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## Persistence and change of regional new business formation in the national league table

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# 2016 – 001

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by

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## Persistence and Change of Regional New Business Formation in the National League Table<sup>1</sup>

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### Abstract

We investigate persistence and change of the levels of regional new business formation in West Germany over a period of thirty years. Our indicator is the position of a region in the national ranking. As indicated by previous studies, we generally find a rather high level of persistence and confirm the role of several sources of this persistence, namely, persistence in regional determinants of new business formation, distinct regional cultures of entrepreneurship, and path dependence in new business formation activity. There are, however, also a number of regions that have moved up or down in the national ranking by a considerable number of positions. We find that main factors that are related to such rank changes are R&D activities, industry diversity, and regional wage levels.

JEL classification: L26, R11, O11

Keywords: Entrepreneurship, new business formation, economic development, regional growth regimes

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## 1. Persistence and change of regional new business formation

Empirical studies have shown that the regional levels of new business formation tend to be rather persistent over time.<sup>2</sup> Moreover, even if the overall level of new business formation in a country undergoes significant changes, the relative positions of regions in a national ranking based on the level of entrepreneurial activity – the National Entrepreneurship League Table – tends to be rather stable (see particularly Fotopoulos and Storey 2015). The reasons for such high persistence of relative levels of regional entrepreneurship are still rather unclear.

This paper investigates sources of persistence and changes of new business formation in the regions of West Germany over a period of thirty years from 1976/77 up to 2006/07. To assess and analyze stability and changes of regional entrepreneurship activity, we use the position of regions in a national ranking with regard to the level of entrepreneurial activity—the National Entrepreneurship League Table. Rank positions have several advantages over continuous metrics such as self-employment rates or start-up rates in capturing persistence of entrepreneurship, especially if longer time periods are analyzed. One main advantage is that rank positions are not shaped by national trends or changes in the statistical reporting system that affects all regions in about the same way. Moreover, analyses of rank positions are not influenced by extreme cases ('outliers'). Finally, the level of entrepreneurial activity as compared to other regions can be regarded a valid assessment of the attractiveness of regions for entrepreneurial talent, investments and relocation of firms.

We deal with three main research questions. First, how persistent is a region's rank position with regard to its level of new business formation and are there any differences of persistence and change according to the rank position? Second, what are the reasons for persistence of rank positions over time? Third, what explains a major rise or decline in the

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<sup>2</sup> See Anderson and Koster (2011) for Sweden, Fotopoulos (2014) and Fotopoulos and Storey (2015) for the UK and Fritsch and Mueller (2007) as well as Fritsch and Wyrwich (2014) for Germany.

ranking? Persistence of regional levels of new business formation over time, as compared to other regions, may have important implications for the prospects of policy strategies that build on increasing the regional number of start-ups in order to stimulate growth. The results of our analysis may provide answers to the question of how far such a policy can succeed in the short and medium term. Moreover, identifying the main determinants of changes in regional levels of new business formation, as compared to other regions, we provide indications for appropriate starting points of a policy that aims at stimulating entrepreneurship.

While nearly all available studies of regional levels of entrepreneurship over longer time periods use changes of the stock of entrepreneurs (self-employment) as a measure of entrepreneurship, i.e. net entry, our analysis is based entirely on transitions into self-employment, i.e. gross entry.<sup>3</sup> We believe that gross entry is much better suited for analyzing the regional entrepreneurial activities for three reasons.

- *First*, as the number of entries and exits are quite often of similar size, changes in the stock of self-employment largely conceal changes in the gross flows. Because gross entries show greater variation over time than the respective net-changes in the stock of existing businesses, they are more sensitive to changes of entrepreneurial activity than net-entry.
- *Second*, the macroeconomic factors that influence exits out of self-employment may be quite different from the determinants of entry (see e.g. Caballero and Hammour 1994). Analyzing net-entry may, thus, confound these two groups of determinants such that the factors driving entry and exit cannot be clearly distinguished from one another.

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<sup>3</sup> Fotopoulos and Storey (2015), in their study of entrepreneurship in regions of the UK between 1921 and 2011, use self-employment rates. Fritsch and Wyrwich (2014) relate self-employment rates in the year 1925 to start-up rates in the period 1984 – 2006. Andersson and Koster (2011) and Fritsch and Mueller (2007) analyze the development of regional gross entry over time but for shorter time periods.

- *Third*, analyzing the gross influx of business founders into self-employment may provide better information about the dynamics of the economy. In this context it is often argued that increased entrepreneurial activities, in the sense of more new businesses, may considerably stimulate economic performance by exerting additional competitive pressure on incumbents by contesting established market positions (Nickell 1996; van Stel, Carree and Thurik 2005), or because they create new jobs. Since there are few indications of important positive effects of business closures on growth, an analysis of gross entry appears to be more relevant.

The remainder of the paper is organized as follows. Section 2 discusses several explanations for persistence and change of regional levels of entrepreneurship. Section 3 introduces data as well as the spatial framework of the analysis, and the following section (Section 4) gives an overview on regional new business formation in the observation period. We then describe and analyze the sources of persistence in the ranking of regions (Section 5) and try to identify those factors that may have caused changes in the ranking of regions (Section 6). The final section (Section 7) summarizes the results and concludes.

## **2. Sources of persistence of regional levels of entrepreneurship**

There are three types of reasons for persistence of the level of regional entrepreneurship and stability of its position in a national ranking. One of these explanations could be that the region's relative positions with regard to important determinants of entrepreneurial activity, such as the regional knowledge stock and the availability of resources, also remain largely unchanged. In an analysis for UK regions, Fotopoulos (2014) demonstrated that such durable and spatially 'sticky' regional characteristics (Andersson and Koster 2011) may explain a large part of the persistence of regional new business formation activity that can be observed.

A second reason may be the presence of a regional entrepreneurship culture that affects the level of new business formation. A regional entrepreneurial culture is described as a “positive collective programming of the mind” (Beugelsdijk 2007, 190) or an “aggregate psychological trait” (Freytag and Thurik 2007, 123) of the local population. A well-developed entrepreneurial culture may be characterized by a high level of social acceptance or “legitimacy” of entrepreneurship (Etzioni 1987; Kibler, Kautonen and Fink 2014) among the population that manifests in the acceptance of values such as individualism, independence, and achievement (e.g. McClelland 1961; Hofstede and McCrae 2008). Regions with a pronounced entrepreneurial culture should also have a high share of persons with pronounced entrepreneurial personality traits such as extraversion, openness to experience and conscientiousness, as well as with a high ability to bear risk (Rauch and Frese 2007; Zhao and Seibert 2006; Obschonka, Schmitt-Rodermund, Gosling and Silbereisen 2013). Generally, an entrepreneurship culture can be regarded as an informal institution that comprises norms, values, and codes of conduct (Baumol 1990; North 1994). Historical research provides many examples for informal institutions such as a culture changing only very slowly, much slower than the formal institutions or governance structures (e.g., North 1994; Williamson 2000; Nunn 2012).<sup>4</sup>

Analyzing the development of entrepreneurship in the regions of Germany from 1925 to 2005, Fritsch and Wyrwich (2014) show that a regional entrepreneurship culture can persist through even drastic changes of the socio-economic environment such as a devastating war and long decades of a socialist regime that undertakes severe efforts to extinct private sector economic initiative. Hence, a regional culture of entrepreneurship may also be regarded as a spatially sticky characteristic. In contrast to the determinants of new business formation, however, a

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<sup>4</sup> East Germany is a good example of the differences between formal and informal institutions. With the reunification of Germany in 1990, the ready-made West German framework of formal institutions became effective practically overnight. However, more than two decades later a specific East German mentality can still be identified.

culture of entrepreneurship should particularly shape the responsiveness of a region to these determinants.<sup>5</sup>

One of the transmission mechanisms of an entrepreneurial culture could be the well-documented transfer of positive entrepreneurial attitudes in the regional population across generations (Laspita et al. 2012). Moreover, a large number of self-employed persons in a region may reinforce a regional culture of entrepreneurship through demonstration and peer effects. Such role models provide a non-pecuniary externality that reduces ambiguity and influences the decision to pursue an entrepreneurial career (Minniti 2005). Furthermore, observing active entrepreneurs, especially successful ones, may increase social acceptance of entrepreneurship and self-confidence of people in regard to their ability to successfully set up an own business (Stuart and Sorenson 2003; Bosma et al. 2012; Kibler et al. 2014).

A third type of explanation for the persistence of high levels of regional entrepreneurship that may contribute to the persistence of a regional entrepreneurship culture is path dependency in the sense that current entrepreneurial activities can be regarded as a response to similar activities in a region's history (Martin and Sunley 2006). One type of such a path dependency could be that high levels of new business formation create additional entrepreneurial opportunities that induce further start-ups. Another type of path dependency may result from the observation that most new businesses remain rather small (Schinde and Weyh 2011) and that small firms are a fertile seedbed for future entrepreneurs (Parker 2009; Elfenbein, Hamilton and Zenger 2010).

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<sup>5</sup> In East Germany, there were considerable regional differences with regard to the response to the new entrepreneurial opportunities that occurred with the regime switch in the year 1990. Those regions that had a relatively high level of an entrepreneurial culture as indicated by the self-employment in the year 1925 reacted much stronger by having considerably higher start-up rates than those regions where the historical levels of self-employment were relatively low (for details see Fritsch and Wyrwich 2014).



### 3. Data and spatial framework of analysis

Our data on new business formation is obtained from the Establishment History File of the German Social Insurance Statistics. This dataset contains every establishment in Germany that employs at least one person obliged to pay social insurance contributions (Spengler 2008). Since each establishment is assigned a unique identification number, new establishments can be identified by newly emerging numbers. Since the statistics were introduced in the year 1975, the first year for which this information can be generated is 1976. For a more reliable identification of start-ups based on newly emerging establishment numbers we exploit a novel method that is based on workflow analyses (see Hethey and Schmieder 2010, for details). The start-up rate is the yearly number of new businesses in the private sector divided by the number of private-sector labor forces (in thousands).

