Long-term growth determinants of young businesses in Germany: effects of regional concentration and specialisation

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Mit der Reihe „IAB-Discussion Paper“ will das Forschungsinstitut der Bundesagentur für Arbeit den Dialog mit der externen Wissenschaft intensivieren. Durch die rasche Verbreitung von Forschungsergebnissen über das Internet soll noch vor Drucklegung Kritik angeregt und Qualität gesichert werden.

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Contents

Abstract

This paper explores how different levels of regional concentration and specialisation affect the long-term growth of young firms. The sample consists of knowledge-intensive and non-knowledge-intensive western German manufacturing firms which were set-up in 1992 and managed to survive 11 years. The paper examines the joint effect of regional, industrial and firm-specific determinants. The analysis of the concentration and specialisation factors takes into account the industrial and technological dimensions and the regional level of human capital. With regard to the concentration measures being located in an industrial or technological agglomeration slightly reduces the growth rates of start-ups. The same negative, but stronger, effect can be observed for competition measures. Furthermore, our results suggest that start-ups exhibit higher growth rates the higher specialised the region is in which they are located.

JEL classification: R11, L25, R12, O30

Keywords: firm growth, regional concentration, regional specialisation and diversification, GLS model

1 Introduction

The major reason for the peculiar interest in firm growth processes is based on the fact that the industry structure might change due to growth and decline of new firms. The regional as well as the national employment situation is also affected by the performance of start-ups (Fritsch, Müller and Weyh 2006; Fritsch and Grotz 2005; Otto and Köhler 2007).

Previous firm growth studies have found out that firm growth processes rely on a mixture of systemic factors and stochastic shocks (Marsili 2001; Geroski 2000). In spite of the weak explanatory power of most of these studies empirical tests have revealed significant coefficient estimates indicating that systemic factors stimulate start-up growth. The explanatory factors included in these studies are entrepreneur-, firm-specific and industry-specific or related to the region. Most firm growth studies, however, have neglected these external dimensions (Hoogstra and van Dijk 2004). The focus of this paper is therefore on exploring region-specific growth determinants.

Regions characterized by a high degree of concentrated economic activities (e.g. industrial clusters) exhibit usually strong start-up activities. Empirical evidence suggests that the regional conditions in such areas generate a favourable entrepreneurial environment, whilst the effect of these determinants on new firm performance is rather ambiguous: Growth and survival of new establishments can be fostered or hampered depending on the balance of positive and negative externalities which operate at the same time within these concentrated regions (Brixy and Grotz 2006; Falck 2005; Stuart and Sorenson 2003).

In regional science there is also a controversy which regions provide more favourable regional conditions for the productivity and innovativeness of firms: specialised or diversified regions (Van der Panne and Van Beers 2006). The regional degree of specialisation is considered to be a key factor triggering the emergence of positive and negative externalities within a region. We extend the research of this strand of literature not by focusing on innovativeness, but by concentrating on firm growth as the variable affected by specialisation or diversification externalities. Drawing on organisational ecology the effect of local competition on new firms' post-entry performance is widely discussed as well (Geroski et al. 2003).

This paper aims at investigating the effects of regional concentration, specialisation and competition determinants on long-term employment growth of new firms. Only a few firm growth studies have included such region-specific determinants so far. In this context, this paper seeks to address the following questions: Is the location of a newly started firm in a regional concentration detrimental or beneficial for its growth? Have new firms located in a diversified or specialised region the more favourable growth prospects? Does regional competition foster or hamper firm growth?

Hence, on the one hand we intend to go beyond the traditional focus on entrepreneur-, firm- and industry-specific growth determinants by including region-specific factors. On the other hand in recent literature regional concentration and specialisation are represented in most cases only by the industrial dimension. We extend this perspective towards an technological- and human capital-based view. The sample for our analysis consists of western German manufacturing firms which were set-up in 1992 and survived until 2002. In addition, we differentiate between knowledge- and non-knowledge intensive firms. The Birch-Index which considers relative as well as absolute employment growth rates is applied as firm growth measure. The empirical analysis in this paper explores both robust Ordinary Least Square regressions as well as Generalized Least Squares regressions.

With regard to the concentration determinants our results suggest that being located in an industrial or technological agglomeration slightly reduces long-term growth of start-ups. The same negative, but stronger, effect could be observed for the competition determinants. We found also that start-ups grow the better the higher specialised the region is in which they are located. In turn, these results point to the fact that cluster policies should be implemented rather cautiously because local competition hampers firm growth in regional concentrations whereas regional specialisation and economic growth sustain the performance of new firms.

The remainder of this paper presents these outcomes and the evidence supporting them in greater detail. In Section 2 previous findings from the literature dealing with the effects of concentration, specialisation and competition are presented. Section 3 highlights the methodological background of the paper. Here the data sources, the dependent and explanatory variables as well as the regression models are introduced. The results of the estimations are discussed in Section 4 and the last Section concludes and gives an outlook.

2 Previous Findings on Concentration, Specialisation and Competition

There are several strands of recent literature discussing the region-specific effects of either concentration, specialisation or competition on new firms' post-entry-performance. In the following we highlight the major theoretical explanations and arguments dealing with the effects of these three groups of growth determinants on firm performance.

Regional specialisation in this respect is a measure which indicates whether the *composition* of activities (e.g. industries) in a certain region differs from the average activities over all regions. For example, one region can be occupied by only one type of industry while on average this industry accounts for only a minor share of industrial activities. Regional concentration in comparison indicates whether the *amount* of activities in a certain region is higher than the average. For example, in the extreme case 100 per cent of the activities in a certain industry may be concentrated in a single region. A specific region can be specialised in one industrial activity and exhibit a high degree of concentration in the respective industry at the same time, but this is not always the case. Even if 100 per cent of an activity are concentrated in one region, this region can be strongly diversified.

Explanations for regional concentration of industrial activities focused primarily on resurrecting Marshall's (1890) ideas on agglomeration externalities. These externalities are based on the co-location of firms which enable them to operate more efficiently by sharing some critical resources. Marshall has put forward three main reasons for the emergence of such positive externalities (see also Gordon and McCann 2000):

- The firms develop and utilise a common regional labour market pool: They generate human capital in-house and they profit from the human capital developed in other firms (Krugman 1991). By such a pooling effect the search and screening processes for employees as well as firms are facilitated and, hence, the matching process between human capital demand and supply is more effective. In particular young and small firms can profit from this labour pool because they can access experienced and highly-skilled employees which they are not able to train themselves due to their limited resources.
- Services and suppliers, which are focused on the necessities of the local firms, emerge in the region (Feldman 1994).
- Firms can share apparatus which would be too expensive for a single (small) firm.

In the last two decades other rationales for positive externalities accruing for firms situated within industrial agglomerations were identified (Armington and Acs 2002):

- Inside a region intended and un-intended information (Muscio 2006) and knowledge exchanges take place because, for example, employees of different firms are part of the same local network in which they exchange knowledge. Local spillovers represent all the unintended knowledge and information exchange between organisations. Thus, spillovers are different from knowledge transfer, for instance based on inter-firm worker mobility. The latter was already included in Marshall's argument on local labour markets.
- Furthermore, inter-organisational co-operations are more likely to occur within regional concentrations. For instance, the spatial proximity between firms within such concentrations enables more face-to-face contacts between them and in the end the emergence of trust-based inter-firm-relationships. This is especially important for firms when a frequent exchange of knowledge and quick feedback processes are necessary, `face-to-face´ interactions ease this exchange. The running of co-operations is related with lower transactions for new firms. Co-operations might enable new firms to overcome their limited resources and thus to face up the liabilities of newness and smallness (Armington and Acs 2002; Uzzi 1997).

All these positive externalities are more or less important and operate differently over industries. However, in most industries these positive externalities may still contribute to the development of firms in such regional concentrations.

