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Growth determinants of start-ups in Eastern Germany: a comparison between innovative and non-innovative firms

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Discussion Paper No. 99-05

Growth Determinants of Start-Ups in Eastern Germany: A Comparision Between Innovative and Non-Innovative Firms

Matthias Almus, Eric A. Nerlinger, Fabian Steil

Non-technical Summary

The present study deals with the development of new firms in Eastern Germany. Firm formations are regarded as a means to reduce the still high unemployment in Eastern Germany through the creation of new jobs. Primarily, the analyses concentrate on the employment growth of manufacturing firms founded between 1992 and 1996. Hypotheses on the influence of various potential growth factors are derived by the combination of theoretical approaches. The validity of these growth hypothesis is tested for by multivariate analyses, based on data of the ZEW-Foundation Panel (East).

The results of the multivariate analyses regarding employment dynamics and growth potential of young (innovative) firms show that innovative firms achieve significantly higher growth rates compared to non-innovative firms. The results also indicate that innovative as well as non-innovative firms start with a suboptimal size and realize high growth rates in the first years of existence. In addition, effects on growth result from the legal form. Firms, that are founded with a liability-limited legal form, achieve higher growth rates compared to formations where the owner is fully liable. Positive effects on the growth rate can be found if the firm has links to external firms that can act as potential capital and/or know-how providers. This influence is the strongest if the involved firms are from Western Germany or other western industrial countries. With respect to founder-specific characteristics, positive effects can be derived from the human capital of the founder(s). This holds especially for technological disciplines whereas business knowledge only plays a minor role. In addition to firm- and founder-specific characteristics, location-specific factors controlling for agglomeration effects and the industry structure in the Eastern German counties have an impact on growth.

Das Wichtigste in Kürze

Die vorliegende Arbeit beschäftigt sich mit der Entwicklung junger Unternehmen in den neuen Bundesländern. Diese werden als ein Mittel angesehen, die nach wie vor hohe Arbeitslosigkeit in den neuen Bundesländern durch die Schaffung neuer Arbeitsplätze zu verringern. Primär konzentriert sich die Arbeit auf das Beschäftigungswachstum von innovativen und nicht-innovativen Unternehmen im Verarbeitenden Gewerbe, die zwischen 1992 und 1996 gegründet wurden. Auf der Basis theoretischer Erklärungsansätze werden zahlreiche Einflußfaktoren abgeleitet, die einen potentiellen Beitrag zur Erklärung des Wachstums junger Unternehmen leisten. Der Einfluß dieser Erklärungsfaktoren wird im Rahmen multivariater Analysen überprüft, wobei Vergleiche zwischen innovativen und nicht-innovativen Unternehmen durchgeführt werden.

Die Ergebnisse der multivariaten Analysen zur Beschäftigungsdynamik und dem Wachstumspotential junger (innovativer) Unternehmen lassen erkennen, daß junge innovative Unternehmen signifikant höhere Wachstumsraten erzielen als junge Unternehmen mit traditionellen Produkten. Die Schätzergebnisse deuten darüber hinaus an, daß sowohl innovative als auch nicht-innovative Unternehmen mit einer suboptimalen Größe gegründet werden und daher in den ersten Lebensjahren hohe Beschäftigungswachstumsraten erzielen, die mit dem Alter und der Größe abnehmen. Effekte gehen auch von der Rechtsform der Unternehmen aus, wobei Unternehmen, die als haftungsbeschränkte Gesellschaften gegründet werden, höhere Wachstumsraten erzielen als Personengesellschaften. Ein positiver Zusammenhang stellt sich hinsichtlich der Beteiligung externer Unternehmen ein. Dieser Einfluß ist am stärksten, wenn die beteiligten Unternehmen aus den Alten Bundesländern oder anderen westlichen Industrieländern stammen. Zusätzlich zu den unternehmensspezifischen Einflußfaktoren gehen gründerspezifische Merkmale in die Wachstumsschätzungen ein. Hier zeigt sich, daß die Wachstumsaussichten der Unternehmen am besten sind, wenn die Unternehmensgründer sowohl über technologische als auch über betriebswirtschaftliche Kenntnisse verfügen. Darüber hinaus zeigt sich hinsichtlich des Einflusses unternehmensexterner Faktoren ein negativer Effekt zwischen dem Verdichtungsgrad der Kreise und dem Wachstum der jungen (innovativen) Unternehmen.