In order to reduce the effect of short-term fluctuations of the start-up rate between subsequent years we base our analysis on two year averages. Hence, the start-up rate at the beginning of our period of analysis is the average start-up rate of the years 1976/77. While data on the establishment size distribution, qualification of workforce, R&D employment, regional wage levels<sup>6</sup> and sectoral structure is also obtained from the Social Insurance Statistics, other information is from the Statistical Offices and from further sources. The spatial framework of our analysis are the 71 planning regions<sup>7</sup> of West Germany<sup>8</sup>, which represent

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<sup>6</sup> Data on regional wage levels are taken from the Integrated Employment Biographies Sample of the Institute for Employment Research (IAB) at the Federal Employment Agency (see: [http://fdz.iab.de/en/FDZ\\_Individual\\_Data/Integrated\\_Employment\\_Biographies.aspx](http://fdz.iab.de/en/FDZ_Individual_Data/Integrated_Employment_Biographies.aspx)).

<sup>7</sup> We have also performed these analyses at the level of 326 West German districts where most of the results for planning regions are confirmed. Differences to the analyses at the level of planning regions mainly pertain to the stability of positions at the top as compared to the bottom of the ranking. The results of these analyses at the district level are available from the authors upon request.

<sup>8</sup> We restrict our analysis to West Germany because many empirical studies indicate that the East German economy in the 1990s was a special case with very specific conditions that cannot be directly compared to those of West Germany (Fritsch and Wyrwich 2014). There are actually 74 West German planning regions. For administrative reasons, the cities of Hamburg and Bremen are defined as planning regions even though they are not

functionally integrated spatial units comparable to labor market areas in the US.

#### **4. New business formation in West German regions**

Figure 1 shows the spatial distribution of start-up rates at the beginning and at the end of our period of analysis, 1976/77 and 2006/07. Regions with the highest rates of new business formation are rather scattered across the country. A number of these regions with relatively high start-up rates are located south of Munich, south of Cologne but also in the very north of the country. A brief visual inspection of the two figures suggests that many of those regions that have been characterized by relatively high (low) start-up rates in the years 1976/77 also have relatively high (low) start-up rates thirty years later. The categories of start-up rates in Figure 1 are based on the standard deviation distances from the mean values. When comparing the values for the 1976/77 period with those of the years 2006/07, 32 planning regions or 45 percent of all regions have retained their position within the same standard deviation distance from the mean start-up rate of the respective time period pointing to a rather pronounced persistence in levels of new business formation.

Figure 2 shows the distribution of start-up rates across planning regions for the years 1976/77, 1986/87, 1996/97 and 2006/07. Obviously, these distributions are close to the normal distribution but with a rather steep increase among the regions with low levels of new business formation and, particularly in the 1976/77 period, with a longer tail of regions with relatively high start-up rates. The mean and median values of the start-up rates for the different time periods differ over time but they do not indicate any trend towards more start-ups in West Germany with

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functional economic units (see Federal Office for Building and Regional Planning 2003). To avoid distortions, we merged these cities with adjacent planning regions. Hamburg has been merged with the region of Schleswig-Holstein South and Hamburg-Umland-South. Bremen has been merged with Bremen-Umland. Thus, the number of regions in our sample is 71.

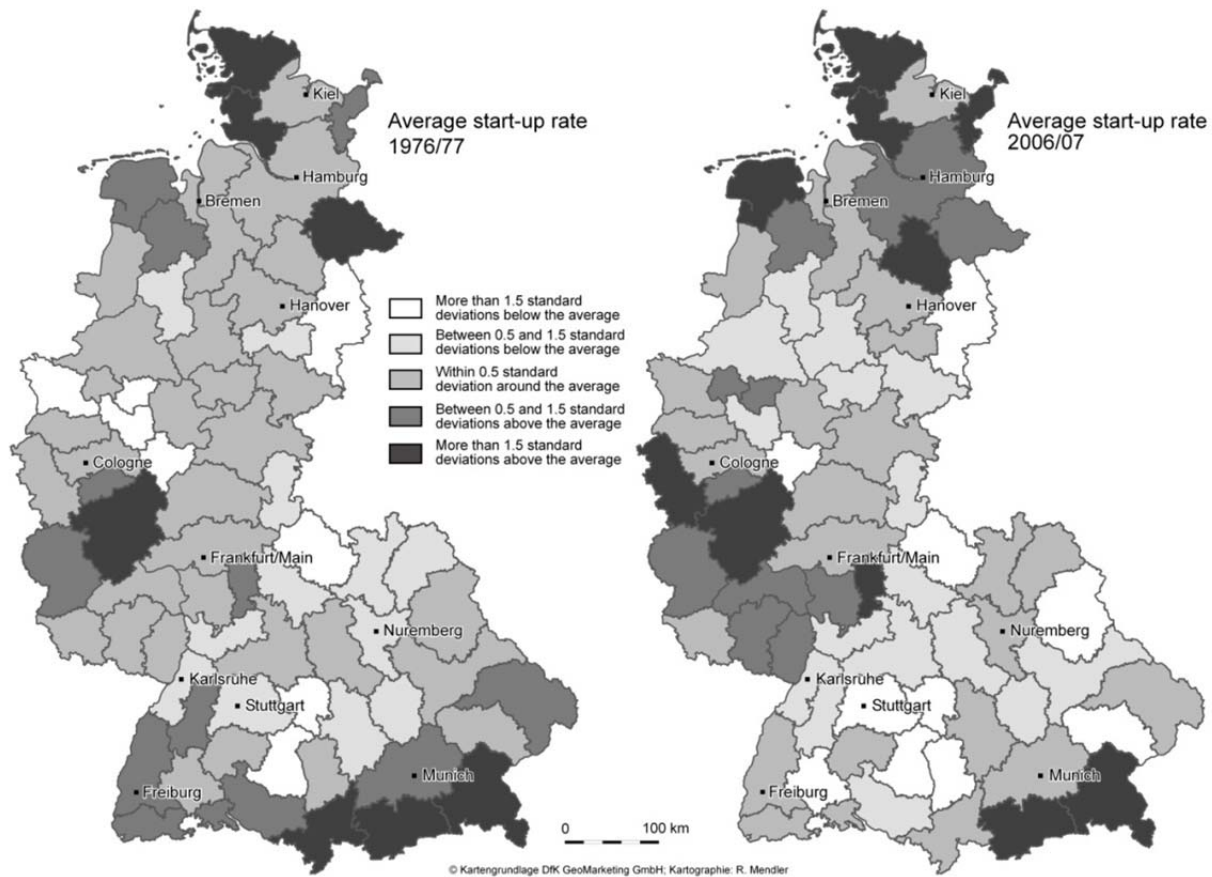


Figure 1: Regional distribution of start-up rates in West Germany 1976/77 and 2006/07

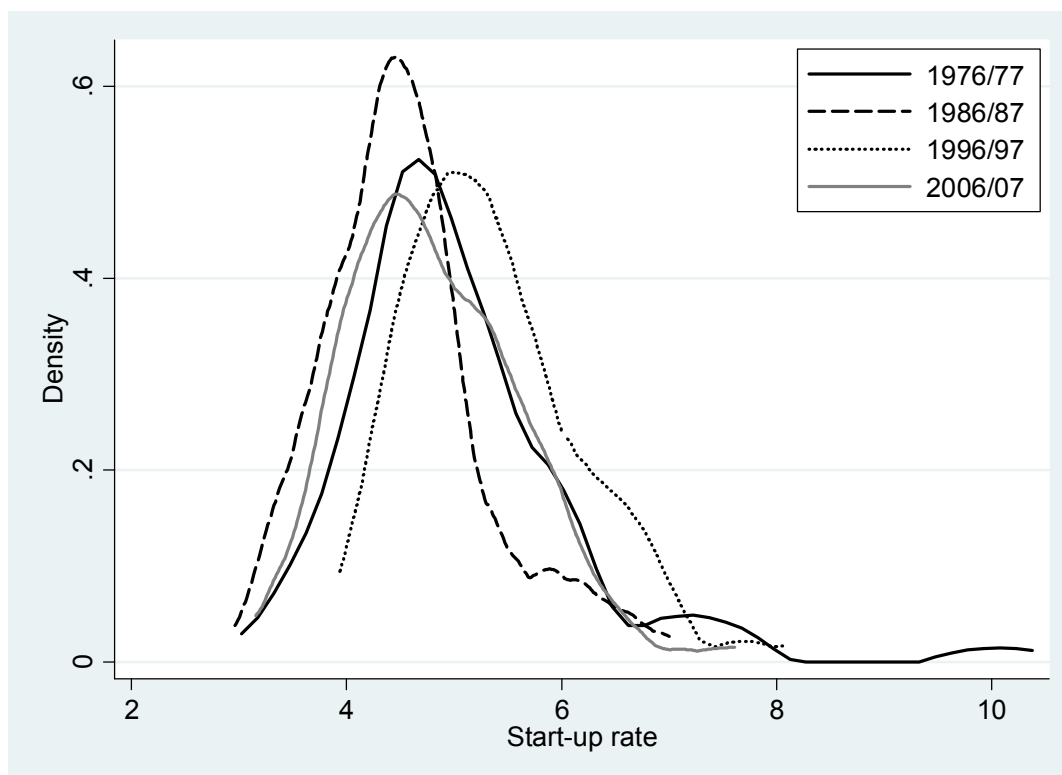


Figure 2: Distribution of regional start-up rates 1976/77, 1986/87, 1996/97 and 2006/07

regard to businesses with dependent employees (see Table A1 in the Appendix). This is consistent with a study by Fritsch, Kritikos and Sorgner (2015) that shows a rise of the number of businesses without any dependent employees (solo self-employed) that are not included in our data base but a constant level of self-employment with employees in the period 1991-2009.