Besides the positive effects of being located in a concentrated region, there are also negative externalities in such regions hampering the performance of new and young firms. In general, two different directions can be identified: Firstly, there are negative effects based on local competition which are discussed in more detail further below. Secondly, regional concentration bears the danger of a negative technological or economic lock-in as it decreases the probability of radical innovations. In contrast, such radical innovations would lead to a 'wider' development path and an increased ability of the firms to adapt to changing external conditions (Grabher 1993). A high risk of regional lock-in reduces in turn the strategic options of firms. The reason for such a lock-in lies mainly in long-existing, closed and homogeneous networks which are unable to renew the regional knowledge base by integrating often new external knowledge. Additionally, the regional technological trajectory can also converge due to a strong exchange of knowledge workers. Hiring managers from organisations that are similar to the focal firm was discovered to have a negative impact on organisational growth (Sørensen 1999).

Since both, positive and negative externalities, operate at the same time in a regional concentration, it is difficult to postulate which of these two effects on firm growth might prevail.

According to Marshall the above mentioned positive externalities operate in regions which are specialised in one or a few related industries. In contrast, Jacobs (1969) postulates that positive externalities are generated by regional diversity. Accordingly, knowledge spillovers occur between individuals and organisations with different experiences, capabilities and knowledge resources, for instance between firms from complementary industries. This combination of before unrelated pieces of knowledge generates the basis for invention and subsequent growth and regional development. There exist several studies which analysed whether a specialised or diversified regional structure foster innovativeness, productivity or GDP growth. However, the results of these studies are inconclusive: some studies show that both specialisation and diversification positively affect innovativeness or different aspects of innovativeness and its commercialisation (Shefer and Frenkel 1998; Paci and Usai 1999; van der Panne and van Beers 2006), while others find that especially diversification externalities favour innovativeness (Feldman and Audretsch 1999; van Oort 2002). Nevertheless, all of them draw the conclusion that diversification in particular is favourable for innovations in high-tech or knowledge-intensive industries. As outlined in the section before, our analysis will extend this strand of literature by exploring firm growth as the variable influenced by specialisation or diversification externalities.

Marshall and Jacobs, each of them has got a different perspective on local market structure and local competition as well (see van der Panne and van Beers 2006): for Marshall local market power of one or a few firms maximises the innovative potential of these firms. In contrast, Jacobs regards competition as a struggle for new ideas and, hence, as a positive aspect. The empirical evidence is mixed again supporting Marshall as well as Jacobs arguments (Feldman and Audretsch 1999; van Oort 2002). As pointed out above, a high degree of industry-specific concentration of firms, in most cases, also intensifies the local competitive pressure (Hannan and Freeman 1989; Stuart and Sorenson 2003). Such a strong competition increases the failure rates of the firms in these regions and decreases their growth rates. For example, studies suggest that new firms set-up in periods when markets are rather crowded with other start-ups and established firms are more likely to experience higher risks of failure than those started in less densely populated markets and regions (density delay effect) (Geroski et al.

2003; Carroll and Hannan 1989; Carroll and Hannan 2000). The organizational ecology assumes that the competitive processes are most intense at local and regional levels because they are tightly bound resource arenas (Staber 2001). The intensity of this competitive effect depends on the degree of overlapping needs of resources among the regional firms (e.g. human capital, financial support, local demand of customers). Especially knowledge-intensive firms compete at the local level for at least one important input factor of their production which is human capital. High demand for this input factor increases in turn the risk that employees leave a firm and start to work in another firm; potentially a competitor (labour poaching). In particular, highly skilled employees have high mobility rates between firms. This can strongly increase the local wage rate for highly qualified employees and firms can loose parts of their knowledge to competitors (probably as often as they gain from hiring employees of other firms).

All in all, the theoretical approaches are contradictory. In other words, the effects of either regional concentration, specialisation or competition on firm growth seems to be quite ambiguous. Before we take up these three groups of growth determinant again we outline the design of the empirical analysis in the following section.

3 Design of Empirical Analysis

3.1 Data background and measurement of firm growth

The 'IAB Establishment Register' is used as data source which comprises all enterprises employing at least one employee who is obliged to be a member of the German Social Insurance[1]. The 'Establishment File' is used in this analysis because it is the only German firm panel that provides longitudinal employment data for new firms. Larger start-ups could be the result of outsourcing and reorganisation processes in established firms. New businesses with more than 20 employees are therefore not considered to be 'genuine' start-ups and, thus, excluded from the following analysis (Fritsch and Brixy 2004).

We distinguish between knowledge-intensive and non-knowledge-intensive industries (3-digit-level) because the former outperform the latter in terms of growth (e.g. Almus and Nerlinger 1999; Calvo 2006; Geroski and Machin 1992). Hence, we suspect that the explanatory variables affect the growth rates of the two types of firms differently. The joint classification of the Institute of Economics in Lower Saxony and of the Fraunhofer Institute for Systems and Innovation Research (ISI) is applied to differentiate the firms into these two groups of industries (Legler and Frietsch 2006). Accordingly, industries are regarded as knowledge-intensive if the share of university and college graduates, the share of scientists and engineers and/or the proportion of employees conducting research, development and construction activities in total industry's employment are above average.

[1] IAB is the abbreviation for the Institute of Employment Research which belongs to Germany's Federal Employment Agency.

The growth patterns of new service and manufacturing firms differ significantly (Audretsch et al. 1999). In the following, we concentrate only on new firms started in the manufacturing sector. 16,706 manufacturing firms were set-up in 1992 in western Germany of which 11,365 start-ups quit the market until 2002[2]. Hence, only 5,341 firms of this cohort survived this eleven-year period. These surviving manufacturing firms build the data samples for the upcoming analysis: they comprise 1,042 firms of knowledge-intensive industries and 4,299 firms of non-knowledge-intensive industries, respectively.[3]

Firm growth is measured by the number of employees (E). Numerous studies revealed that small firms exhibit larger relative growth rates of employment while bigger firms show larger absolute growth rates. Therefore, the Birch-Index, developed by David Birch (1987), is applied for measuring firm growth because this 'balanced' index considers both, the relative as well as the absolute growth rates of the firms. It is based on a multiplicative combination of the absolute growth rate and the relative growth rate. This index was primarily designed for growth comparison for observation periods of equal lengths. The value of this index for a business is calculated by

(1) $$BI_{t+1} = \left|E_{t+1} - E_t\right| \times \frac{(E_{t+1} - E_t)}{E_t}$$

We modified this original computation because we needed the firm's index-values for annual average employment change. The formula of the Birch-index (BI) is as follows (T_{1992}: year when the firm was set-up; T_{2002}: the last year of the period of observation):

(2) $$BI = \left[\frac{\left|E_{T_{2002}} - E_{T_{1992}}\right|}{T_{2002} - T_{1992}}\right] \times \left[\sqrt[T_{10}]{\frac{E_{T_{2002}}}{E_{T_{1992}}}} - 1\right]$$

The mean Birch-Index of the knowledge-intensive businesses accounts for 0.12 and exceeds the one of the non-knowledge-intensive firms (0.06) by a factor of 2. This result is in line with empirical evidence. The calculation of non-parametric Kolmogorov-Smirnov-Tests suggests that the distributions of the firm size in the last year (2002) as well as the distributions of the Birch-Index differ significantly (p=0.001) between knowledge-intensive and non-knowledge-intensive businesses. This result does not hold for the distributions of the firm size in the first year (1992).

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2 We confine our analysis to the territory of western Germany because of the specific economic environment in eastern Germany for firm growth due to German reunification. A recent change of the industrial classification in the ‚IAB Establishment Register', namely the introduction of the NACE-code, does not allow to examine long-term growth of younger cohorts.

3 The outcomes of our analysis might be shaped by a survivor-bias in our samples. However, firm growth studies which compare the results of estimations either controlling or not controlling for survivor-bias did not find striking differences (e.g. Harhoff, Stahl and Woywoode 1998).