Growth Determinants of Start-Ups in Eastern Germany: A Comparision Between Innovative and Non-Innovative Firms[1]

by

Matthias Almus, Eric A. Nerlinger and Fabian Steil
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Abstract: This empirical analysis deals with the determinants of growth and the explanation of variations in the growth between innovative and non-innovative start-ups. Based on theoretical models explaining the growth of firms, hypotheses on potential determinants are formulated. The regression results indicate strong correlations between the growth rate on the one side and firm-specific, founder-specific as well as external factors on the other side. These factors influence the growth rates of innovative and non-innovative young firms in different ways. It becomes obvious that large and mature firms have smaller growth rates than small and young innovative as well as non-innovative firms. Moreover, other firm-specific characteristics like legal form and formal links to other firms from Western industrialised countries have an impact on the development of start-ups. With respect to founder-specific characteristics, positive effects can be derived from the human capital of the founder(s). This holds especially for technological disciplines whereas business knowledge plays a minor role. In addition to firm and founder characteristics, location-specific factors controlling for agglomeration effects and the industry structure in the Eastern German counties have an impact on growth. Comparing annual growth rates of start-ups, innovative start-ups grow on average faster than non-innovative start-ups.

Keywords: New Technology-based Firms, Employment Growth, Determinants of Growth

JEL Class: D92, J23, L11

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1 Introduction

Since the summit in the first half of 1997, the official number of unemployed persons in Germany has only slightly reduced to about 4 million till the end of 1998. Even 8 years after unification, the Eastern Germany faces an unemployment rate of about 16 % and the labour market is still confronted with dramatically unfavourable conditions compared to Western Germany (about 9 %), though a higher working participation in Eastern Germany has to be considered. At the same time hidden unemployment in form of short-time working, early retirement, qualification (e.g. retraining measures) and special employment measures (e.g. job-creating measures) occurs much more frequently in Eastern Germany (Trabert, 1997), leading to a severe underestimation of the real unemployment rate.

One central problem of the transformation process in the *Neuen Laender* is the lack of dynamic regarding the development of new, self supporting working units (Steiner et al., 1998). Due to the collapse of the former East German economy, new firms are expected to overcome the labour market problems and to contribute to economic development. This holds particularly for innovative start-ups. The creation of such firms has been stimulated by public policies, such as the pilot scheme for the 'Promotion of New Technology-based Firms' and the programmes 'Direct Investment Capital for Small Technology Firms' and 'Funding and Support of New Technology-based Firms in the Neuen Laender and Berlin (East)' (Kulicke et al., 1993; BMBF and BMWi, 1998).

In the current academic debate, the role of innovative start-ups for employment dynamics, technological innovation and the diffusion of new technological knowledge is not unambiguous. Some argue that new companies of this kind are rare, so their contribution to overall employment and national technological performance is only marginal, but others suggest that innovative start-ups are much more important, being the primary source of new employment and the engine of technological change and economic growth (Oakey, 1993, 1994; Storey and Tether, 1996, Nerlinger, 1998). However, the debate about the potential of innovative start-ups and other small firms for employment creation started long ago with the work of David Birch in the late 1970s (Birch, 1979), and since then it has become clear that the expectations of employment creation by innovative start-ups and other small firms as the solution for high unemployment has been exaggerated.

Existing literature concerned with innovative start-ups only provides partial answers to the question of their contributions to economic development, employment and technological performance (Storey and Tether, 1996). The major reason is that the empirical results derived vary considerably due to methodological differences as well as differences in the data base used and the study aims (Breheney and McQuaid, 1988). This holds especially for Eastern Germany, where only a few empirical analyses have been conducted and which at the same time are limited to

specific samples (e.g. firms participating in promotion schemes) or regions (e.g. Berlin).

The purpose of this paper is to analyse potential growth determinants of innovative start-ups in Eastern Germany. Based on theoretical approaches, hypotheses on the influence of firm-specific and founder-specific factors as well as external characteristics are formulated. The influence of these factors is examined in multivariate analyses taking into account potential selection biases. Moreover, comparisons with non-innovative start-ups are carried out.

2 Hypotheses on Growth of innovative start-ups

A solid theoretical growth model for start-ups as well as mature firms does not yet exist (Fritsch, 1990; Bruederl et al., 1991), though various existing theoretical approaches on growth have to be used and extended by aspects especially relevant for innovative firms (Nerlinger, 1998). This applies for growth theories (e.g. 'theory of the firm', 'minimum efficient size') as well as for organisational ecological theories, in which the focus is mainly on the survival and failure of organisations rather than on the growth of firms. According to empirical literature, the determinants are distinguished between firm-specific, founder-specific and external characteristics (Storey, 1994). A detailed discussion of existing frameworks is given in Steil and Wolf (1997) and Nerlinger (1998). Therefore, we refrain from a further description and only give a summary of the hypotheses which will be tested in the multivariate analyses.