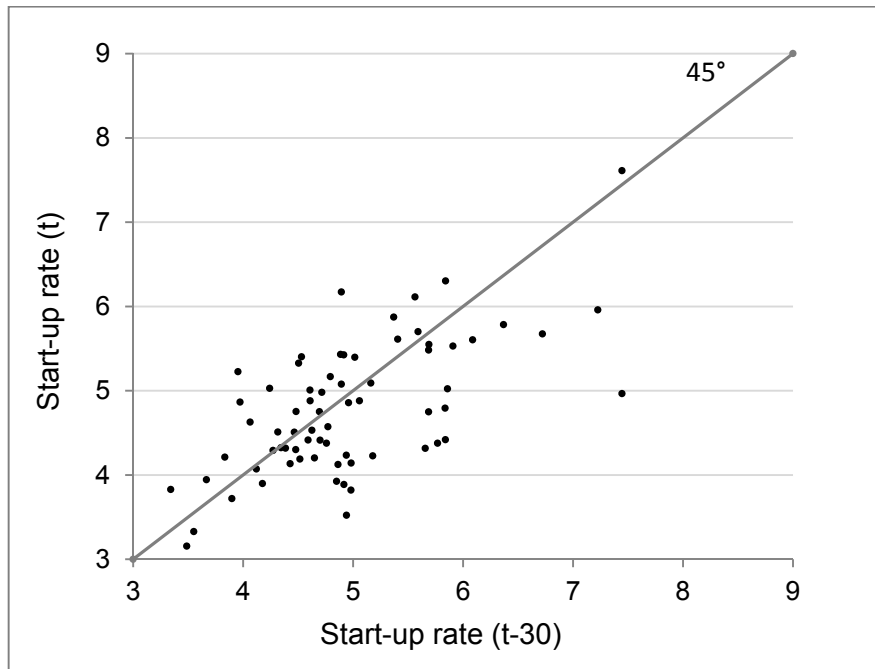
Looking at the shares of innovative manufacturing start-ups or new businesses in knowledge-intensive services, we do not find any statistical relationship with the overall level of new business formation. This means that regions with a relatively high or low start-up rate do not have remarkably high or low shares of new businesses in such innovative industries.

## 5. The national ranking of regions

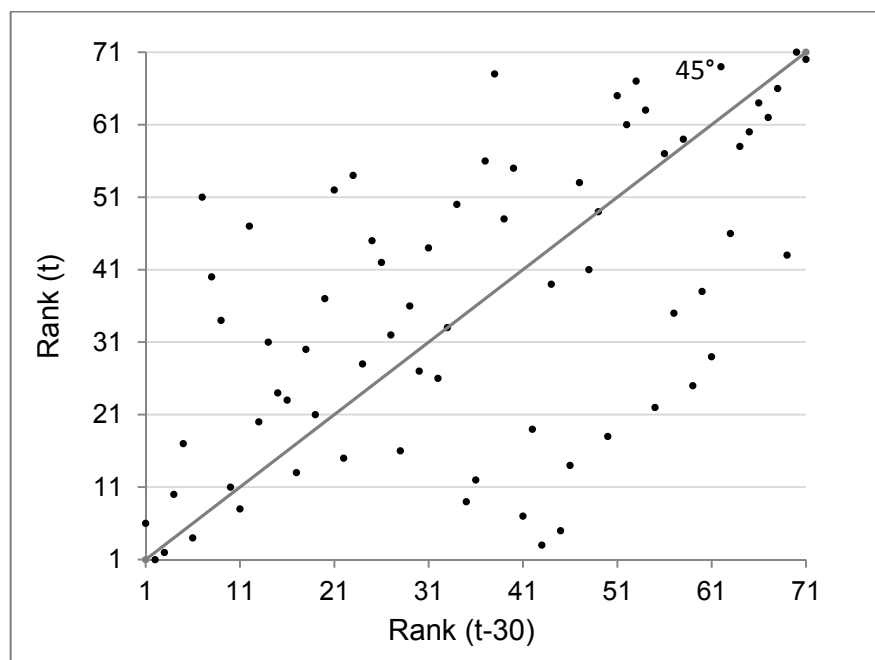
### 5.1 Persistence and change of rank positions

To assess and to analyze stability and changes of regional entrepreneurship activity, we take the positions of regions in the national ranking with regard to the level of new business formation (National Entrepreneurship League Table). Table A2 in the Appendix presents this ranking of West German regions for the years 1976/77 and 2006/07. The ranking comprises 71 planning regions ordered according to the rates of new business formation at the beginning of the observation period. As already mentioned (Section 1), rank positions have several advantages over metrics such as start-up rates in capturing persistence of a phenomenon like new business formation, especially if longer time periods are analyzed.

Figure 3 shows the variation of rank positions and start-up rates in the initial and the final years of our analysis. While the start-up rates appear to be slightly decreasing in planning regions with an above average level of new business formation in the initial period, the comparison of the rank positions indicates a tendency to keep the same rank levels. There are, however, quite a number of regions that change their rank positions over such a long period of time. The Pearson correlation coefficient between regional start-up rates in the first years (1976/77) and in the final year (2006/07) of our observation period is 0.657 (statistically significant at the 1 percent level) indicating a high degree of persistence. The Spearman rank correlation coefficient of 0.580 (statistically significant at the 1 percent level) is somewhat lower. These rather high values of the correlation coefficients clearly indicate that regions with relatively high (low) start-up rates in one period are very likely to have a correspondingly high (low) start-up rate in later periods. This also means that rank positions show a higher level of variation and may, therefore, be a more sensitive indicator for changes of the entrepreneurial character of regions over time.



(a)



(b)

Figure 3: Relationship between start-up rates (a) and ranks (b) at the beginning (1976/77) and at the end (2006/07) of the observation period

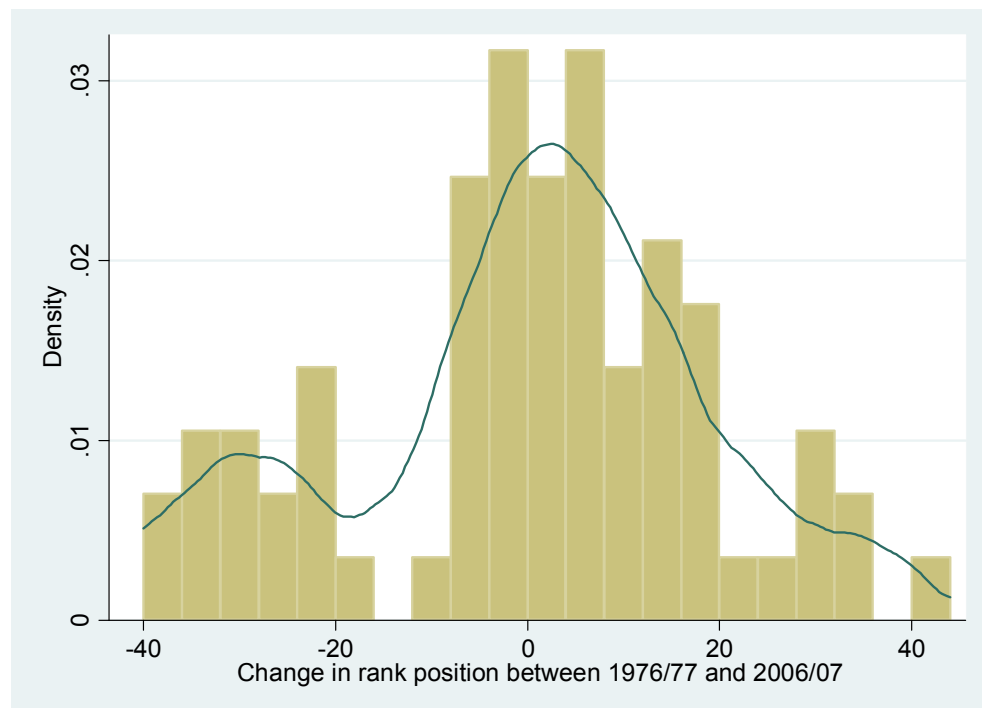


Figure 4: Distribution of changes in rank positions between 1976/77 and 2006/07

Figure 4 displays the distribution of the changes in the rank positions between 1976/77 and 2006/07. While 22 regions (about 31 percent of all regions) have not changed their rank by more than five positions, there are also quite a number of regions that climbed up or moved down the ranking by more than 20 positions. The distribution of the rank changes is close to a normal distribution with a mean of zero pointing to the high probability of maintaining the same rank even over a period of thirty years. However, the distribution possesses fat tail features at both ends of the distribution due to quite a considerable number of regions that have climbed up or moved down by more than 20 positions.