Table 1
Statistical parameters of the distributions of the Birch-Index

Average annual Birch-Index (1992-2002)	Mean	Minimum	Maximum	Standard Deviation	Kurtosis	Skewness
All manufacturing firms of the cohort (n=5,341)	0.07	-2	4.77	0.27	82.53	7.15
- Knowledge-intensive industries (n=1,042)	0.12	-2	4.59	0.36	57.91	6.34
- Non-knowledge-intensive industries (n=4,299)	0.06	-4	4.77	0.25	87.48	7.11

The large values of the kurtosis indicate that the empirical distributions of the Birch-Index are more peaked and have fatter tails than the often assumed Gaussian shape. The positive values of the skewness show that the distributions are skewed to the right (Table 1). One could conclude from these results that the distributions are apparently not Gaussian. These findings confirm the outcome of recent studies which revealed that the distribution of firm growth rates corresponds to a symmetric exponential function (Laplace) (Stanley et al. 1996) or to a Subbotin function (Bottazzi and Secchi 2003).

Studies investigating the growth determinants of new firms rely usually on traditional OLS regression methods (Brixy and Kohaut 1999; Hoogstra and van Dijk 2004; Reichstein and Dahl 2004). However, the non-Gaussian growth rate distributions suggest alternative regression methods. For this reason, in this paper Generalized-Least-Square (GLS) regressions are conducted in order to analyze factors influencing firm growth. These results are compared to those of traditional OLS regressions. Since the paper focuses on the long-term growth effects covering the first eleven years of survival, we decided against a panel estimation procedure including single year growth rates as the dependent variable.

3.2 Growth determinants

It is distinguished between four sets of independent variables (growth determinants): basic determinants and determinants of regional concentration, specialisation and competition. This section introduces the assumptions about the impacts of these determinants on firm growth relying on the theoretical explanations discussed in the second section as well as the applied definitions and indicators for all determinants. In most cases, average values were calculated for the determinants covering the whole period of analysis (1992-2002). The determinants at the regional level refer to the Standard Statistical Regions of which there are 74 in western Germany. The descriptive parameters of the distributions of the regional determinants over all Standard Statistical Regions are reported in Table A-1.

3.2.1 Basic determinants

The so-called basic determinants are such factors at the firm, industry and regional level which are usually included in studies dealing with new firm's survival and growth (see Table 2).

Since the present paper focuses on the impact of regional factors on firm employment growth, the firm level variables **establishment size** and **minimum efficient size (MES)** in the year when the firms were set-up (namely in 1992) act basically as control variables in order to avoid estimation biases and are not discussed in the following (e.g. Evans 1987; Sutton 1997; Almus and Nerlinger 2000).

Table 2
Definitions and expected influence of the basic determinants

Basic Determinants	Expected influence	Definition
Firm size (1992)	+/-	Number of employees of start-ups in their first year of existence (1992)
Minimum efficient size (MES 1992)	+	The minimum efficient size (MES) is the mean establishment size of the 50 percent of the largest firms within an industry (3-digit-level) (COMANOR/WILSON 1967). The calculation of the MES is based on the number of employees. The MES refers to first year of existence (1992) of the new businesses.
Industrial employment growth	+	Average annual change ratio of the number of employees within an industry (3-digit-level) (1992-2001)
Industrial Herfindahl-Index	+/-	Average annual Herfindahl-Index of employment for each industry i (3-digit-level) over all standard statistical regions r (74 in total). The formula for the calculation is as follows: $HHI_i = \sum_{r=1}^{74} \left(\frac{employment_{ri}}{employment_i} \right)^2$
Population density	-	Average annual number of inhabitants per square kilometre (1992-2002)
Population growth (lag)	+	Average annual change ratio of inhabitants over the period 1992-1997
GDP growth (lag)	+	Average annual change ratio of gross domestic product (1992-1997)

Start-ups may have more opportunities to increase in size if they operate in growing markets with increasing demand. Thus, **industrial employment growth** is considered to foster firm growth (Reichstein et al. 2006). The **industrial Herfindahl-Index (HHI)** over all regions indicates whether there are industry level advantages of geographic concentration. Both firms situated in industrial agglomerations and those which are not can profit from a high HHI. Such an effect arises if localisation improves overall industry functioning, for example, by more efficient input-output-linkages (Mare and Timmins 2006).

The advantages of new firms being located in densely populated regions range from the access to diversified input and output markets (e.g. capital, labour, services, suppliers, customers and knowledge) to a high probability of many face-to-face-interactions (Armington and Acs 2002). Besides, start-ups also have to face up negative externalities when they are located in highly agglomerated urban regions. For instance, it is much more expensive to start and to run a business due to higher rents, business taxes or wages within such areas (Almus and Nerlinger 2000). All in all, **population density** might have a positive or a negative effect on firm growth. **Population growth** is assumed to drive rising demand for goods and services, which in turn can lead to higher firm growth (Sutaria and Hicks 2004).

The increase or the decrease in regional gross domestic product (GDP) shows whether a regional economy provides favourable or unfavourable growth conditions for new businesses. For instance, **GDP growth** can be seen as an indicator for expanding output and/or input markets (Almus and Nerlinger 2000). This leads in turn to the attraction of human capital to the region. Thus, growing regional economies might provide more opportunities for the growth of new firms. Population and GDP growth are included as lag variables in the estimation sets (see Table 2).

3.2.2 Determinants of regional concentration

Drawing on the theoretical debate outlined in section 2 industrial concentration is considered to have an ambiguous effect on firm employment growth because it is unclear whether the positive externalities outweigh the negative ones or vice versa.

We apply the **Concentration-Index (CI)** of Sternberg and Litzenberger (2004) in order to measure the degree of **industry-specific concentration** at the regional level (Table 3). This Concentration-Index is based on three different components: the relative industrial density (ID), the relative industrial stock (IS) and the relative size of the establishments (SB). This index allows to control for the size (a) and the population (p) of a region (r). Besides, the number of businesses (b) in the region is also taken into account. The relative industrial density and the relative industrial stock might be above average due to the predominance of one or two firms within a region which does, however, not correspond to our understanding of industrial concentration. This is characterized by a high local density of firms. The Concentration-Index (CI) is defined as the product of the ID, the IS and the reciprocal of SB (Sternberg and Litzenberger 2004). The values of ID, IS and SB range from 0 to infinite. The larger the Concentration-Index the higher the degree of industrial concentration. If the index-value for a single region does not deviate from the respective value for the whole country (western Germany), the respective values of the three components amount to 1. The formula for the industrial Concentration-Index (CI) is as follows:

$$CI_{ri} = ID_{ri} \times IS_{ri} \times {}^{1}\!/_{SB_{ri}} \quad \text{with}$$

(3)
$$ID_{ri} = \frac{\dfrac{e_{ri}}{a_r}}{\dfrac{\sum_{r=1} e_{ri}}{\sum_{r=1} a_r}} \qquad IS_{ri} = \frac{\dfrac{e_{ri}}{p_r}}{\dfrac{\sum_{r=1} e_{ri}}{\sum_{r=1} a_r}} \qquad SB_{ri} = \frac{\dfrac{e_{ri}}{b_{ri}}}{\dfrac{\sum_{r=1} e_{ri}}{\sum_{r=1} b_{ri}}}$$

e (number of employees), a (size of the area), b (number of firms), p (population) r (standard statistical region).

A high degree of industrial concentration within a region does not mean that this region provides also specific cutting-edge knowledge and technological know-how for the firms in the respective industry. Knowledge-intensive firms rely particularly on the access to external knowledge. Patents, qualified human capital and R&D personnel are important external knowledge resources. Firms can absorb and adapt this external knowledge to their processes of organization and production in order to generate innovations and in the end to sustain their growth. For this reason, we include also determinants specifying the degree of regional **concentration of patenting activities, qualified human capital and R&D–personnel**.

There are two conflicting effects with regard to a high degree of regional concentration of patenting activities (Döringer and Schnellenbach 2006): On the one hand, this fact indicates that a lot of new technological knowledge is generated in the respective region. This knowledge in turn may diffuse via various channels within the region and newly founded firms might benefit from such knowledge spillovers and transfers. On the other hand, the knowledge incorporated in the patents is not accessible for every local firm. This holds especially true when the patent applications are not licensed. In this case, only the patenting organisation is allowed to use this knowledge for a certain period of time. Considering the theoretical discussion in section 2 the effect of highly concentrated qualified human capital and R&D personnel within a region on firm performance is ambiguous due to counteracting labour pooling (Marshallian externality) and labour poaching effects.