(a) Firm-specific Characteristics:

- Due to financial constraints and risk avers behaviour of new entrepreneurs, firms often start with a suboptimal size (Jovanovic, 1982). To reduce possible shortages in competing with mature firms, start-ups have to reach an efficient size shortly after entry. Therefore, growth rates should decrease c.p. with age (Evans 1987a, b; Hall, 1987).
- The start-up size is negatively correlated with growth, i.e. small firms grow c.p. faster than large firms (Evans 1987a, b; Hall, 1987). This hypothesis contradicts 'Gibrat's law', which assumes no systematic correlation between growth and firm size (Wagner, 1992; Sutton, 1997).
- Firms with limited liability realise c.p. higher growth rates than firms in which the founder(s) are liable with their private fortune due to differences in the incentives to pursue risk-intensive projects (Harhoff and Stahl, 1995). In contrast, non-corporate firms ('Personengesellschaften') benefit from tax advantages which are especially relevant while using public promotion schemes (Baumhoff, 1994). This effect however would interfere with the first

one mentioned. Therefore, an unambiguous hypothesis on the correlation between liability statutes and growth can not be derived.

- Links to external firms may provide additional know-how or capital as well as networks with customers or suppliers (Aldrich et al., 1990; Variyam and Kraybill, 1992). With respect to firms in Eastern Germany, positive effects on growth can especially be expected for links with firms from Western industrialised countries due to their financial resources and knowledge of the mechanisms of market economy. Innovative firms often require above average financial capital and know-how, therefore a positive impact of these links can be expected.
- Diversified firms realise c.p. higher growth rates than firms with a highly concentrated product/process spectrum (Nerlinger, 1998).

(b) Founder-specific Characteristics:

- Due to the complexity of innovation projects and the qualifications necessary for the application of new technologies, growth of innovative new firms can be assumed to be positively correlated with the human capital of founders. This holds especially for technical and engineering skills, reflecting the firms' technical orientation (Kulicke et al., 1993; Storey and Tether, 1996). A comparable lower influence of the human capital of the founder(s) can be expected regarding non-innovative start-ups.
- Firms founded by a team grow c.p. faster than firms founded by only one person. This hypothesis is based on the assumption that potential individual know-how shortages may be compensated within a team (Reynolds, 1993; Storey, 1994).

(c) External Characteristics:

- According to North and Smallbone (1993) and Storey (1994) there is a strong correlation between local characteristics and firm growth. Of particular importance are agglomeration effects (Henderson, 1988; Stahl, 1995; Steil, 1998). A popular proxy for urbanisation economies is population density, by which it can be assumed that advantages deriving from the density increase up to a critical threshold and then turn into disadvantages hampering growth. The spatial proximity to firms with similar innovation and economic activities can either be favourable (e.g. via spill-over effects or qualified working force) or disadvantageous (e.g. via competition or risk of imitation) for growth ('localisation economies'). Regarding innovative start-ups, spill-over effects also result from universities and R&D institutions, whereby externalities are often restricted with regard to spatial expansion (Jaffe, 1989; Schrader, 1991).
- Regional differences regarding public promotion programmes have an impact on growth of innovative and non-innovative start-ups. Unfortunately, information about participation of firms in promotion schemes are rarely

available. Therefore, in order to control for regional variations in the supply of subsidies, regional dummies should be included. These variables however, catch the influence of various other location factors, too.

3 Data and Definitions

The multivariate growth analyses are based on data from the ZEW-Foundation Panel (East), which was started in early 1990. The firm-specific data are provided by the largest German credit rating agency CREDITREFORM. This agency systematically records all firms which have a commercial registration ('Handelsregistereintrag'). In addition, inquiries about the financial situation of the respective firm by customers or suppliers play a major role regarding the recording of new, incorporated firms (Stahl, 1991; Harhoff and Stahl, 1992). Almost every six months, information on newly recorded start-ups and updated information on existing firms are delivered and integrated into the panel, though updated information is not available for each firm at each delivery (Harhoff and Steil, 1997).[2] Cumulated up to 1998, the panel now consists of more than 750,000 firms in Eastern Germany. Due to the restructuring processes in the early nineties and a time-lag in the data-collecting process, the multivariate growth analyses are restricted to firms founded between 1 January, 1992 and 31 December, 1996.

The definition of innovative firms goes back to a differentiation of 'technology-intensive' goods derived by the OECD (Gehrke and Grupp, 1994). On the basis of the so-called NIW-ISI-list, manufacturing industries are separated due to their R&D-intensity into 'High-Tech Industries' (R&D-intensity above 3.5%) and 'Non-High-Tech Industries' (R&D-intensity below 3.5%).[3] In the following, firms in 'High-Tech Industries' are regarded as innovative and firms in 'Non-High-Tech Industries' as non-innovative.

In addition, the definition of firm foundation types (e.g. differentiation with respect to prior structural existence as well as independence) plays a crucial role regarding growth and survival patterns of firms (Bruederl et al., 1992). This holds especially for Eastern-Germany with its specific characteristics and historical development (Steiner et al., 1998; Steil, 1998). In this paper, only newly founded independent firms, defined as firms without prior structural existence have been considered. In order to differentiate these firms from other formation types (e.g. MBO, take-overs),

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[2] The probability of getting actualised information depends on formal firm characteristics (e.g. legal form, size), on the demand for credit rating upon the firm as well as on the extent of economic relations to other firms (Harhoff and Steil, 1997; Nerlinger, 1998).