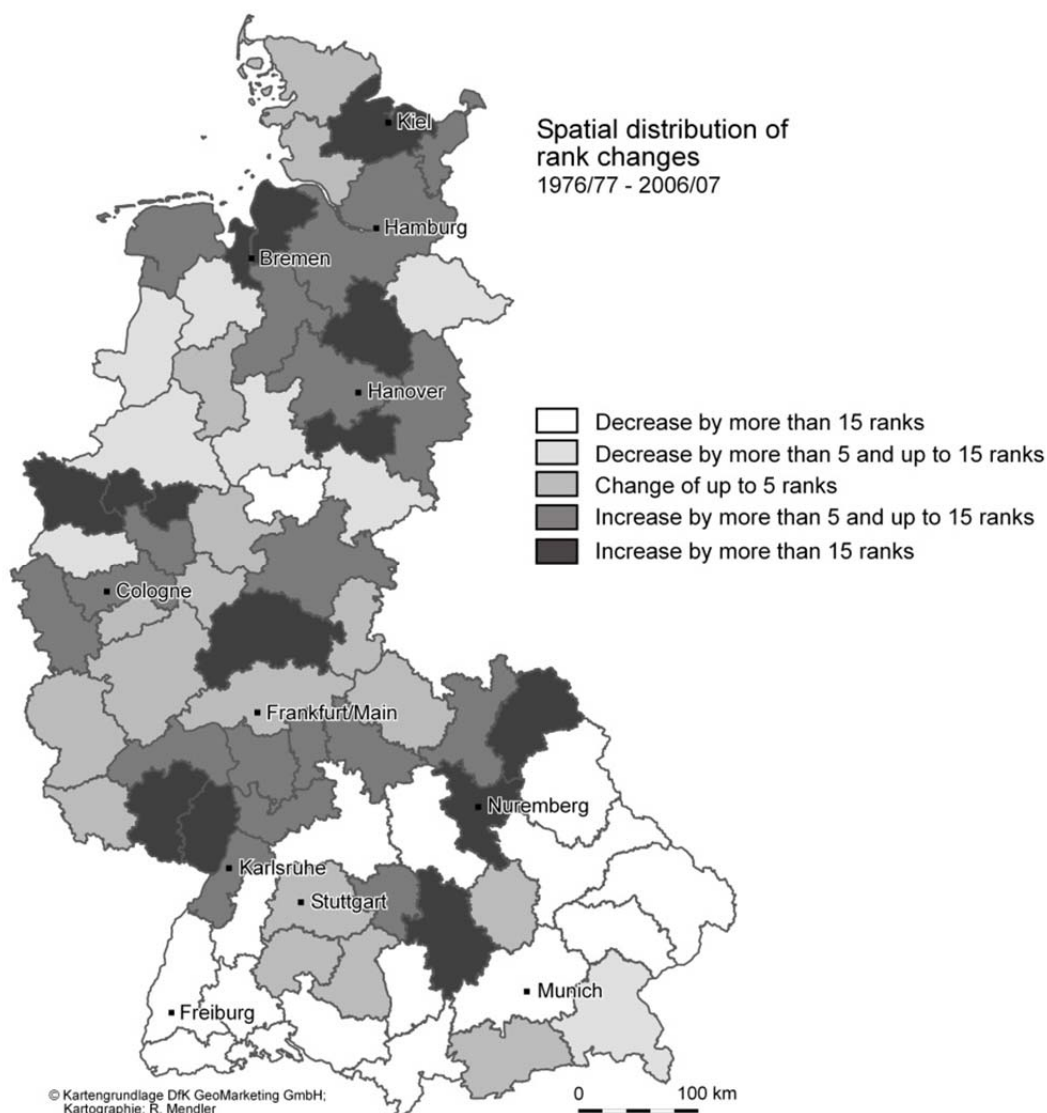


Figure 5: The spatial distribution of rank changes in West Germany 1976/77 - 2006/07

Figure 5 shows the spatial distribution of the rank changes in the ranking of West German regions between 1976/77 and 2006/07. We distinguish five categories of changes: “≈ 0” (-4 to 4 positions); “+” (5 to 15 positions); “++” (more than 15 positions); “-” (-5 to -15 positions); “--” (more than -15 positions). That adjacent regions are often assigned to the same category of positional change suggests the presence of neighborhood effects in the sense that many adjacent regions show the same tendency of persistence or change. Nearly all of the regions that have decreased in the ranking by more than 15 positions are located in the South. There are



also some regions in the South located close by that have considerably increased their ranks such as Augsburg, Central Franconia and Upper Franconia-East. Other regions that have increased by more than 15 rank positions are scattered across the central and northern parts of the country.

## **5.2 Determinants of persistence**

This Section tries to identify those factors that may be responsible for the persistence of a region's position in the national ranking according to the level of new business formation. In particular, we investigate how much the three potential sources of persistence that we have outlined in Section 2 apply. Section 5.2.1 deals with the invariance of the regional determinants of start-up activity, Section 5.2.2 tests for the effect of a regional culture of entrepreneurship and for indications of path dependency.

### **5.2.1 Persistence of the determinants of entry**

Andersson and Koster (2011) and particularly Fotopoulos (2014) have argued that main region-specific determinants of regional start-up activity may be rather stable over time leading to the persistence of the resulting levels of new business formation. A first assessment of the stability of regional determinants of new business formation over time can be based on correlations of the respective indicators at the beginning of the period of analysis and in the final year. Important determinants of the level of start-up activity at the regional level that have been identified in the literature are the share of small firm employees, the level of private sector R&D activities, the sectoral structure, regional wage levels as well as population density<sup>9</sup> (see Fotopoulos 2014, Fritsch and Falck 2007, Ghatak et al. 2007, Verheul et al. 2002). For a more detailed discussion of these determinants and indicators see Section 6.1.

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<sup>9</sup> Population density is a catch-all variable for a number of region-specific characteristics such as thickness of regional input markets, the regional wage level, qualification of the regional workforce, regional level of demand, etc.

Table 1: Correlations between determinants of new business formation in years 1976 and 2006

Indicator	Correlation between indicators in 1976 and 2006
Share of private sector R&D employment	0.81
Employment share of small businesses	0.88
Level of entrepreneurial culture (self-employment rate)	0.86
Level of industry diversity	0.44
Related variety	0.72
Unrelated variety	0.66
Regional wage levels	0.71
Share of manufacture employment	0.85
Population density (log)	0.99

*Note:* All correlation coefficients are statistically significant at the 1 % level.

Table 1 shows the correlation coefficients for determinants of the level of start-up activity at the regional level in the first and the final year of the period of our analysis (1976 and 2006). The high correlation coefficients between these indicators in the two years clearly indicate rather high levels of stability. As a second test for the stability of important regional determinants of new business formation as a source of persistence we estimate multivariate models with the regional start-up rate as the dependent variable. Table 2 shows the results of two models. Model I regresses the start-up rate of the period 2006/7 on the values of the explanatory variable of the year 2006. Model II tries to explain the start-up rate of the period 2006/7 with the values of the independent variables thirty years earlier in the year 1976. Both models show rather similar results for the employment share in small businesses, for indicators of diversity and variety, regional wage levels, and for population density. The main differences can be found for the share of private sector R&D

Table 2: Regressions for explaining new business formation 2006/07 with regional characteristic 2006 (Model I) and 1976 (Model II)

<i>Indicator</i>	Model I		Model II	
	Model Ia	Model Ib	Model IIa	Model IIb
Share of private sector R&D employment	13.56 (10.39)	8.97 (10.83)	60.21** (25.03)	62.08** (24.39)
Employment share of small businesses	13.99*** (1.58)	14.38*** (1.53)	15.31*** (2.45)	15.01*** (2.36)
Level of industry diversity	-1.42 (2.39)	-	-0.47 (2.24)	-
Related variety	-	-1.13* (0.51)	-	-0.86* (0.47)
Unrelated variety	-	0.00 (0.35)	-	-0.30 (0.36)
Regional wage level	0.00 (0.02)	0.00 (0.02)	-0.02 (0.03)	-0.04 (0.03)
Share of manufacturing employment	-1.35* (0.79)	-1.81** (0.78)	1.15 (1.32)	0.40 (1.32)
Population density (log)	0.52*** (0.14)	0.60*** (0.14)	0.87*** (0.18)	0.96*** (0.18)
Constant	-0.61 (3.03)	-0.52 (2.37)	-1.99 (3.40)	0.88 (3.24)
Federal State dummies	Yes**	Yes**	Yes***	Yes**
Number of observations	71	71	71	71
R2	0.85	0.87	0.75	0.77
Variance inflation factor (vif)	2.69	2.63	2.71	2.70

*Notes:* Dependent variable: Start-up rate in 2006/07; Independent variables: in Model I from year 2006, in Model II from year 1976; Standard errors in parentheses; \*: statistically significant at the 10 percent level; \*\*: statistically significant at the 5 percent level; \*\*\*: statistically significant at the 1 percent level.

employees and for the share of manufacturing employment. In particular, the share of explained variation, as represented by the  $R^2$  values in Model II where the independent variables are for the year 1976, are not much smaller as compared to Model I that is based on the values of the year 2006 (0.75 and 0.77 as compared to 0.85 and 0.87). We conclude that a considerable part of the persistence of regional levels of new business formation may be explained by stability of important regional determinants of start-ups. Given that many new businesses remain rather small (Schindele and Weyh 2011) and that small firms tend to act as a seedbed for new business formation (Parker 2009), the high persistence of the

employment share of small businesses and its highly significant effect on the start-up rate in later years can be regarded an indication of path dependence.

### **5.2.2 Regional culture of entrepreneurship and path dependence**

Having demonstrated the stability of important determinants of regional new business formation over time the question arises of how far a regional culture of entrepreneurship can contribute to a further explanation of the observed persistence in rank positions. Anderson and Koster (2011) and Fritsch and Wyrwich (2014) find that the level of persistence of regional entrepreneurial activity is particularly pronounced for regions with relatively high start-up or self-employment rates. As an explanation for this result these authors argue that a regional culture of entrepreneurship requires a certain threshold level in order to be effective. This would imply that regions at the top of the rank distribution show higher levels of persistence than regions at the bottom. Another reason to expect differences with regard to changes of the rank position according to the initial position in the national ranking is that having a top (bottom) position limits the potential of moving further upwards (downwards). Hence, one might expect lower levels of change at the upper and the lower end of the distribution.