The Concentration-Index (CI) is also applied in order to measure the degree of regional concentration of patents, qualified human capital and R&D personnel. Due to missing firm level data it is not possible to display the relative size of the establishments (SB). For this reason we modified the Concentration-Index (CI) which is then defined as the product of the relative density of an activity (AD) and of the relative stock of this activity (AS). The higher the values of this index the higher the degree of concentration of an activity (Table 3).

(4) $$CI_r = AD_r \times AS_r$$

With respect to the technological concentration the respective activity is specified by the number of patent applications in each region. The concentration of qualified human capital is represented by the number of employees with a college or university degree. Because of missing data about R&D employees the number of engineers and mathematicians who are supposed to be particularly involved in R&D activities within firms is used as a proxy for the availability of R&D personnel on the regional labour market. The respective formulas for these three concentration indices are reported in Table 3.

Table 3
Definitions and expected influence of the determinants of regional concentration

Determinants	Expected influence	Definition
Concentration determinants (standard statistical regions (n=74))		
Concentration-Index (specific industry)	+/-	The Concentration-Index is calculated for each industry (3-digit-level) on the basis on average annual values over the period 1992-2001 in Standard Statistical Regions.
Concentration-Index (patents)	+/-	This Concentration-Index (CI) is calculated based on the average annual number of patents (pa) (1994-2001) in Standard Statistical Regions. Patents are assigned to the region of the inventors. $CI_r = AD_r \times AS_r$ with $AD_r = \frac{pa_r}{\frac{a_r}{\frac{\sum_{r=1} p_r}{\sum_{r=1} a_r}}}$ $AS_r = \frac{pa_r}{\frac{p_r}{\frac{\sum_{r=1} p_r}{\sum_{r=1} i_r}}}$ pa (number of patents), a (size of the area), p (population), r (standard statistical region).
Concentration-Index (Qualified human capital)	+/-	This Index is calculated based on the average annual number of employees with a college and university degree (1992-2002) in Standard Statistical Regions. $CI_r = AD_r \times AS_r$ with $AD_r = \frac{qh_r}{\frac{a_r}{\frac{\sum_{r=1} p_r}{\sum_{r=1} a_r}}}$ $AS_r = \frac{qh_r}{\frac{p_r}{\frac{\sum_{r=1} p_r}{\sum_{r=1} i_r}}}$ qh (number of high qualified employees), a (size of the area), p (population), r (standard statistical region).
Concentration-Index (R&D Personnel)	+/-	This Concentraiton-Index (CI) is calculated based on a prixy for R&D personnel: the average annual number of engineers, mathematicians and scientists (1992-2002) in Standard Statistical Regions. $CI_r = AD_r \times AS_r$ with $AD_r = \frac{rd_r}{\frac{a_r}{\frac{\sum_{r=1} p_r}{\sum_{r=1} a_r}}}$ $AS_r = \frac{rd_r}{\frac{p_r}{\frac{\sum_{r=1} p_r}{\sum_{r=1} i_r}}}$ rd (number of R&D employees), a (size of the area), p (population), r (standard statistical region).

The debate on the ambiguous impact of regional concentration on firm growth indicates that it is difficult to differentiate empirically between pure effects of concentration and competition because concentrations are characterized by the mutual interplay of positive and negative externalities. In turn, these externalities are affected by competition amongst others. Further below, specific indicators of local inter-firm competition are presented.

3.2.3 Determinants of regional specialisation

Drawing on Marshall's externalities regional specialization (see section 2) should be positively related to firm growth. However, we expect a negative effect for the degree of overall specialisation when Jacobian externalities are at work. We distinguish between the overall specialisation and the industry-specific specialisation of a region. The Krugman-Specialization-Index (KSI) is applied as an indicator for regional overall specialisation and the Location Quotient (LQ) as a measure for industry-specific specialisation.

Regional overall specialisation

The Krugman-Specialization-Index (KSI) compares the regional structure to the national average. For measuring the degree of industrial overall specialisation the **KSI (all industries)** is calculated for each Standard Statistical Region r based on the number of employees over all industries i (with n=total number of industries on 3-digit-level) (Südekum 2004).

(5) $$KSI_r = \sum_{i=1}^{n} \left| employment_{ri} - \overline{employment_i} \right|$$

The KSI ranges from 0 to 2; the larger this index the more the regional industrial structure deviates from the national one. Since the industrial structure of western Germany should be more diversified than any regional industrial structure, a larger index indicates a higher degree of regional overall specialisation.

According to the concentration measures, the KSI is also computed in order to illustrate the degree of overall specialization of patenting activities and of qualified human capital at the regional level. Thus the **KSI (patents)** was calculated based on regional patent data differentiated in 30 technological fields in order to measure the degree of overall technological specialisation. To show up the overall specialisation of qualified human capital at the regional level the **KSI (qualified human capital)** is applied to regional employment data segregated in 30 academic occupations. In addition, the **KSI (start-ups)** was calculated, relying on data on the industrial structure of new firms (on the 3-digit-level), for measuring the degree of overall specialisation of industrial start-up activities (Table 4).

Industry-specific specialisation

The location quotient (LQ) indicates the degree of specialisation for each single industry at the regional level (Feldman and Audretsch 1999; Glaeser et al. 1992). The location coefficient is computed for industry-specific employment as well as for industry-specific start-up activities (3-digit-level) (Table 4). A normalization of the location coefficients is conducted [LQ = (LQ +1)/(LQ-1)] which leads to a range of LQ from -1 to 1. If LQ is > 0 the industry-specific specialization of a region is above national average.

Table 4
Definitions and expected influence of the determinants of regional concentration

Determinants	Expected influence	Definition
Specialization determinants (standard statistical regions (n=74))		
KSI (all industries)	+/-	The Krugman-Specialization-Index (KSI) is calculated for each standard statistical region r based on the average number of employees (averaged over 1992-2001) over all industries i (n=total number of industries). $KSI_r = \sum_{i=1}^{n} \left| employment_{ri} - \overline{employment_i} \right|$
KSI (patents)	+/-	The KSI is calculated for each standard statistical region r based on the average number of patents (averaged over 1994-2001) in 30 technologies (t) which are defined according to the OST/INPI/ISI system. Patents are assigned to the region of the inventors. $KSI_r = \sum_{t=1}^{n} \left| patents_{rt} - \overline{patents_t} \right|$
KSI (qualified human capital)	+/-	The KSI is calculated for each standard statistical region based on the average number of employees (averaged over 1992-2001) in 30 academic occupations (o). $KSI_r = \sum_{o=1}^{n} \left| employment_{ro} - \overline{employment_o} \right|$
KSI (start-ups)	+/-	The KSI is calculated for each standard statistical region r based on the average annual number of start-ups over all industries (3-digit-level) (averaged over 1992-2001). $KSI_r = \sum_{i=1}^{n} \left| startups_{ri} - \overline{startups_i} \right|$
Location coefficient (specific industry, normalised)	+/-	Calculation of average annual location quotients for industries (3-digit-level) for each standard statistical region r (1992-2001). $LQ = \dfrac{e_{ir} / \sum_r e_{ir}}{\sum_i e_{ir} / \sum_{ir} e_{ir}}$ e(employment), i(industry), r (region) Normalised LQ = (LQ +1)/(LQ-1)
Location coefficient (start-ups, specific industry, normalised)	+/-	Calculation of average annual location quotients based on the average annual number of start-ups (s) for each industry I (3-digit-level) in each standard statistical region r (1992-2001). $LQ = \dfrac{s_{ir} / \sum_r s_{ir}}{\sum_i s_{ir} / \sum_{ir} s_{ir}}$

3.2.4 Determinants of regional competition

With regard to the density delay-argument of organizational ecology strong competitive pressure on regional markets should have a negative effect on firm growth (Staber 2001; Hannan and Freeman 1988). Competitors for new firms may be other start-ups or incumbent businesses. The study of Stuart and Sorenson (2003) shows that the performance of new firms located within an industrial agglomeration deteriorates because of a high level of start-up activities in the respective industry. In contrast to the findings for innovativeness (see Section 2), up to know there is no empirical evidence that competition positively affects firm growth.