[3] Storey and Tether (1996) and Nerlinger (1998) also consider high-tech service sectors (e.g. software).

information about prior dates of foundation are used and firms with more than fifty employees at first time of recording are excluded.

4 Growth Model

The analyses of the validity of the hypotheses are based on a growth model, which includes a control for potential selection biases.[4] A requirement for the calculation of a growth rate for firm i is the existence of employment numbers E at least at two different points of time t_1 and t_2 $(t_1 < t_2)$. Due to the variation of the inquiry frequency, the firm-specific growth rate G_i is calculated on a yearly base with minimal time distance of six months $(t_2 - t_1 \geq 0.5\,\text{Years})$ between the two employment figures. The calculation of the growth rate follows Evans (1987a, b), assuming an exponential growth path. Thus, for all N_1-firms fulfilling the requirements, the firm-specific growth rate can be computed as

$$G_i = \frac{\ln E_{t_{i2}} - \ln E_{t_{i1}}}{(t_{i2} - t_{i1})} \qquad \forall \quad i = 1,\ldots,N_1.$$

At the same time, there are N_2-firms remaining $(N_1 + N_2 = N)$ for which no growth rate can be computed due to missing second employment numbers or a time difference below six months.

The estimation of the growth equation is based on a specification in which the firm-specific growth rate G_i is a function $f(X_i'\beta)$ of X_i, comprising the exogenous variables, the parameter vector β and the normal distributed error term $u_i \sim N(0, \sigma_u^2)$

$$G_i = f(X_i'\beta) + u_i \qquad \forall \quad i = 1,\ldots,N_1.$$

Similar to Hall (1987) and Evans (1987a, b) we assume the identity of $f(X_i'\beta) = X_i'\beta$. Thus the firm-specific growth rates for the N_1-firms can be estimated using the linear regression model

$$G_i = X_i'\beta + u_i \qquad \forall \quad i = 1,\ldots,N_1 .$$

Potential selection biases deriving from observations without growth rates are controlled for by using the sample selection approach developed by Gronau (1974) and Heckman (1974). On the one side the probability that a growth rate exists is modelled using all N-observation. The endogenous variable Y_i is a Bernoulli-distributed random variable and takes on the following values

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[4] Harhoff and Stahl (1995) and Nerlinger (1998) discuss various potential sources for selection biases in the ZEW-Foundation Panel (West) in detail.

$$Y_i = \begin{cases} 1, & \text{if the growth rate can be computed} \\ 0, & \text{otherwise} \end{cases}.$$

On the other side the growth estimation for the N_1-firms with growth rates is computed simultaneously, using the results of the participation equation.

The framework for the regression of the sample selection model is a bivariate Tobit-Model (Ronning, 1991), simultaneously identifying the probability of an existing growth rate and the size to which it amounts. The existence of selection biases is confirmed if the correlation coefficient between the error terms of the selection and growth equation differs statistically significant from zero.

We estimate the model using the maximum-likelihood method. The respective likelihood function takes on the form[5]

$$L = \prod_{i \in N_2} \Pr(Y_i = 0) \cdot \prod_{i \in N_1} \Pr(Y_i = 1) \cdot f(G_i | Y_i = 1)$$

$$= \prod_{i \in N_2} \left[1 - \Phi(Z_i' \gamma)\right] \cdot \prod_{i \in N_1} \Phi(Z_i' \gamma) \cdot \varphi(G_i | Y_i = 1),$$

with $\phi(\bullet)$ and $\Phi(\bullet)$ as the probability respectively cumulative density function of the standard normal distribution. The first term on the right side of the equations above states the individual probability for the N_2-firms, that a growth rate does not exist. The remaining term represents the joint probability of the existence of the individual growth rate for the N_1-firms and of its value.

5 Empirical results

In order to control for the validity of the discussed growth hypotheses, separate regressions for innovative and non-innovative firms are conducted.[6] Moreover, in order to stress variations between the two types of firms and to evaluate the average annual growth rates, a pooled model is estimated. The results of the bivariate Tobit-Model[7] indicate insignificant coefficients of the correlation coefficient, i.e. no selection biases exist or existing ones overlap mutually (cp. Table 5.1).

An important determinant for the explanation of growth is age ('ln(age)'). Unlike Evans (1987a, b) and Harhoff et al. (1996) we refrain to control for non-linear

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[5] A detailed description of the derivation is given in Ronning (1991).

[6] Descriptive statistics of the variables used are presented in Table A.1 in the appendix.

[7] In order to describe the results of the growth estimations in detail, we refrain from a discussion of the empirical results of the participation equation (cp. Table A.2 in the appendix).

effects of age due to the comparably short time period (1992-1996). The coefficient shows a high significant influence on the growth rates and fulfils the a priori hypothesis (cp. Table 5.1). The shape confirms the assumption of a suboptimal start-up size of firms, which have to reach a (minimum-) efficient size in order to become competitive (Fritsch, 1990; Scherer and Ross, 1990; Audretsch, 1994).