In order to shed more light on the role of the initial position in the national ranking on positional changes, we divide the sample of regions into seven groups of about ten regions, each according to their initial position in the ranking, and calculate the probability that a region will remain in the same rank segment after 30 years. The results are shown in Figure 6. In line with Andersson and Koster (2011) we find the highest level of persistence at the top and at the bottom of the distribution with the highest probability to remain in the same segment for those regions that make the top ten (rank 61-71). Regions at the very middle of the

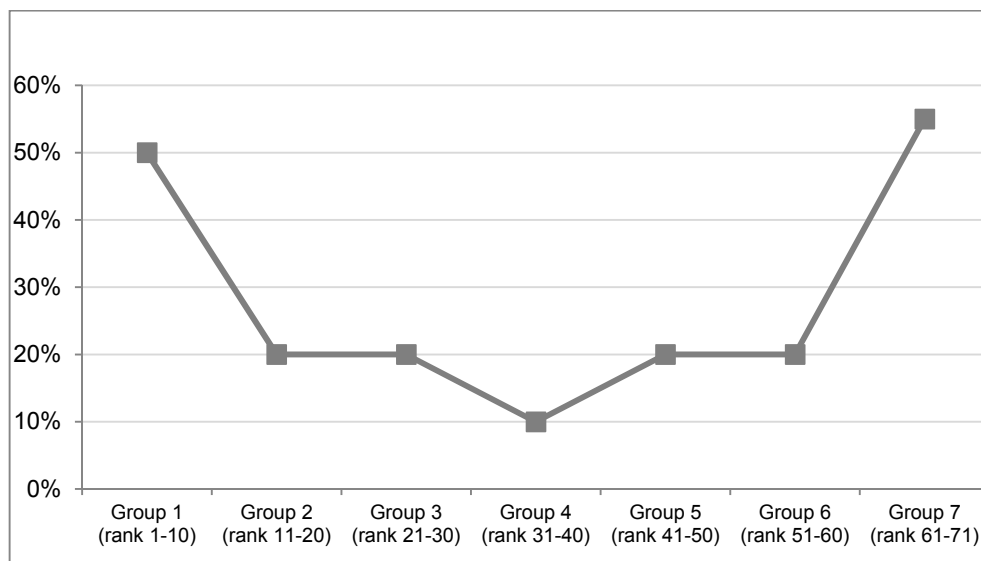


Figure 6: Probability of persistence in different segments of the ranking

Table 3: Change between final and initial rank positions as well as of start-up rates in different segments of the national ranking over the period of analysis (1976/77 – 2006/07)

Rank level	<i>In absolute values</i>			<i>In real values</i>		
	Average change in rank positions	Average change in start-up rate	Relative change in the start-up rate	Average change in rank positions	Average change in start-up rate	Relative change in the start-up rate
Group 1 (ranks 01-10)	12.90	0.47	0.12	12.10	0.31	0.08
Group 2 (ranks 11-20)	11.30	0.21	0.05	9.90	0.05	0.01
Group 3 (ranks 21-30)	13.60	0.38	0.08	9.20	0.11	0.02
Group 4 (ranks 31-40)	15.80	0.54	0.11	4.60	0.09	0.02
Group 5 (ranks 41-50)	21.90	0.68	0.14	-20.70	-0.61	-0.12
Group 6 (ranks 51-60)	15.90	0.64	0.11	-6.30	-0.37	-0.06
Group 7 (ranks 61-71)	9.45	1.15	0.16	-8.00	-1.03	-0.14

Notes: Relative change is expressed relative to the initial start-up rate

distribution (ranks 31-40) have the lowest probability to remain in the same segment, i.e., these regions are most likely to change their position in the ranking.

A possible critique of this type of assessment could, however, be that the density of regions in the center of the start-up rate distribution is

relatively high (see Figure 2). Hence, a relatively small change of the start-up rate in a region in the center of the distribution may lead to a change of many ranks while the same absolute change of the start-up rate at the top or at the bottom of the distribution results in changes by fewer positions. This could make the finding that rank mobility is most pronounced at the center of the distribution rather trivial. To further investigate this issue we calculate changes of the start-up rate that are necessary to change by one rank position within the particular group (Table 3). We find that the average as well as relative change of the start-up rate is of rather similar magnitude in groups 2-6 while relatively high changes of the start-up rate are necessary for a rank change at the bottom and at the top of the distribution. Looking at the absolute changes of rank positions within the groups over the period of analysis, we find the smallest average absolute change at the very top level, namely in the group that comprises ranks 61-71. This higher persistence level at higher rank levels could be regarded an indication of higher persistence of regional new business formation in the highly ranked regions implying that a regional culture of entrepreneurship has to reach a certain threshold level in order to become effective.

The pronounced variation of the absolute changes of the start-up rates indicates that the changes in the level of new business formation differ according to the initial position in the national ranking. These changes are considerably higher in the group with the highest ranks. Remarkably, the changes of the start-up rates in this group are much higher than for the regions at the lower end of the ranking (1.15 as compared to 0.47). This may mean that regions at the top level of the ranking are more responsive to changes in their economic environment than regions at the bottom which would be consistent with the hypothesis that the relatively high start-up rates in these regions are partly an effect of a pronounced entrepreneurial culture.

Table 4: Strength of regional persistence at different rank levels

Sample	Coefficient (Regressing rank 2006/07 on 1976/77, OLS)	R <sup>2</sup>	Number of observations
<i>Full sample</i>	0.58***	0.34	71
Top half (from position 36 upwards)	0.30***	0.29	36
Bottom half (up to position 35)	0.16	0.08	35
Top 25 positions	0.29***	0.50	25
Bottom 25 positions	0.13	0.10	25
Top 20 positions	0.25***	0.40	20
Bottom 20 positions	0.09	0.07	20
Top 10 positions	0.04	0.02	10
Bottom 10 positions	0.02	0.02	10
Middle positions (ranks 26-46)	0.09	0.07	21
Middle positions (ranks 31-41)	0.06	0.10	11

Notes: \*\*\*: statistically significant at the 1 percent level; \*\*: statistically significant at the 5 percent level; \*: statistically significant at the 10 percent level.

To further investigate the persistence at different positions of the rank distribution, we regress a region's final rank position on its initial rank at the outset of the period of analysis. We find that the effect of the rank position in the initial period is only statistically significant in explaining relatively high positions in the national ranking (see Table 4). The positive signs of the respective coefficients clearly indicate that regions in the top half of the rank distribution show a pronounced tendency to have a relatively high rank position even 30 years later. According to the values of the R<sup>2</sup>, a relatively high initial rank position can explain up to 0.3 percent of the variation in the final rank position. There is no significant effect of the initial rank positions in the lower half of the distribution. The non-significance of the coefficient for an initial position among the top and the bottom ten positions is probably due to rather small numbers of observations. These results clearly confirm the conjecture that a regional

culture of entrepreneurship requires a certain threshold level in order to become effective.

Table 5: Wilcoxon tests for differences of rank positions between 1976/ and 2006/07

Sample	Wilcoxon test for mean comparison	Number of observations
Top half (from position 36 upwards)	**	36
Bottom half (up to position 35)	**	35
Top 25 positions	**	25
Bottom 25 positions	**	25
Top 20 positions	n.s.	20
Bottom 20 positions	***	20
Top 10 positions	n.s.	10
Bottom 10 positions	**	10
Middle positions (ranks 26-46)	n.s.	21
Middle positions (ranks 31-41)	n.s.	11

Notes:  $H_0$  = rank positions are significantly different; \*\*\*: statistically significant at the 1 percent level; \*\*: statistically significant at the 5 percent level; \*: statistically significant at the 10 percent level.

As a further analysis of the effect of the initial position in the national ranking for subsequent changes we performed Wilcoxon tests for differences of rank positions between 1976/77 and 2006/07. Since this test procedure assumes an ordinal ranking of the variables, it is particularly appropriate for analyzing changes of rank positions. Moreover, as a non-parametric test, it does not require a normal distribution of variables and a constant variance as is the case with OLS regressions (Randles 2006). The Wilcoxon test indicates mobility in the rank position so that non-significance suggests persistence. The results for different top and bottom rank levels shown in Table 5 point again to persistence among the higher positions of the ranking and to significant mobility in the lower part. While the results of the OLS regression for the top and bottom ten positions have



been insignificant (Table 4), the Wilcoxon test indicates persistence for the ten regions at the top of the national ranking and non-persistence for the ten regions at the bottom.

Altogether, the analyses in this section confirm the relevance of several possible determinants of persistence in regional new business formation. Results show high persistence of the determinants of entry, pronounced path dependence in regional new firm formation and they are also consistent with the notion of Andersson and Koster (2011) and Fritsch and Wyrwich (2014) that the level of entrepreneurship has to reach a certain threshold level in order to constitute a regional culture of entrepreneurship that persists over longer periods of time.

## **6. Changing places – who and why?**

### **6.1 Hypotheses and indicators**

While there are many empirical investigations into the determinants of regional levels of new business formation (for an overview, see Sternberg 2011; Fritsch and Storey 2014) those factors that cause changes of these levels are largely unexplored. The very few analyses of the factors that lead to changes of regional start-up rates (Fritsch and Mueller 2007; Fotopoulos 2014) suggest that many of the variables that influence the level of new business formation activity in a region also have an effect on the change of entrepreneurial activity. Fritsch and Mueller (2007), in an analysis for West Germany, find a significantly positive effect of the share as well as of the changes in the number of R&D employees on an increase of new business formation activity. While such a positive effect was also identified for the share of employees in small and young firms, as well as for labor productivity, the effect of population density was significantly negative. They conclude that, “the main factors that lead to an increase in start-up activity are regional innovativeness and the already existing level of entrepreneurship” (Fritsch and Mueller 2007, 310). Factors on the demand side of the regional economy, such as regional GDP growth, did not prove to be statistically significant.