We account for competition among new firms at the regional level by calculating both start-up rates covering all private industries and industry-specific start-up rates (Table 5). Drawing on the labour market approach which is widely accepted in entrepreneurship research the start-up rate is defined as the number of new firms per 1,000 employees (Armington and Acs 2002).

Additionally, the local industry-specific competition caused by incumbent firms is taken into consideration by building an industrial competition indicator which consists of the quotient of the number of firms and of the number of employees in the respective industry and region.

Table 5
Definitions and expected influence of the determinants of regional concentration

Determinants	Expected influence	Definition
Competition determinants (standard statistical regions (n=74))		
Start-up rate (all private industries)	-	Average annual number of new firms in all private industries in 1992-2001 per 1,000 employees
Industrial start-up rate	+/-	Average annual number of new firms in the respective industry (3-digit-level) 1992-2001 per 1,000 employees
Industrial competition	-	Average annual number of firms in the respective industry (3-digit-level) per average annual number of employees firms in the respective industry (3-digit-level) 1992-2001

3.3 OLS- and GLS-regressions

We estimate Ordinary-Least-Square regressions and feasible Generalized-Least-Square (GLS) regressions in order to identify the growth determinants of start-ups in knowledge-intensive and non-knowledge-intensive manufacturing industries in western Germany. The Birch-index is the dependent variable and the growth determinants were introduced in the section before. Table A-2 depicts the matrix of the correlations between all regional growth determinants. In order to avoid multicollinearity caused by correlations between regional determinants several regressions are estimated. Therefore, most regional determinants are included in separate regressions. As discussed in Section 3.1 GLS regressions are conducted to correct for the non-Gaussian distribution of the dependent variable and, thus, to correct for the skewness of the distribution. In contrast to traditional OLS regression, feasible GLS-models do not rely on the

Gauss-Markov-Assumption and on the prerequisite that the error term has got a zero population mean. Ordinary-least-square-regressions are estimated based on White's heteroskedasticity-robust estimator (Greene 2003).

$$\beta = (X'X)^{-1}(X'[\Omega]X)(X'X)^{-1} \quad (6)$$

The following variation of the estimation of the covariance-matrix is performed. First, we estimate traditional OLS-regression in order to obtain the residuals. Then, the residuals of the matrix of the covariance were computed. We apply a GLS-model based on a diagonal matrix with □ on the diagonal.

$$\Omega_i^{\ 2} = E\left(u_i^{\ 2} \middle| Z_i\right) = \exp(Z_i \alpha) \quad (7)$$

The results of the OLS estimations are reported in Tables A-3 to A-6 in the appendix, whereas the Tables 6 to 9 depict the outcomes of the GLS estimations. The values of the adjusted R^2 in all OLS estimation sets are quite small; the largest value only amounts to 0.041. This weak explanatory power corresponds to recent empirical evidence on firm growth (e.g. Reichstein and Dahl 2004; Honjo 2004). Marsili (2001) summarizes that the values of R^2 are usually lower than 30 % in studies investigating firm growth. The values of the adjusted R^2 in the GLS estimation sets range from 0.08 to 0.59. The adjusted R^2 exceeds in 19 of all 28 models the value of 30 %; hence, the explanatory power seems to be stronger in contrast to studies applying OLS regressions. In addition, the GLS regressions exhibit more significant coefficient estimates than the OLS regressions. Except for one determinant the signs and, thus, the directions of the relationship between the growth determinants and the dependent variable are identical for the OLS and GLS estimation sets. Consequently, we confine the analysis to a discussion of the GLS-estimations in the next section.

Table 6
Basic and competition determinants – GLS regression results for employment growth (dependent variable: Birch-Index)

	Knowledge-intensive industries				Non-knowledge-intensive industries			
Explanatory variables	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*
Firm size in 1992	-0.002***	-0.003***	-0.004***	-0.004***	-0.005***	-0.005***	-0.005***	-0.006***
	-5.75	-5.59	-5.47	-7,20	-34.14	-67.91	-55.19	-70.31
Minimum efficient size	0.001***	-0.001**	0.001***		0.001***	0.001***	0.001***	
	2.62	2.09	2.61		21.06	27.14	41.29	
Industrial employment growth	-0.365	0.625***	0.212		0.932***	1.057***	1.135***	
	-0.14	2.10	0.73		19.62	38.09	27.03	
Industrial Herfindahl-Index	0.794***	1.154***	1.349***	0.965***	-0.106***	-0.096***	-0.133***	0.170***
	4.44	7.92	9.89	7.27	-5.48	-4.84	-6.76	11.53
Population density			-0.001***			-0.001***		
			-7.32			-9.38		
Population growth (lag)		7.945***					3.043***	
		11.83					20.64	
GDP growth (lag)	3.392***				0.614***			
	11.33				6.74			
Start-up rate (all private industries)	-0.007***				-0.010***			
	-3.08				-14.64			
Start-up rate (specific industry)		-355.9**					-570.4***	
		-2.01					-26.66	
Local competition (specific industry)				-0.273***				-0.366***
				-11.35				-44.94
Significance	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Number of observations	1,042	1,042	1,042	1,042	4,299	4,299	4,299	4,299
R-squared	0.268	0.241	0.216	0.167	0.330	0.541	0.566	0.594
Adjusted R-squared	0.256	0.236	0.213	0.165	0.329	0.541	0.565	0.593

Note: ***p<=0.01; **p<=0.05; *p<=0.1; coefficients and t-values reported in the cells.

Table 7
Concentration determinants – GLS regression results for employment growth (dependent variable: Birch-Index)

	Knowledge-intensive industries				Non-knowledge-intensive industries			
Explanatory variables	*5*	*6*	*7*	*8*	*5*	*6*	*7*	*8*
Firm size in 1992	-0.004***	-0.002***	-0.003***	-0.003***	-0.005***	-0.005***	-0.005***	-0.005***
	-6.47	-5.37	-6.37	-5.40	-50.46	-38.16	-41.48	-45.89
Minimum efficient size	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	2.65	3.00	3.27	3.37	41.84	22.12	20.03	24.59
Industrial employment growth	0.427	0.282	-1.978	0.083	1.051***	0.995***	1.054***	1.198***
	1.64	1.01	-0.71	0.30	40.08	22.90	22.71	29.37
Industrial Herfindahl-Index	0.933***	0.669***	3.562***	0.425**	-0.080***	-0.076***	-0.073***	-0.071***
	5.21	3.67	2.64	2.42	-3.66	-3.76	-4.00	-3.96
GDP growth (lag)	2.705***	2.968***	3.562***	3.634***	0.463***	0.172**	0.478***	0.348***
	8.69	9.74	13.88	14.38	6.53	2.25	6.29	4.68
Concentration-Index (specific industry)	-0.001				-0.001			
	-0.69				-0.30			
Concentration-Index (patents)		-0.004***				-0.003***		
		-6.97				-12.67		
Concentration-Index (qualified human capital)			-0.002***				-0.001***	
			-4.99				-6.66	
Concentration-Index (R&D personnel)				-0.021***				-0.004***
				-7.28				-5.28
Significance	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Number of observations	1,042	1,042	1,042	1,042	4,299	4,299	4,299	4,299
R-squared	0.165	0.199	0.218	0.291	0.462	0.348	0.369	0.437
Adjusted R-squared	0.160	0.194	0.214	0.287	0.461	0.347	0.368	0.436

Note: ***p<=0.01; **p<=0.05; *p<=0.1; coefficients and t-values reported in the cells.

