishments included in the IAB establishment panel. Source: Bellmann (2002, 181)



<u>Illustration 2</u>: Kaplan-Meier smoothed hazard function; analysis time in years

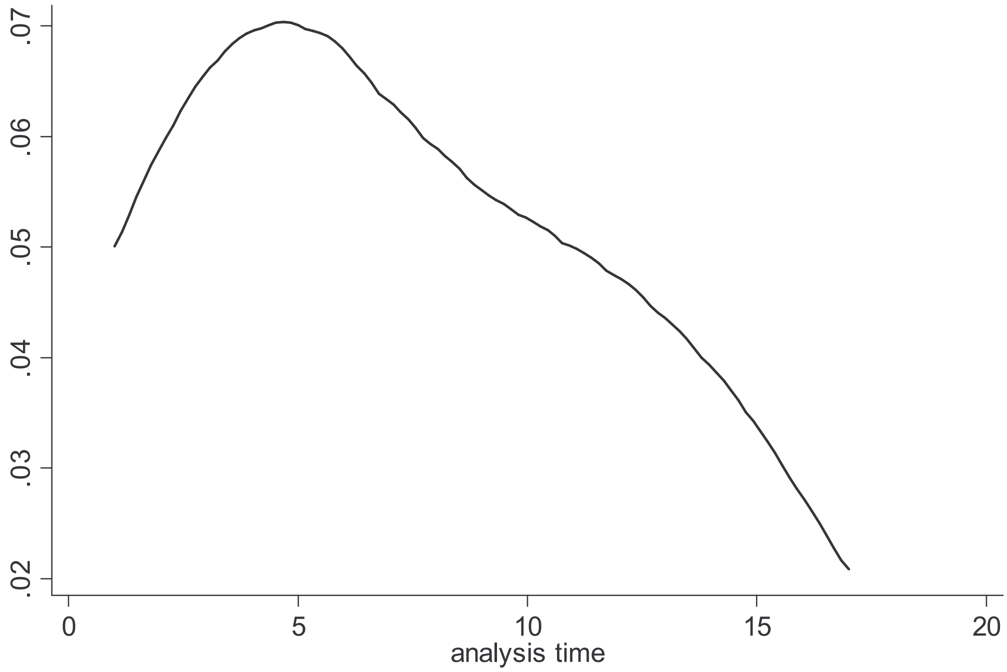


Table 2: Log-rank and Wilcoxon test for the examination of the equality of the survival functions

variable	**log-rank** test statistic	**Wilcoxon** test statistic
federal state	180.25***	169.22***
industry	25.57**	22.79*
size of establishment	53.22***	50.93***
public investment assistance	9.87***	8.47***
RaD department	0.60	0.99
newly founded establishment in multi-plant firm	0.09	0.63
legal form	3.51*	3.74*
spin-off	5.50**	7.81***

* statistically significant on the 10% level / ** statistically significant on the 5% level / *** statistically significant on the 1% level

Table 3: Log-rank test for the examination of the equality of the survival functions, controlled for firm size

variable	**log-rank** test statistic
federal state	195.08***
industry	23.70**
public investment assistance	0.91
RaD department	0.01
newly founded establishment in multi-plant firm	1.35
legal form	1.91
spin-off	1.50

* statistically significant on the 10% level / ** statistically significant on the 5% level / *** statistically significant on the 1% level

Table 4: Results of the accelerated failure time model with log-logistic distribution; time-varying co-variables

co-variable	**coefficient** **z-value**
number of employees operating under social security in establishment (log)	0.8135*** 4.01
growth rate of employment covered by social security in establishment	0.0008*** 2.65
growth rate of employment covered by social security in industry	0.0287* 1.74
growth rate of employment covered by social security in federal state	0.0491** 2.01
type of region by BIK classification	-0.0523*** -3.93
growth rate of the price deflated national gross domestic product	1.099*** 11.98
number of newly founded establishments in industry and federal state	-0.1512*** -5.31
minimum efficient size in industry (log)	-0.1090** -2.22
γ	0.5430
Number of establishments considered in model	9273
LR $\chi^2(8)$	715.77**
log likelihood	-854.83

* statistically significant on the 10% level / ** statistically significant on the 5% level / *** statistically significant on the 1% level