< Insert Table 5.1 about here >

A further important growth determinant is the size of firms at start-up. This factor is computed as the logarithm of the sum of employees and founders, and is also squared in order to control for possible non-linear effects ('ln(size)', 'ln(size)^2'). The estimation results confirm the existence of a (minimum-) efficient size which has to be reached in order to be competitive. Figure 5.1 indicates that growth rates decrease with start-up size. Once a threshold is reached, a further increase of size does not reduce growth. The obtained results describe an average behaviour and therefore neglect that many founders prefer to stay small because a large number of employees is, in their view, often associated with increasing control and administration duties (Storey, 1994).

The estimated correlation between size and growth contradicts 'Gibrat's law'. This is confirmed by numerous empirical analyses, showing that the growth rate of small firms is c.p. higher than that of large firms (Wagner, 1992; Almus and Nerlinger, 1999). The shape of the partial effects of size on growth in Figure 5.1 shows considerable variations between innovative and non-innovative start-ups. The smaller the firms are at start-up, the less negative is the partial effect[8] on growth. After a critical threshold is reached at 33 employees in innovative firms, no further negative impact on the average annual growth rates becomes obvious. Regarding non-innovative start-ups, this threshold is outside the defined size of start-up.

< Insert Figure 5.1 about here >

Beside size and age, other firm-specific characteristics influence the average annual growth rates. This holds for the legal form, which is used as a dummy-variable (0/1), indicating the status of liability. The variable ('Limited Liability') takes on the value 1 if the firm is founded as a limited liable unit. The estimated coefficients confirm the hypothesis that firms with limited liability achieve significant higher growth rates than firms in which the founders are liable with their own personal fortune. The underlying assumption is a comparatively higher willingness to risk among founders who, in case of failure, are only liable with a limited amount of their own

8 $partial\ effect = \hat{b}_{\ln(size)} \cdot \ln(size) + \hat{b}_{\ln(size)^2} \cdot \ln(size)^2 + \hat{b}_{\ln(size)\cdot\ln(age)} \cdot \ln(size) \cdot \overline{\ln(age)}$

capital (Harhoff et al., 1996; Woywode, 1998).[9] Moreover, the hypothesis upon taxation advantages of non-corporate firms especially relevant while participating in promotion measures can not be confirmed (Baumhoff, 1994). This effect may have been compensated by a reversed correlation between legal form and growth.

Non-innovative start-ups with tight links to at least one firm from Western industrialised countries ('Affiliation West') show significantly higher growth rates on average than firms which are entirely independent. This does not hold for affiliations with firms from Eastern Countries ('Affiliation East') or firms with unknown location ('Affiliation Unknown')[10] where no significant impact turns out. In contrast to the results regarding non-innovative start-ups, growth of innovative new firms is not significantly influenced by any affiliation independently from location, contradicting the a priori hypothesis upon an additional support with know-how, capital or relation with customers or suppliers from out side the firm. Due to the comparably small size of the sample used, this result should be interpreted cautiously.

Diversified innovative start-ups ('Diversified') realise significantly higher growth rates than firms with a very narrow product or process spectrum. Picot et al. (1989) and Kulicke et al. (1993) mention that numerous innovative start-ups partly finance their innovation activities by selling a so-called "bread and butter"-product. The insignificant coefficient of diversification in the model containing only non-innovative start-ups indirectly confirm this argumentation (Nerlinger, 1998).

In addition to firm-specific factors, founder-specific characteristics also contribute to the explanation of growth of innovative as well as non-innovative start-ups. The hypothesis that firms founded by a team ('Team-Foundation') achieve higher growth rates than firms established by a single person can not be confirmed. Therefore, no statistically reliable statement regarding the compensation of potential know-how deficits of the founders can be made (Reynolds, 1993). The importance of individual abilities and skills of the founders is clearly illustrated in the regression results, though potential correlations between e.g. industry-specific patterns or regulations on the one side and the qualification and human capital of founders on the other side have to be considered (Prantl, 1998). Compared to the reference category technological skills ('Technical Skills'), the combination of technological and business skills ('Busin./Techn. Skills') leads to a positive significant impact on the growth of innovative start-ups similarly to Western Germany (Almus and Nerlinger,

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[9] The choice of legal form may be determined by the degree of risk, i.e. a limited liability legal form is considered if, from the viewpoint of a founder, a certain amount of risk combined with a higher growth potential is involved with the establishment of the new firm.

[10] Due to missing information on location, roughly 5% of affiliated firms can not be assigned to either Western or Eastern affiliations. Previous analyses however leads one to suppose that the majority of these affiliated firms are located in Eastern Germany.