Table 8
Specialisation determinants – GLS regression results for employment growth in knowledge-intensive industries (dependent variable: Birch-Index)

	Knowledge-intensive industries					
Explanatory variables	*9*	*10*	*11*	*12*	*13*	*14*
Firm size in 1992	-0.005***	-0.005***	-0.005***	-0.003***	-0.005***	-0.004***
	-6.42	-7.00	-7.89	-4.34	-7.16	-6.76
Minimum efficient size	0.001***	0.001**	0.001***	0.001***	0.001***	0.001***
	3.83	2.44	3.84	3.17	3.44	3.30
Industrial employment growth	-0.578***	0.641**	-0.695***	0.679**	0.222	0.802**
	-2.64	2.28	-3.01	2.26	0.84	2.53
Industrial Herfindahl-Index	0.506***	1.229***	0.428***	0.621***	0.517***	0.607***
	2.83	8.20	2.83	3.27	2.82	3.20
KSI (all industries)	0.047					
	1.55					
KSI (patents)		-0.037*				
		-1.70				
KSI (qualified human capital)			0.056*			
			1.62			
KSI (start-ups)				0.393***		
				7.81		
Location coefficient (specific industry, normalised)					0.002	
					0.32	
Location coefficient (start-ups specific industry, normalised)						0.070***
						4.62
Significance	0.001	0.001	0.001	0.001	0.001	0.001
Number of observations	1,042	1,042	1,042	1,042	1,042	1,042
R-squared	0.083	0.131	0.099	0.098	0.069	0.097
Adjusted R-squared	0.078	0.127	0.095	0.094	0.064	0.093

Note: ***p<=0.01; **p<=0.05; *p<=0.1; coefficients and t-values reported in the cells.

Table 9
Specialisation determinants – GLS regression results for employment growth in non-knowledge-intensive industries (dependent variable: Birch-Index)

	Non-knowledge-intensive industries					
Explanatory variables	*9*	*10*	*11*	*12*	*13*	*14*
Firm size in 1992	-0.005***	-0.005***	-0.00***5	-0.006***	-0.005***	-0.005***
	-36.88	-33.79	-45.30	-44.66	-38.73	-33.04
Minimum efficient size	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	20.78	19.48	24.27	29.50	33.37	20.52
Industrial employment growth	1.011***	0.994***	0.988***	1.097***	1.024***	0.952***
	20.36	21.73	24.36	25.35	26.07	21.95
Industrial Herfindahl-Index	-0.089***	-0.082***	-0.095***	-0.093***	-0.074***	-0.099***
	-4.87	-3.84	-4.41	-4.54	-3.38	-4.68
Krugman-Index (all industries)	0.095***					
	11.07					
Krugman-Index (patents)		0.081***				
		16.05				
Krugman-Index (qualified human capital)			0.084***			
			9.90			
Krugman-Index (start-ups)				0.059***		
				5.04		
Location coefficient (specific industry, normalised)					0.024***	
					10.66	
Location coefficient (start-ups specific industry, normalised)						0.035***
						10.34
Significance	0.001	0.001	0.001	0.001	0.001	0.001
Number of observations	4,299	4,299	4,299	4,299	4,299	4,299
R-squared	0.317	0.307	0.396	0.424	0.363	0.275
Adjusted R-squared	0.317	0.306	0.395	0.423	0.362	0.274

Note: ***p<=0.01; **p<=0.05; *p<=0.1; coefficients and t-values reported in the cells.

4 Empirical Results and Discussion

In this section, the results of the GLS regressions are to be introduced. At first, the outcomes of the baseline regressions (Table 6) and then the effects of the concentration determinants (Table 7), the specialization determinants (Tables 8 and 9) and of the competition indicators (Table 6) on firm growth are illustrated and discussed.

Basic determinants

All in all the results of the baseline regressions, for the knowledge- as well as for the non-knowledge-intensive industries, confirm our initial expectations on the included explanatory variables.

The influence of the initial firm size on average annual firm growth (Birch-index) over the period 1992-2002 is weakly negative in both baseline models which is supported by the literature: The impact of initial firm size is usually rather strong during the first years of the post-entry-phase of newly founded firms whereas some studies show that this effect is rather weak from the seventh and eighth year on (e.g. Geroski, Mata and Portugal 2003).

The coefficient of the industry-specific minimum efficient size (MES) is slightly positive and significant in all baseline estimations. In accordance with Almus and Nerlinger (1999) the effect of MES on firm growth is rather strong during the first years of the life-cycle of new firms. Apparently, this does not hold for long-term growth of start-ups in the manufacturing sector.

The baseline estimations exhibit a positive effect of industrial employment growth. Empirical evidence suggests also that industrial employment growth fosters the survival and growth of new businesses (Brixy and Kohaut 2005; Falck 2005, Geroski et al. 2003, Honjo 2004).

The influence of the industrial Herfindahl-index is positive and negative for the knowledge- and non-knowledge-intensive industries, respectively. This implies, the higher the degree of regional concentration in knowledge-intensive industries the greater is the growth of new businesses within these industries. In turn, in non-knowledge-intensive industries a high degree of regional concentration, in most cases, causes only moderate growth of new businesses. These results suggest that industry level effects of regional concentration are more likely to operate in knowledge-intensive industries.

The coefficient of population density is rather weak and negative. This finding corresponds with the evidence of other studies which find a significant negative influence of population density on new firm's survival and growth (Almus and Nerlinger 1999; Brixy and Kohaut 2005).

Regional population growth, as expected, fosters the growth of new businesses. The coefficient of this variable is positively significant under all estimation sets. This holds also true for the estimated coefficients of the variable average annual change ratio of GDP. Thus, young manufacturing firms seem to grow faster in regions with GDP growth. The market potential of regions increases due to raising numbers of inhabitants and GDP. Additionally, firms tend to invest more in their businesses in regions with GDP and population growth due to a favourable investment climate and this in turn fosters firm growth. Therefore, these results suggest such regions provide favourable growth conditions for young firms.

Concentration determinants

The coefficients in all estimation sets for the explanatory variables related to regional concentration are negative and extremely weak. Apart from the coefficient for industrial concentration, the coefficients for the other concentration variables (patenting activities, qualified human capital, R&D personnel) are significant. Hence, being located in a technological or human capital concentration has got a negative influence on firm growth, but only a very small one. With regard to the negative effect of being located in a technological concentration, the conclusion can be drawn that young firms can evidently not profit from potential knowledge spillovers or transfers, irrespective whether such externalities operate at all within such agglomerations. Alternatively the positive effects which accrue from knowledge exchange are outweighed by the negative ones. The latter could be caused for instance by knowledge outflows from new firms to incumbent businesses. In addition, strong patenting activities dominated by one or a small number of large firms might restrict the window of technological opportunities for new and young firms because they usually tend to follow the established technological trajectory. In other words, new firms might hesitate to pursue and exploit promising alternative opportunities which are not directly bound to this trajectory. In turn, this might reduce the likelihood for dynamic firm growth. Furthermore, it can be concluded from the slightly negative coefficients of the Concentration-Indices for human capital that labour poaching effects may prevail on the regional labour markets which is caused by intense intra-regional competition due to similar needs for (highly) qualified human capital.

Our findings are in line with already existing literature on the negative effects of being located in an industrial concentration on performance (Stuart and Sorenson 2003; Otto and Köhler 2007). Nevertheless, the results of this paper differ because we do not find a negative effect of industrial concentration as such, but especially with regard to the concentration of technologies and human capital.

In total, these results indicate that the negative externalities slightly take precedence over the positive ones impeding firm growth based on a narrowing technological trajectory and intra-industry-competition effects as a result of overlapping resource needs.

Specialisation determinants

All the estimation results of the Krugman-Index (all industries, patents, start-ups and human capital) for the non-knowledge-intensive start-ups show positive and highly significant coefficients. This implies that these firms have higher growth rates if the region exhibits a high degree of overall specialisation. Hence, non-knowledge-intensive firms grow faster, the smaller the variety of active industries, technologies and academic occupations in the region. This finding confirms the Marshallian specialisation argument. Apart from the negative effect of overall technological specialisation on firm growth, the other Krugman-Indices (all industries, start-ups and human capital) are positively related to the performance of knowledge-intensive start-ups, too. As already pointed out above high patenting activities and especially strongly focused patenting activities in a region, may narrow the window of technological opportunity leading in turn, in the most extreme case, to a technological lock-in. Since the performance of knowledge-intensive firms relies on invention and innovation activities, these firms are affected particularly by limited technological opportunities. Our results point to the fact that this might impede the growth potentials of new knowledge-intensive firms.