Table 6: Description of independent variables included in the empirical analysis and expected effects

Hypotheses	Indicators and measurement	Expected effect
Regional knowledge base and innovation potential	Share of R&D employees in private sector employment	+
Regional industry structure	Share of employment in establishments with < 20 employees (excluding employment in start-ups)	+
Diversity of the industry structure	Regional industry diversity index (according to Theil, 1972)	+
	Related and unrelated diversity: entropy measure of employment across industries (3 digit within 2 digit classification)	?
General regional conditions for entrepreneurship	Self-employment rate	+
Regional wage level	Median full-time equivalent regional wage level	-
Share of manufacturing employment	Employment share of employees in the manufacturing sector	+
Controls	Population per km <sup>2</sup> ; dummies for Federal States; initial rank position; dummies for top/bottom 10 ranks	

Notes: All explanatory variables are measured at the initial year of the analysis (1976/77) and as a change in variables between final (2006/07) and initial (1976/77) years.

Based on the results of previous studies, we include the following variables into our analysis of the factors that might explain changing rank positions with regard to the level of new business formation (see Table 6 for an overview).

- *Regional knowledge base and innovation potential*: According to the knowledge-spillover theory of entrepreneurship (Acs, Audretsch and Lehmann 2013), the size and the quality of the regional knowledge base can have a positive effect on the number of start-ups: particularly on the emergence of those innovative start-ups that constitute a challenge for incumbent firms. Hence, entrepreneurship can be regarded an important element of the regional innovation system (Qian, Acs and Stough 2013). We identify the regional knowledge base and innovation potential by the share of private sector R&D employment. An alternative proxy would be the general qualification level of the workforce measured by the share of private sector employees having

tertiary education. Due to the high correlation between both measures, we chose R&D employment to capture not just the effects of knowledge intensity but also the regional innovation potential. We expect that a high share of R&D employment is positively related to a region's ability to hold or to increase its position in the national ranking.

- *Regional industry structure:* To assess the effect of the regional industry structure on the level of entrepreneurship, we apply several indicators that could capture industry structure and its change. One of the characteristics of regional industry structure that can have an effect on knowledge exploitation through start-ups is the minimum efficient size of the regional industries. Regions that have high shares of industries with low minimum efficient size should also experience relatively high levels of new business formation (Fritsch and Falck 2007). Another reason why the presence of small scale industries should be conducive for new business formation is the relatively high propensity of small firm employees to start an own firm that is well documented by empirical research (Parker 2009; Elfenbein, Hamilton and Zenger 2010). Based on these findings, we expect the high employment share in small businesses to be positively related to the probability of an increase in the rank positions. Our measurement for the presence of small scale industries is the share of private sector employment in establishments with less than 20 employees over the total private sector employment. In order to reduce the statistical relationship with the start-up rate that determines the rank position, we exclude the employment in the start-ups of the current year.
- *Diversity of the industry structure:* Another factor that may have an effect on regional performance is the concentration or diversity of the industry structure (Noseleit 2013). The empirical evidence in this respect is, however, rather diverse. Boschma and Frenken (2011) argue that it is not industry diversity per se but the related variety of similar or complementary industries that has positive effects. It has been shown that new business formation can make an important contribution to the emergence of such related variety (Neffke, Henning

and Boschma 2011). We estimate the overall level of industry diversity and expect it to be positively related to the probability of an increase of a region's position in the national ranking. Our measure for the overall level of industry diversity is based on an entropy measure as used by Fotopoulos (2014). In general, the value of an entropy measure increases with higher evenness of the distribution of employment shares across industry sectors. The measure can be constructed in a way that it varies between 0 and 1, with 0 indicating the presence of only one industry in the region and 1 representing a situation where all industries employ an equal number of employees. To distinguish further between related and unrelated variety we adopt the methodology of Frenken, van Oort and Verburg (2007). Unrelated variety of a region is calculated by the entropy at the two-digit level; related variety is calculated by the weighted sum of entropy at the three-digit level within each two-digit class.

- *General regional conditions for entrepreneurship*: Relatively high and increasing start-up rates can be seen as an indication for favorable conditions for entrepreneurship. This may include easy accessibility of inputs such as labor and finance, an entrepreneurial climate that is characterized by a positive attitude of the population towards self-employment (Kibler, Kautonen and Fink 2014; Westlund, Larsson and Olsson 2014), as well as a large number of entrepreneurial role models (Bosma et al. 2012). Thus, we expect high shares of self-employed persons especially in regions that have managed to increase their rank position.
- *Regional wage level*: The theory of occupational choice (Knight 1921; Lucas 1978) highlights the role of the wage level for the decision to be in dependent employment or in self-employment. Accordingly, people tend to choose dependent employment if wage levels, as compared to expected incomes in self-employment, are relatively high, and they have a high propensity to start their own business if wages are comparatively low. Distinguishing between entrepreneurs of different quality, rising wages in a region may drive low quality entrepreneurs out

of the market resulting in an improved average quality of entrepreneurs and in an increase of the average returns to entrepreneurship (Ghatak, Morelli and Sjöström 2007). Moreover, since larger firms tend to pay higher wages (Parker 2009), high wage levels in a region could also imply that the labor market is dominated by large firms that discourage entrepreneurship (Nordas 2004). To account for the impact of wages on the propensity for self-employment we include the regional wage level. The regional wage level is measured by the median value of the full-time equivalent regional wage expressed in the prices of 2005.

*Population density* is included as a catch-all variable of various regional characteristics such as housing and land prices, availability of infrastructure and other inputs, etc. The *share of employment in manufacturing* controls for the industry structure and particularly indicates the portion of those industries that tend to have relatively low entry rates due to high minimum efficient size. Moreover, this measure can be regarded an indication of the regional position in the general trend towards an increasing share of the service sector (*Petty's law*) where entry rates tend to be considerably higher than in manufacturing. One might expect that such a shift towards the service sector leads to an increase of new business formation. Since regions with a high share of manufacturing employment in the initial period (1976/77) have a relatively high potential for increasing their share of service sector activities, we expect that this variable may be related to an increasing start-up rate and a rise in the national ranking. To capture effects of different political conditions, we include *dummies for the Federal State* that a region belongs to.<sup>10</sup>

We control for a region's position in the national ranking at the outset of our period of analysis since this initial position may have a significant effect on the magnitude of rank changes. Finally, we also test for the effect of changes in the possible determinants of new business formation activity over the period of analysis.

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<sup>10</sup> Federal States in Germany are an important level of policy making.

## 6.2 Methodology and model specification

The rank changes in the national ranking that we observe over a period of 30 years range from minus 40 to plus 44. One way of transforming this information into a dependent variable would be to categorize the regions according to the change of rank positions and to apply an ordered probit analysis. One could, for example, form three categories such as the decrease of more than one standard deviation (value = 1), the change within one standard deviation (value = 2) and the increase of more than one standard deviation (value = 3). We follow, however, the approach of Fotopoulos and Storey (2015) and calculate a Rank Mobility Index (RMI) in the following way

$$RMI = \frac{RANK_t - RANK_{t-30}}{n-1}$$

The numerator of the index represents the change in the rank position over the period of analysis, and the denominator adjusts the change by the number of observations ( $n = 71$ ) minus 1 to restrict the index to the  $[-1, 1]$  interval. The RMI standardizes the rank change variable to account for the large variation in absolute values of rank changes. While the actual rank change in this study varies from -40 up to +44 rank positions, the RMI converts these rank changes into the interval from -0.57 to + 0.63. A value of zero indicates no change in the ranking of regions over the period of analysis. The advantage of this form of dependent variable, as compared to a categorization of rank changes, is that one can use the full information about the numbers of ranks that increased or decreased. From a pragmatic perspective, rescaling the rank change variable to the RMI makes it comparable in terms of magnitude to the explanatory variables that are all expressed as shares or indices.

Since the values of the dependent variable are restricted to the interval of -1 to +1, Tobit regression would be the most appropriate estimation procedure for this model (Greene 2008). However, for reasons of simplicity, we present the results of OLS estimations here that lead to about identical results. For Tobit estimates of the main models see Table A7 in the Appendix. Table A3 in the Appendix provides descriptive

statistics for the variables used in the empirical analysis, and Table A4 informs about correlations among these variables.

### **6.3 Results of multivariate analyses**

Table 7 shows the results of models for explaining the change in the regional positions in the national ranking with the initial regional characteristics and with the changes of these variables as independent variables. In these models we use the initial rank position as a control variable; models with dummies belonging to the top/bottom 10 positions show similar results (see Table A6). Models I and III contain the levels of the indicators for the first year of the period of analysis as well as the changes of these levels until the end year. Models II, IV, and V are run for the changes only. We do not include the indicators for the employment share in small businesses and the self-employment rate in the same model due to the high correlation between these variables. For the same reason, we also test the effect of the overall variety and unrelated variety in separate models (for models with related and unrelated variety see Table A5 in the Appendix).