1998; Nerlinger, 1998). Business skills ('Business Skills') only have a significant negative effect on the growth of non-innovative firms, i.e. firms established by founders with a technological background achieve in average higher annual growth rates.[11]

Firm-external characteristics like local factors and agglomeration effects also have an impact on growth of non-innovative start-ups. In order to control for localisation effects, the employee-share of the firm's industry has been calculated on a two-digit level of the producing sector ('Employment within firms' Industry').[12] Moreover, the employment share of the remaining industries in manufacturing ('Employment outside firms' Industry') as well as a concentration-ratio within the remaining industries ('Concentration Index') based on the Herfindahl-index are calculated. The regression results only show a significant correlation between the employment share of the firms' industry and growth, indicating that proximity to firms with similar economic and innovation activity is favourable. Similar results are obtained by Steil and Wolf (1997). In contrast, no significant coefficients occur regarding specialisation or the proximity to firms with different activities. This result may be affected by the aggregation level of the variables used. With respect to innovative start-ups and the emergence of new industries, a specialisation indicator on a much less aggregated level (e.g. product level) would maybe have an impact on the estimation result. Empirical findings for Western Germany proof the existence of externalities using a very detailed industry classification (Nerlinger, 1998). For Eastern Germany however, an equivalent computation fails due to the lack of suitable data.

The inverse u-shaped relation between the population density of the 215 counties in Eastern Germany ('Inhabitants/km^2', '(Inhabitants/km^2)^2') and growth confirms the a priori hypothesis. However, only the joint test is only significant on the 5%-level for non-innovative start-ups. It has been assumed that up to a critical threshold, advantages directly linked with the increasing density have a positive impact on growth. After this threshold, the advantages are expected to become exceeded by disadvantages deriving from a high population density.

In order to evaluate differences in the average growth rates between innovative and non-innovative start-ups, a pooled model is estimated in which separate effects of

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[11] We refrain from a discussion of the variable 'Missing Skills' because it catches various effects which can not be isolated or differentiated (e.g. consequences regarding the recording and actualisation of firm information, missing information due to low qualification).

[12] One disadvantage of this indicator is that data is available only for the 1987 and that firms in the former GDR are at the same time characterised by a strong vertical integration. It can therefore be assumed that the work of a significant share of employees does not correspond with the major activities of the industry they are classified to. A calculation of the employee-shares on basis of actual data would have been problematic as well since unemployed persons can not be related to an industry (Steil and Wolf, 1997).

the two firm types are controlled for by a dummy-variable ('Innovative Start-ups'). The value of the variable is 1 if the firm is an innovative start-up, otherwise 0. The results indicate that surviving innovative new firms achieve c.p. significantly higher growth rates than non-innovative ones. In order to evaluate differences between the growth rates, the expected average annual growth rates have been calculated for the different firm types separately. Innovative surviving start-ups realise average annual growth rates of 13.7% which are about 3 per cent points higher than those of non-innovative ones (10.6%). When interpreting these results, the specific situation in Eastern-Germany has to be considered. The majority of innovative start-ups in Eastern-Germany received financial support from public promotion schemes, which have to be paid back not until several years after start-up (Nerlinger, 1998; Spielkamp. et al., 1998; Steiner at al., 1998). Moreover, the time period for the growth analyses is rather short (January, 1992 – December, 1996). The two mentioned aspects might have an positive influence on survival probability and growth, resulting in biased results. Nevertheless, the results confirm the findings of Almus and Nerlinger (1998) to which start-ups in 'High-Tech Industries' and 'Medium-Tech Industries' achieve significantly higher average annual growth rates than new firms in 'Low-Tech Industries'.

6 Summary

The results of the growth regressions indicate strong correlations between growth rate on the one side and firm-specific as well as external factors on the other side. It becomes obvious that older firms have c.p. smaller growth rates than young innovative and non-innovative firms. Start-up size is also negatively correlated with growth, i.e. small firms have apparently higher potentials than larger ones. This result leads to a rejection of 'Gibrat's law'. Moreover, other firm-specific characteristics like legal form and formal links to other firms have an impact on the development of start-ups. With respect to founder-specific characteristics, effects are ambiguous and further research is needed to evaluate the impacts. In addition to firm-specific and founder-specific characteristics, firm-external factors controlling for agglomeration effects and the industry structure in the East German counties have an impact on growth of start-ups. The results of the regressions also indicate that surviving innovative start-ups achieve on average considerably higher annual growth rates than non-innovative ones and may have a higher potential to create additional jobs.

Conclusions upon mid- or even long-term employment effects can however not be derived because differences in failure rates resulting in job losses (Wagner, 1994; Gerlach and Wagner, 1997) as well as indirect employment effects leading to a substitution of or an increase in the number of employees in already existing firms have to be considered (Nerlinger, 1998). Due to the lack of suitable data which is especially relevant for Eastern Germany, survival patterns and the degree of

complementary and substitution effects of start-ups in general and innovative new firms in special are hardly to evaluate. It can however be assumed that innovative start-ups especially occur in emerging new industries. Therefore, substitution and replacement effects are expected to play only a minor role.