The normalised location coefficients for the explanatory variables industrial employment and industry specific start-up activities are positive and highly significant for both types of industries. The higher the degree of regional specialisation and start-up activities in the specific 3-digit industry of the newly founded firm is, the higher is the likelihood that this firm will grow faster. The same effect is shown by the study of Hoogstra and van Dijk (2004) studying the impact of regional industrial specialisation on firm growth in the Netherlands (for similar results see Reichstein and Dahl 2004; Reichstein et al. 2006). This finding sustains also the Marshallian argument which postulates that firms located in specialised regions can make use of positive externalities.

All in all, our results support the evidence of the existing literature. We add to these findings a supplementary perspective by differentiating on the one hand between the degree of overall regional specialisation vs. industry-specific specialisation and on the other hand we examine specialisation at the regional level by a variety of complementary variables, namely the composition of the industrial, technological, human capital and start-up activities.

Competition determinants

The effect of each of the three competition indicators (start-up rates in the private sector, industry-specific start-up rates, local competition) on firm growth is negative and significant under all estimation sets for both groups of industries. These results can be seen as empirical evidence for the thesis postulated by organisational ecology that local competition among established and new firms as consequence of overlapping resource requirements hampers growth (Staber 2001; Hannan and Freeman 1989). Additionally, this supports Marshall's argument that firms that are not affected by competitors can at least temporarily generate specific rents (Marshall 1890).

5 Conclusions

The aim of this paper consisted of answering the questions how the location of newly founded firms in regional concentrations affects their long-term growth and whether regional specialisation as well as competition increases or decreases the likelihood of firm growth. We used firm panel data provided by the IAB Establishment Register and explored the growth determinants of those manufacturing firms that started in 1992 and survived on the market until 2002 in western Germany. For all these 5,341 firms we computed the Birch-Index as a measure for employment firm growth. Since, we found out that the distribution of the Birch-Index does not follow a Gaussian distribution, we applied Generalized Least Square regressions which account for the skewness of the distribution. In order to figure out whether knowledge-intensive and non-knowledge-intensive firms are affected differently by growth determinants, we analysed these two groups of industries separately. For these both firm groups different estimation sets were conducted including either the basic determinants or those of regional concentration, specialisation and competition.

All in all, the estimation results indicate that favourable regional (measured by GDP or population growth) and industrial conditions (measured by industrial employment growth) positively affect long-term growth probabilities of firms located in these regions or industries. Furthermore, we found out that firms situated either in- or outside industrial concentrations can profit from a high degree of geographic concentration in the respective industry. Such industry level advantages are more likely to operate in knowledge-intensive industries and positively affect the growth of the firms in these industries.

Focusing on our core questions outlined above the GLS regressions revealed the following results:

With regard to the concentration measures we can conclude that being located in an industrial, technological or human capital agglomeration rather slightly reduces the growth rates of the newly founded firms. This holds for knowledge-intensive and non-knowledge-intensive firms alike. Hence, the negative externalities operating in concentrations (e.g. labour poaching or potential for technological lock-in) prevail the positive ones.

Accounting for the specialisation determinants we found the following results: First, the higher the degree of specialisation in the respective industry and region of the start-up, the higher are the long-term growth rates. Second, the higher the degree of overall specialisation of the region – the smaller the variety of active industries, technologies and academic occupations in the region – the higher are the growth rates. This holds true for both the knowledge- as well as for the non-knowledge-intensive industries. Hence, the conclusion can be drawn that could be drawn the conclusion that start-ups grow the better the higher specialised the region is in which they are located. In turn, this outcome supports the Marshallian argument. Considering the regional degree of technological specialisation of patenting activities the pattern is different for the knowledge-intensive industries: the higher the degree of specialisation the lower are the average growth rates of the start-ups. One reason for this outcome can be seen in the sensitivity of knowledge-intensive start-ups taking into consideration the technological development opportunities within a region, for instance a narrowing of the window of opportunity.

The impact of regional competition on firm growth does not differ between knowledge- and non-knowledge-intensive firms. All applied measures for regional competition indicate that a high degree of competitive pressure on regional markets caused by a high density of new and incumbent firms reduces the growth rates of manufacturing firms. Thus, strong regional competition for input factors and demand hampers long-term firm growth. This outcome confirms the Marshallian argument.

In summary, our findings are in line with the evidence of many studies dealing either with the question which determinants affect firm growth or with the issue which impact regional concentration and specialisation has got on different economic performance variables of firms, for instance innovative activities, productivity or growth. Our empirical approach allows us to differentiate between the effects of regional concentration, specialisation and competition by using a set of industrial, technological and human capital variables. A striking result is that the determinants show in most cases the same impact on firm growth irrespective of the industry group. One could have expected that especially technological and human capital determinants would have had a stronger effect, either positive or negative, on knowledge-intensive firms because they rely more heavily on such input factors. Taking into consideration the controversy whether Marshallian or Jacobian externalities have an impact on economic variables, our analysis add results on firm level growth and find support for the Marshallian perspective for nearly all of the included determinants.

Based on our results we suggest that policy measures focusing on the support of the emergence and development of localised industrial clusters, shall be designed and evaluated very cautiously. On the one hand, our study reveals that being located in concentrations and regions characterized by strong inter-firm competition is detrimental for long-term firm performance. On the other hand, a high degree of regional specialisation and an increase in regional demand and GDP positively affects firm growth in the long-run. All in all, these results point also to an interaction between the different determinants. Hence, it is difficult to draw clear lessons for cluster policy from the outcomes of our empirical analysis.

Considering the findings of this paper the analysis might be extended by some alternatives. Since the gazelles, the quite fast growing firms, are of peculiar interest, one might restrict an analysis to this firm type in order to figure out which firm-, industry and region-specific determinants differentiate the gazelles from the rest of the firms. Since our analysis showed that the growth rate distributions are tent-shaped and exhibit fatter tails than a normal distribution does quantile regression techniques could be applied in order to analyse the effect of the variables on different parts of the growth rate distribution. Currently, the effects of concentration, specialisation and competition are analysed separately. Since there is some overlap between these determinants, further analysis may concentrate on the interaction between them.

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Appendix

Table A-1
Statistical parameters of the distributions of the regional determinants

Regional determinants (standard statistical regions; n=74)	Mean	Standard deviation	Minimum	Maximum
population density	334.40	375.41	77.08	2261.93
population growth (lag)	1,006	0,004	0,997	1,016
GDP growth (lag)	1,023	0,008	1,005	1,055
start-up rate (all private industries)	6,68	1,24	4,71	10,25
Krugman-Index (all industries)	0.54	0.08	0.36	0.72
Krugman-Index (patents)	0.58	0.16	0.27	1.04
Krugman-Index (qualified human capital)	0,34	0,09	0,18	0,58
Krugman-Index (start-ups)	0,26	0,06	0,14	0,41
Concentration-Index (patents)	1,44	2,28	0,00	12,22
Concentration-Index (Qualified human capital)	1,79	4,08	0,04	26,52
Concentration-Index (R&D Personnel)	0,24	0,54	0,00	3,08

Table A-2
Correlations between regional determinants (standard statistical regions (n=74))