Although we do not find an effect of the level of the regional knowledge base as measured by the regional share of R&D employment on rank mobility (models I and III), there is a positive and statistically significant effect of the change in R&D employment. Increasing R&D activities go together with a higher position in the national ranking. The share of small business employment in the base year is statistically significant with a positive sign (model I). The respective changes rate is only significant at the 10 % level if the level is excluded (model II). Interestingly, not the level of industry diversity but the change of that level proves to be statistically significant for an increase of new business formation and the position in the national ranking. Testing for different forms of industry variety, the results suggest that it is particularly an increase in the unrelated variety that has a significantly positive effect on

Table 7: Determinants of changes in rank positions

<i>Indicator</i>	I	II	III	IV	V
Share of private sector R&D employment	8.75 (10.77)	-	6.57 (11.02)	-	-
Change in private sector R&D employment	0.07** (0.03)	0.06** (0.03)	0.07** (0.03)	0.07** (0.03)	0.05* (0.03)
Employment share of small businesses	2.56** (1.27)	-	-	-	-
Change in employment share of small businesses	2.16 (1.40)	2.35* (1.35)	-	-	-
Level of industry diversity	0.82 (1.18)	-	0.66 (1.18)	-	-
Change in level of industry diversity	3.92** (1.50)	2.00** (0.91)	3.81** (1.59)	1.82** (0.86)	2.60*** (0.85)
Level of self-employment rate	-	-	5.24 (4.26)	-	-
Change of the self-employment rate	-	-	6.85 (4.69)	10.66*** (4.07)	-
Regional wage level	0.00 (0.01)	-	0.00 (0.01)	-	-
Change in the regional wage level	-0.02** (0.01)	-0.03*** (0.01)	-0.02* (0.01)	-0.02** (0.01)	-0.04*** (0.01)
Share of manufacturing employment	0.09 (0.55)	-	-0.28 (0.43)	-	-
Change in share of manufacturing employment	-0.01 (0.67)	0.09 (0.67)	0.01 (0.71)	0.29 (0.65)	-0.33 (0.63)
Population density (log)	0.12* (0.07)	0.13* (0.07)	0.11 (0.07)	0.11 (0.07)	0.15** (0.07)
Rank (initial position)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
Constant	-2.16 (1.61)	-0.58 (0.39)	-1.5 (1.52)	-0.71* (0.38)	-0.58 (0.40)
Federal State dummies	Yes**	Yes***	Yes*	Yes**	Yes**
R2	0.75	0.70	0.74	0.72	0.69
Variance inflation factor (vif)	3.75	2.07	3.92	2.12	2.16

*Notes:* Dependent variable: Rank Mobility Index, Standard errors in parentheses. The number of observations (regions) is  $n = 71$ . All variables representing levels are for the first years of the period of analysis (1997/77); changes denote differences between the value of a variable between the final year (2006/07) and the first year expressed in percent. \*: statistically significant at the 10 percent level; \*\*: statistically significant at the 5 percent level; \*\*\*: statistically significant at the 1 percent level.

rank mobility (see Table A5 in the Appendix). The highly significant effect of the change of the self-employment rate in model IV may be regarded an indication for the relevance of the two types of path dependence mentioned in Section 2: the creation of additional entrepreneurial opportunities by start-ups and role model effects of an increasing share of active entrepreneurs. Because one might suspect an endogeneity problem



due to this variable – an increasing start-up rate will likely result in higher levels of self-employment – we ran this model also without the change of the self-employment rate (model V). Comparing the results of model IV and V, we find that omission of the change of the self-employment rate leads to no substantial changes of the estimates of the other variables.

While the wage level of a region is insignificant, changes of that level are statistically significant with a negative sign. This indicates that rising relative wage levels in a region lead to a decline in the national ranking which is in accordance with the basic models of occupational choice (Knight 1921; Lucas 1978). According to Ghatak, Morell and Sjöström (2007) this might also mean driving low quality entrepreneurs out of the market thus improving the average quality of entrepreneurs. Therefore, there may be fewer entrepreneurs, however, they could be more successful with higher survival rates.

The share of manufacturing employment, as well as the changes of this share, is statistically insignificant, and regional population density has only a rather weak positive effect. The initial position in the national ranking has a highly significant negative effect. As we know from our previous analyses (see Section 5.2) this indicates that particularly the regions with positions in the middle of the national ranking have a tendency to increase their position. Models with dummy variables for being among the regions with the highest or the lowest initial rank position reveal that belonging to the very top or bottom of the ranking has nearly no effect on rank mobility (see Table A6 in the Appendix). The mean variance inflation factor (vif) for all model specifications varies between 1.85 and 3.18 thus not pointing to any serious problem of multicollinearity.

To a large extent, the empirical results confirm our expectations and show that the initial regional characteristics, and especially changes in these characteristics, play a significant role for explaining development trajectories of regions even over a time period as long as thirty years. According to these results it is particularly an increase of the regional knowledge base as measured by the share of R&D employees, favorable conditions for entrepreneurship (self-employment rate) and industrial

diversity that are conducive for an increase of the regional level of new business formation.

## 7. Conclusions

We have investigated persistence and changes of the rank positions of West German regions with regard to new business formation over a period of thirty years. Compared to start-up rates, rank positions have the advantage of being less affected by national trends of rising or declining start-up rates that induce about the same changes in all regions. Hence, they indicate changes in the relative position of a region much clearer than variations of the regional start-up rate. Moreover, an analysis of rank positions is, to a much lesser degree, disturbed by cases with extreme levels of new business formation ('outliers').

Our analysis confirms previous studies that have found high levels of persistence over time with regard to the position in the national ranking. This persistence is particularly pronounced for regions with an above average level of the start-up rate. This result is consistent with the findings of Andersson and Koster (2011) and Fritsch and Wyrwich (2014) who explain this phenomenon with the presence of a regional entrepreneurship culture that tends to be long-lasting. These authors argue that entrepreneurship activity needs to reach a certain threshold level for such a culture to become effective.<sup>11</sup> We also find evidence for other determinants of persistence, namely, highly persistent determinants of new business formation and path dependence.

Besides such persistence, we also observed a number of significant positional changes in the national rankings: 23 regions (that is 32 percent

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<sup>11</sup> In contrast to these empirical results and explanations, Fotopoulos and Storey (2015) find a relatively high stability of rank positions at the bottom of the national ranking in their analysis for the UK. This pattern may, however, be largely shaped by a rather special case: the strong increase of self-employment in the regions of London over the last decades. It is important to note here that the empirical analysis of Fotopoulos and Storey (2005) is at the rather spatially disaggregated level of local authority districts (LAD) that are in many cases considerably smaller than labor market areas. Accordingly, the region of Greater London consists of 33 LADs. Moreover, while our analysis uses the ranks of start-up rates, Fotopoulos and Storey (2015) use the self-employment rate as indicator for entrepreneurship.

of all regions) changed their position by more than one standard deviation (19 ranks). The highest probability for a change of the rank position can be found in the center of the distribution, i.e. for those regions with an about medium level of new business formation. Multivariate analyses revealed a number of regional characteristics that are significantly related to regional rank mobility. In particular, regions that experienced an increase of their levels of new business formation are characterized by an intensification of R&D activity, a high initial share of small business employment in the base year, an increase of this share over the observation period, as well as an increase of regional industry diversity, particularly a rise of the unrelated type of variety (Boschma and Frenken 2011). Consistent with the basic model of occupational choice (Knight 1921; Lucas 1978), high increases of the regional wage level, as compared to other regions, are likely to lead to a decrease of the position in the national ranking. The level and the development of the share of manufacturing employment have no significant effect on a region's position in the national ranking. This may indicate that most of the regions have been affected by the general trend towards a higher share of service employment where starting an own business is easier in about the same way. The statistically significant effect of population density on a change of the rank position indicates that there has been a general trend of agglomerated areas towards higher levels of new business formation in the observation period. Generally, these results are in line with an earlier analysis of changes in the level of new business formation in West Germany by Fritsch and Mueller (2007).

The pronounced persistence of regional positions in the national ranking suggests that policies aiming at stimulating regional levels of entrepreneurship may not be able to cause larger changes of the regional start-up rates in the short-run but need a long-term orientation. The results of our multivariate analysis suggest that regional innovation activity, i.e. improvements of the regional knowledge base, may be an important driver of new business formation. This clearly indicates that entrepreneurship is an important element of the regional innovation system that puts knowledge into commercial application (Qian, Acs and Stough 2013).

Further research on the persistence of regional entrepreneurship activity should particularly try to distinguish between different types of entrepreneurship. It would be interesting to know more about the structure of new businesses in regions at the top and at the bottom of the national ranking. One important question would be whether high ranking regions have particularly high shares of start-ups in small-scale industries or whether they also have relatively high levels of new business formation in high-tech manufacturing. Moreover, detailed case studies of regions that experienced considerable changes of their positions in the national ranking could contribute to a better understanding of the phenomenon of (non-)persistence. Finally, we should know more about the sources of a regional culture of entrepreneurship and how it induces the persistence of entrepreneurial activity.

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## Appendix

Table A1: Descriptive statistics of two year averaged start-up rates

<i>Year</i>	<i>Number of observations</i>	<i>Mean</i>	<i>Median</i>	<i>Standard Deviation</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Skewness</i>
1976/77	71	5.03	4.86	1.05	3.34	10.05	1.91
1986/87	71	4.55	4.53	0.78	2.96	7.00	0.84
1996/97	71	5.35	5.27	0.81	3.94	8.07	0.85
2006/07	71	4.81	4.75	0.81	3.15	7.61	0.66

Table A2: National Entrepreneurship League Table of West German regions

Name of region	Rank 1976/77	Start-up rate 1976/77	Rank 2006/07	Start-up rate 2006/07	Change of rank positions 1996/77 to 2006/07
Oberland	71	10.055	70	6.569	-1
Schleswig-Holstein North	70	7.445	71	7.612	1
Allgaeu	69	7.444	43	4.964	-26
Schleswig-Holstein South-West	68	7.225	66	5.958	-2
Southeast Upper Bavaria	67	6.722	62	5.674	-5
Middle Rhine-Nahe	66	6.368	64	5.784	-2
Luneburg	65	6.087	60	5.604	-5
Oldenburg	64	5.908	58	5.530	-6
Munich	63	5.858	46	5.022	-17
Schleswig-Holstein East	62	5.840	69	6.303	7
Danube-Forest	61	5.840	29	4.418	-32
High Rhine-Lake Constance	60	5.837	38	4.792	-22
Northern Black Forest	59	5.769	25	4.376	-34
Trier	58	5.690	59	5.548	1
Southern Upper Rhine	57	5.687	35	4.749	-22
Bonn	56	5.687	57	5.481	1
Lake Constance-Upper Swabia	55	5.657	22	4.316	-33
Bavarian Lower Main	54	5.590	63	5.700	9
East Frisian	53	5.563	67	6.112	14
Hamburg/Schleswig-Holstein South/Hamburg-Umland-South	52	5.406	61	5.611	9
Aachen	51	5.370	65	5.873	14
Western Central Franconia	50	5.179	18	4.227	-32
Rhine-Main	49	5.162	49	5.090	0
Emsland	48	5.058	41	4.879	-7
Starkenburger	47	5.015	53	5.396	6
Franconia	46	4.982	14	4.142	-32
Landshut	45	4.981	5	3.819	-40
Dusseldorf	44	4.959	39	4.856	-5
Black Forest-Baar-Heuberg	43	4.940	3	3.521	-40
Regensburg	42	4.939	19	4.235	-23