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Appendix

Table A.1: Descriptive Statistics for Observation with Growth Rates

	Innovative		Non-innovative		Pooling	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
ln(size)	1.576	1.025	1.486	1.075	1.505	1.065
$\ln(size)^2$	3.533	3.684	3.363	3.719	3.400	3.712
ln(age)	1.270	0.452	1.265	0.462	1.266	0.459
ln(size)*ln(age)	2.027	1.597	1.895	1.620	1.924	1.616
Limited liability	0.706	0.456	0.526	0.499	0.565	0.496
Diversified	0.346	0.476	0.345	0.475	0.345	0.475
Affiliation East	0.092	0.290	0.079	0.269	0.082	0.274
Affiliation West	0.127	0.333	0.086	0.280	0.095	0.293
Affiliation Unknown	0.024	0.153	0.018	0.131	0.019	0.136
Team-Foundation	0.370	0.483	0.298	0.457	0.313	0.464
Business Skills	0.015	0.121	0.018	0.132	0.017	0.130
Busin./Techn. Skills[b)]	0.070	0.256	0.050	0.218	0.054	0.227
Other Skills	0.015	0.121	0.019	0.137	0.018	0.134
Missing Skills	0.213	0.410	0.310	0.463	0.289	0.453
Inhabitants/km^2	0.649	0.916	0.487	0.775	0.522	0.811
$(Inhabitants/km^2)^2$	1.261	2.743	0.839	2.221	0.930	2.351
Employment outside firms' industry [a)]	0.317	0.126	0.336	0.136	0.332	0.134
Employment within firms' industry [a)]	0.048	0.067	0.015	0.034	0.022	0.045
Concentration Index [a)]	0.232	0.116	0.234	0.118	0.233	0.117

Pooling: Innovative and non-innovative start-ups together.
a) Data refer to counties ('Kreise').
b) Business as well as technical Skills.

Source: ZEW-Foundation Panel (East), own calculation.

Table A.2: Regression results of the selection equation (Probit-Model)

Endogenous Variable: Existence of the Average Annual Growth Rate (0/1)						
	Innovative		Non-Innovative		Pooling	
	Coeff.	(t-Value)	Coeff.	(t-Value)	Coeff.	(t-Value)
ln(size)	0.479**	3.789	0.316**	4.973	0.335**	5.968
$ln(size)^2$	-0.073*	-2.230	-0.046**	-2.780	-0.049**	-3.356
ln(age)	1.489**	7.272	1.355**	13.621	1.356**	15.273
$ln(age)^2$	-0.432**	-4.687	-0.481**	-10.442	-0.462**	-11.281
ln(size)*ln(age)	0.061	0.956	0.142**	4.590	0.127**	4.589
Limited liability	0.433**	4.886	0.375**	7.735	0.380**	9.036
Diversified	0.330**	4.075	0.265**	6.598	0.278**	7.789
Affiliation East	0.174	1.111	0.017	0.193	0.064	0.832
Affiliation West	0.129	0.911	-0.081	-0.969	-0.030	-0.415
Affiliation Unknown	0.137	0.455	-0.120	-0.750	-0.066	-0.473
Team-Foundation	0.070	0.841	0.185**	3.863	0.154**	3.766
Business Skills	-0.610*	-2.399	0.131	0.838	-0.050	-0.385
Busin./Techn. Skills[b)]	0.044	0.267	0.006	0.054	0.016	0.179
Other Skills	-0.128	-0.525	-0.244*	-2.187	-0.226*	-2.237
Missing Skills	-0.009	-0.110	-0.181**	-4.569	-0.152**	-4.283
Employment outside firms' industry [a)]	-0.250	-0.633	-0.096	-0.513	-0.150	-0.898
Employment within firms' industry [a)]	1.549*	2.140	-0.237	-0.399	0.465	1.050
Concentration Index [a)]	-0.589	-1.672	0.231	1.294	0.074	0.473
Constant	-1.110**	-4.133	-1.175**	-8.999	-1.182**	-10.106
No. of Observation	2,458		9,011		11,469	
(*N*)	741.50		2411.55		3064.52	
LR-Test:?^{2} (df)	7.06		3.21		3.70	
Bundeslaender (4)	18.72**		112.37**		157.27**	
Industries	(7)		(12)		(15)	
(df)	25.04		44.71**		57.51**	
Vereine Creditreform	(22)		(24)		(24)	
(df)						

Pooling: Innovative and non-innovative start-ups together.

a) Data refer to counties ('Kreise').

b) Business as well as technical Skills.

**, * Significant on the 1% resp. 5% level .

The reference start-up is defined as a firm with its location in the local Verein Creditreform 'Chemnitz', with no affiliation, belongs to the industry sector 'Mechanical Engineering' and is founded by a person with 'Technical Skills'.