Regional determinants	population density	population growth (lag)	GDP growth (lag)	start-up rate (1992, all private industries)	Krugman-Index (all industries)	Krugman-Index (patents)	Krugman-Index (qualified human capital)	Krugman-Index (start-ups)	Concentration-Index (patents)	Concentration-Index (Qualified human capital)	Concentration-Index (R&D Personnel)
population density	1,000										
population growth (lag)	-0,505**	1,000									
GDP growth (lag)	-0,101	-0,536**	1,000								
Start-up rate (1992, all private industries)	-0,144	0,290*	0,190	1,000							
KSI(all industries)	-0,178	,0221	0,099	0,078	1,000						
KSI (patents)	-0,264*	0,099	0,112	0,059	0,445**	1,000					
KSI (qualified human capital)	-0,343**	0,351**	0,207	0,461**	0,546**	0,421**	1,000				
KSI (start-ups)	-0,009	0,117	0,192	0,333**	0,643**	0,399**	-0,645**	1,000			
Concentration-Index (patents)	-0,398*	-0,331**	-0,025	-0,154	-0,308**	-0,62	-0,267*	-0,163	1,000		
Concentration-Index (Qualified human capital)	-0,864**	-0,401**	0,064	-0,119	-0,123	-0,225	-0,227	0,128	0,483**	1,000	
Concentration-Index (R&D Personnel)	-0,807**	-0,440**	0,031	-0,177	-0,152	-0,195	-0,216	0,048	0,549**	0,942	1,000

Note: Pearson correlation coefficients; t-values in parentheses: ***t<=0.01; **t<=0.05; *t<=0.1

Table A-3
Basic and competition determinants – OLS regression results for employment growth (dependent variable: Birch-Index)

	Knowledge-intensive industries				Non-knowledge-intensive industries			
Explanatory variables	*1*	*2*	*3*	*4*	*1*	*2*	*3*	*4*
Firm size in 1992	-0-003 -0.66	-0.002 -0.64	-0.003 -0.69	-0.003 -0.73	-0.006*** -6.30	-0.006*** -6.51	-0.006*** -6.54	-0.006*** -6.25
Minimum efficient size 1992	0.001 1.05	0.001 1.07	0.001 0.83		0.001*** 5.30	0.001*** 5.36	0.001*** 4.88	
Industrial employment growth	-0.390 -0.32	-0.465 -0.37	-0.004 -0.00		1.246*** 3.84	1.288*** 3.94	1.470*** 4.36	
Industrial Herfindahl-Index	1.458* 1.90	1.474* 1.91	1.458* 3.23	1.706** 2.29	-0.107 -1.33	-0.100 -1.24	-0.164** -2.08	0.059 0.72
Population density						-0.001 -1.19		
Population growth (lag)		-0.001 -1.44					0.022* 1.69	
GDP growth (lag)	4.320*** 3.61	3.689*** 3.05			0.989* 1.76	0.354 0.64		
Start-up rate (all private industries)	-0.009 -1.08				-0.013*** -4.20			
Start-up rate (specific industry)			-602.923 -1.18				564.710*** -5.19	
Local competition (specific industry)				0.004 0.10				0.040* 1.67
Significance	0.003	0.001	0.003	0.051	0.001	0.001	0.001	0.001
Number of observations	1,042	1,042	1,042	1,042	4,299	4,299	4,299	4,299
R-squared	0.023	0.025	0.015	0.026	0.033	0.030	0.034	0.010

Note: ***p<=0.01; **p<=0.05; *p<=0.1; coefficients and t-values reported in the cells.

Table A-4
Concentration determinants – OLS regression results for employment growth (dependent variable: Birch-Index)

	Knowledge-intensive industries				Non-knowledge-intensive industries			
Explanatory variables	*5*	*6*	*7*	*8*	*5*	*6*	*7*	*8*
Firm size in 1992	-0.002	-0.003	-0.003	-0.002	-0.006***	-0.006***	-0.006***	-0.006***
	-0.63	-0.72	-0.65	-0.67	-6.44	-6.54	-6.51	-6.51
Minimum efficient size 1992	0.001	0.001	0.001	0.001	0.003***	0.003***	0.001***	0.001***
	1.06	1.09	1.05	1.07	5.33	5.41	5.37	5.37
Industrial employment growth	-0.386	-0.316	-0.387	-0.367	1.280***	1.306***	1.127***	1.127***
	-0.31	-0.26	-0.32	-0.30	3.39	4.02	3.93	3.93
Industrial Herfindahl-Index	1.486*	1.505**	1.484*	1.491**	-0.111	-0.096	-0.102	-0.102
	1.88	1.94	1.92	1.93	-1.27	-1.20	-1.27	-1.27
GDP growth (lag)	3.915***	3.986***	4.195***	4.088***	0.495	0.465	0.518	0.518
	3.30	3.39	3.59	3.50	0.91	0.86	0.94	0.94
Concentration-Index (specific industry)	-0.001				0.001			
	-0.26				0.14			
Concentration-Index (patents)		-0.004				-0.003***		
		-1.61				-2.52		
Concentration-Index (qualified human capital)			-0.003				-0.001	
			-1.09				-1.39	
Concentration-Index (R&D personnel)				-0.022				-0.009
				-1.43				-1.46
Significance	0.003	0.0004	0.001	0.001	0.001	0.001	0.001	0.001
Number of observations	1,042	1,042	1,042	1,042	4,299	4,299	4,299	4,299
R-squared	0.023	0.025	0.024	0.025	0.029	0.031	0.030	0.030

Note: ***p<=0.01; **p<=0.05; *p<=0.1; coefficients and t-values reported in the cells.

Table A-5
Specialisation determinants – OLS regression results for employment growth in knowledge-intensive industries (dependent variable: Birch-Index)

	Knowledge-intensive industries					
Explanatory variables	*9*	*10*	*11*	*12*	*13*	*14*
Firm size in 1992	-0.003 -0.78	-0.003 -0.76	-0.003 -0.76	-0.002 -0.74	-0.003 -0.76	-0.003 -0.74
Minimum efficient size	0.001 1.21	0.001 1.18	0.001 1.17	0.001 1.31	0.001 1.18	0.001 0.98
Industrial employment growth	-0.303 -0.25	-0.266 -0.22	-0.310 -0.26	-0.389 -0.32	-0.327 -0.27	-0.200 -0.17
Industrial Herfindahl-Index	1.526** 1.91	1.520**	1.517** 1.94	1.510** 1.94	1.556** 2.04	1.419* 1.84
KSI (all industries)	0.074 0.71					
KSI (patents)		-0.0716 -0.98				
KSI (qualified human capital)			0.090 0.84			
KSI (start-ups)				0.385* 1.88		
Location coefficient (specific industry, normalised)					0.022 0.63	
Location coefficient (start-ups specific industry, normalised)						0.109 1.58
Significance	0.050	0.047	0.018	0.024	0.041	0.052
Number of observations	1,042	1,042	1,042	1,042	1,042	1,042
R-squared	0.016	0.017	0.016	0.019	0.016	0.019

Note: ***p<=0.01; **p<=0.05; *p<=0.1; coefficients and t-values reported in the cells.

Table A-6
Specialisation determinants – OLS regression results for employment growth in non-knowledge-intensive industries (dependent variable: Birch-Index)

	Non-knowledge-intensive industries					
Explanatory variables	*9*	*10*	*11*	*12*	*13*	*14*
Firm size in 1992	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***
	-6.49	-6.56	-6.50	-6.47	-6.64	-6.52
Minimum efficient size	0.003***	0.001***	0.001***	0.001***	0.001***	0.001***
	5.40	5.36	5-38	5.35	5.38	5.29
Industrial employment growth	1.314***	1.281***	1.306***	1.293***	1.281***	1.305***
	4.01	3.94	4.00	3.97	3.94	4.00
Industrial Herfindahl-Index	-0.104	-0.102	-0.098	-0.107	-0.079	-0.136*
	-1.30	-1.27	-1.22	-1.34	-0.99	-1.67
KSI (all industries)	0.137***					
	3.26					
KSI (patents)		0.097***				
		3.07				
KSI (qualified human capital)			0.112***			
			2.52			
KSI (start-ups)				0.087		
				1.43		
Location coefficient (specific industry, normalised)					0.031***	
					2.54	
Location coefficient (start-ups specific industry, normalised)						0.045***
						2.52
Significance	0.001	0.001	0.001	0.001	0.001	0.001
Number of observations	4,299	4,299	4,299	4,299	4,299	4,299
R-squared	0.032	0.033	0.031	0.030	0.031	0.031

Note: ***p<=0.01; **p<=0.05; *p<=0.1; coefficients and t-values reported in the cells.

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