Source: ZEW-Foundation Panel (West), own calculation.

Table 5.1: Results of the growth estimations (bivariate Tobit-Model)

Endogenous Variable: Average Annual Growth Rate						
	Innovative		Non-innovative		Pooling	
	Coeff.	(t-Value)	Coeff.	(t-Value)	Coeff.	(t-Value)
Firm-specific characteristics						
ln(size)	-0.194**	-7.938	-0.120**	-10.437	-0.131**	-12.592
$ln(size)^2$	0.027**	5.266	0.015**	5.889	0.017**	7.353
ln(age)	-0.070**	-2.809	-0.025*	-2.196	-0.032**	-3.148
ln(size)*ln(age)	0.002	0.187	-0.002	-0.306	-0.002	-0.344
Limited liability	0.118**	7.205	0.072**	9.113	0.082**	11.541
Diversified	0.029*	2.265	0.010	1.573	0.015**	2.605
Affiliation East	-0.026	-1.214	0.016	1.416	0.007	0.651
Affiliation West	0.013	0.687	0.040**	3.540	0.033**	3.405
Affiliation Unknown	-0.015	-0.386	0.025	1.112	0.013	0.687
Founder-specific characteristics						
Team-Foundation	-0.011	-0.802	0.006	0.863	0.001	0.203
Business Skills	0.019	0.375	-0.045*	-2.009	-0.032	-1.586
Busin./Techn. Skills[b)]	0.052*	2.170	0.032*	2.313	0.037**	3.109
Other Skills	0.017	0.352	-0.012	-0.560	-0.008	-0.402
Missing Skills	-0.021	-1.347	-0.013	-1.888	-0.015*	-2.309
Firm-external characteristics [a)]						
Inhabitants/km^2	0.013	0.582	0.007	0.598	0.007	0.640
$(Inhabitants/km^2)^2$	-0.004	-0.591	-0.006	-1.329	-0.005	-1.400
Employment outside firms' industry	0.070	1.107	0.048	1.700	0.048	1.878
Employment within firms' industry	-0.097	-0.946	0.282**	2.986	0.103	1.550
Concentration Index	-0.075	-1.318	0.001	0.023	-0.016	-0.642
Innovative Start-ups	/	/	/	/	0.034*	2.222
Constant	0.275**	5.184	0.182**	7.442	0.213**	9.569
Correlation Coefficient	-0.040	-0.530	-0.062	-1.181	-0.055	-1.287
No. of Observation (N_1)	1,884		6,855		8,739	
Log-Likelihood	-1016.85		-3577.20		-4663.61	
Age and Size (4)	252.13**		483.63**		710.75**	
Affiliation (3)	2.53		13.57**		11.72**	
Skills (4)	7.37		13.84**		18.86**	
Population Density (2)	0.35		6.07*		6.60*	
Agglom. effect (3)	3.81		11.00*		5.16	
Bundeslaender (4)	7.74		5.12		3.21	
Time-Dummies	7.66		11.23		10.90	
(df)	(9)		(14)		(14)	
Industries	2.53		88.38**		90.83**	
(df)	(7)		(12)		(15)	

Pooling: Innovative and non-innovative start-ups together.

a) Data refer to counties ('Kreise').

b) Business as well as technical Skills.

**, * Significant on the 1% respectively 5% level .

The reference start-up is defined as a firm in Saxony with no affiliation, belongs to the industry sector 'Mechanical Engineering' and is founded by a person with 'Technical Skills'.

Source: ZEW-Foundation Panel (East), own calculation.
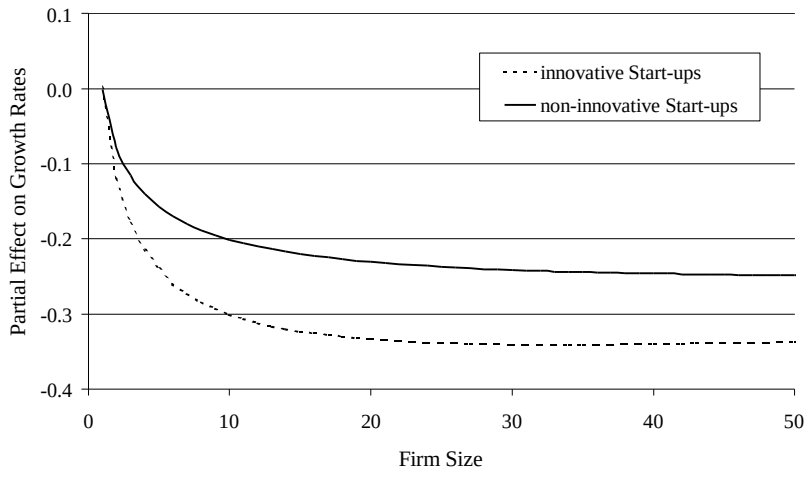
Figure 5.1: Partial effect of firm size on growth rates (evaluated at mean age)