Danube-Iller (BY)	41	4.917	7	3.887	-34
Rhine-Hesse-Nahe	40	4.916	55	5.425	15
Cologne	39	4.893	48	5.077	9
Suedheide	38	4.893	68	6.171	30
Western Palatinate	37	4.886	56	5.431	19
Paderborn	36	4.862	12	4.123	-24
Oberpfalz-Nord	35	4.850	9	3.924	-26
Schleswig-Holstein Central	34	4.793	50	5.167	16
Neckar-Alb	33	4.771	33	4.571	0
Muenster	32	4.758	26	4.376	-6
Bremen/Bremen-Umland	31	4.715	44	4.981	13
Saar	30	4.699	27	4.412	-3
Hanover	29	4.695	36	4.750	7
Bielefeld	28	4.649	16	4.202	-12
Northern Hesse	27	4.625	32	4.530	5
Central Hesse	26	4.610	42	4.879	16
Bremerhaven	25	4.609	45	5.006	20
Arnsberg	24	4.590	28	4.415	4
Emscher-Lippe	23	4.531	54	5.403	31
Gottingen	22	4.516	15	4.189	-7
Rhine Palatinate	21	4.504	52	5.327	31
Upper Franconia-East	20	4.481	37	4.752	17
Osnabruck	19	4.479	21	4.301	2
Upper Franconia-West	18	4.465	30	4.507	12
Ingolstadt	17	4.427	13	4.134	-4
Wurzburg	16	4.385	23	4.318	7
Middle Upper Rhine	15	4.344	24	4.324	9
Augsburg	14	4.316	31	4.510	17
Upper Neckar	13	4.272	20	4.291	7
Hildesheim	12	4.241	47	5.028	35
Stuttgart	11	4.176	8	3.898	-3
Eastern Hesse	10	4.120	11	4.071	1
Industrial Region Central Franconia	9	4.063	34	4.627	25
Duisburg/Essen	8	3.972	40	4.864	32
Dortmund	7	3.952	51	5.225	44
Rhine-Main	6	3.898	4	3.719	-2
Bochum/Hagen	5	3.834	17	4.212	12
Brunswick	4	3.667	10	3.944	6
Danube-Iller (BW)	3	3.551	2	3.329	-1
Siegen	2	3.488	1	3.155	-1
Eastern Wuerttemberg	1	3.342	6	3.827	5

Notes: The top position is denoted by rank 71 and the bottom position is rank 1.

Table A3: Descriptive statistics of variables

<i>Indicator</i>	<i>Mean</i>	<i>Median</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Standard deviation</i>
Rank mobility index	0.000	0.014	-0.571	0.629	0.270
Share of private sector R&D employment	0.009	0.008	0.002	0.025	0.005
Change in private sector R&D employment	1.728	1.677	0.098	4.489	1.027
Employment share of small businesses	0.265	0.260	0.187	0.431	0.052
Change in employment share of small businesses	0.033	0.028	-0.022	0.086	0.026
Level of industry diversity	0.863	0.870	0.783	0.913	0.028
Change in level of industry diversity	-0.018	-0.016	-0.092	0.052	0.028
Related variety	1.342	1.367	0.930	1.676	0.149
Change in related variety	0.188	0.186	0.025	0.503	0.096
Unrelated variety	4.347	4.377	3.617	4.649	0.186
Change in unrelated variety	0.011	0.009	-0.070	0.098	0.034
Self-employment rate	0.083	0.083	0.056	0.139	0.015
Change of the self-employment rate	0.027	0.027	0.007	0.045	0.009
Regional wage level	72.483	72.303	63.024	83.854	4.877
Change in regional wage level	3.391	3.688	-5.522	13.730	4.489
Share of manufacturing employment	0.566	0.576	0.331	0.731	0.087
Change in share of manufacturing employment	-0.131	-0.129	-0.268	-0.006	0.052
Population density (log)	5.349	5.170	4.234	7.106	0.684

*Note:* The number of observations (regions) for all variables is 71.

Table A4: Correlation matrix

	<i>Indicator</i>	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
I	Rank mobility index	1.00														
II	Share of private sector R&D employment	0.28	1.00													
III	Change in private sector R&D employment	-0.42	-0.44	1.00												
IV	Employment share of small businesses	-0.24	-0.62	0.26	1.00											
V	Change in employment share of small businesses	0.61	0.33	-0.63	-0.27	1.00										
VI	Self-employment rate	-0.40	-0.64	0.43	0.93	-0.38	1.00									
VII	Change of the self-employment rate	0.61	0.10	-0.54	0.13	0.84	-0.04	1.00								
VIII	Level of industry diversity	-0.13	0.11	0.03	0.14	-0.12	0.18	-0.09	1.00							
IX	Change in level of industry diversity	0.02	-0.47	0.19	0.10	0.07	0.13	0.12	-0.59	1.00						
X	Related variety	-0.13	0.20	-0.14	-0.19	-0.02	-0.16	-0.22	0.20	-0.22	1.00					
XI	Change in related variety	0.33	-0.12	-0.17	0.20	0.27	0.07	0.46	-0.10	0.12	-0.75	1.00				
XII	Unrelated variety	-0.13	0.33	-0.03	-0.07	-0.08	-0.04	-0.19	0.73	-0.57	0.37	-0.20	1.00			
XIII	Change in unrelated variety	0.21	-0.27	-0.01	0.09	0.28	0.10	0.34	-0.30	0.68	-0.09	0.13	-0.61	1.00		
XIV	Regional wage level	0.37	0.63	-0.50	-0.60	0.33	-0.60	0.08	-0.02	-0.48	0.21	-0.06	0.13	-0.28	1.00	
XV	Change in regional wage level	-0.50	0.20	0.48	-0.31	-0.46	-0.06	-0.65	0.00	0.01	0.27	-0.48	0.17	-0.14	-0.09	1.00
XVI	Share of manufacturing employment	-0.22	-0.06	0.29	-0.47	-0.14	-0.25	-0.39	-0.21	0.44	0.03	-0.30	-0.25	0.29	-0.08	0.54
XVII	Change in share of manufacturing employment	-0.41	-0.53	0.46	0.51	-0.50	0.56	-0.32	-0.12	0.29	-0.07	-0.16	-0.12	-0.04	-0.55	0.03
XVIII	Population density (log)	0.42	0.63	-0.47	-0.64	0.42	-0.71	0.13	0.02	-0.35	0.39	-0.12	0.23	-0.12	0.77	0.05

Table A5: Determinants of change in rank positions

<i>Indicator</i>	Model I	Model II	Model III	Model IV
Share of private sector R&D employment	1.53 (12.74)		-1.34 (13.01)	
Change in private sector R&D employment	0.06 (0.04)	0.06* (0.03)	0.06 (0.04)	0.07* (0.03)
Employment share of small businesses	2.44* (1.38)			
Change in employment share of small businesses	2.48 (1.48)	2.29 (1.38)		
Related variety	0.13 (0.34)		0.09 (0.35)	
Change in related variety	0.40 (0.49)	0.23 (0.28)	0.33 (0.51)	0.16 (0.28)
Unrelated variety	0.07 (0.20)		0.08 (0.21)	
Change in unrelated variety	1.82 (1.12)	1.59** (0.75)	1.70 (1.15)	1.34* (0.75)
Self-employment rate			3.22 (4.55)	
Change of the self-employment rate			8.87* (4.97)	9.81** (4.38)
Regional wage level	0.00 (0.01)		0.00 (0.01)	
Change in regional wage level	-0.02* (0.01)	-0.03*** (0.01)	-0.02 (0.01)	-0.02** (0.01)
Share of manufacture employment	0.43 (0.63)		0.04 (0.50)	
Change in share of manufacture employment	0.53 (0.76)	0.54 (0.72)	0.60 (0.77)	0.60 (0.70)
Population density (log)	0.11 (0.08)	0.13* (0.07)	0.09 (0.09)	0.11 (0.07)
Rank (initial position)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01** (0.00)	-0.01*** (0.00)
Constant	-1.94 (1.65)	-0.65 (0.40)	-1.37 (1.55)	-0.74* (0.39)
Federal State dummies	Yes*	Yes*	Yes	Yes
Number of observations	71	71	71	71
R2	0.73	0.71	0.72	0.72
Variance inflation factor (vif)	4.19	2.06	4.31	2.13

*Notes:* Dependent variable: Rank mobility index, Standard errors in parentheses;  
 \*: statistically significant at the 10 percent level; \*\*: statistically significant at the 5 percent level; \*\*\*: statistically significant at the 1 percent level.

Table A6: Determinants of change in rank positions

<i>Indicator</i>	Model I	Model II	Model III	Model IV
Share of private sector R&D employment	16.18 (11.70)		13.35 (11.74)	
Change in private sector R&D employment	0.07* (0.04)	0.05 (0.03)	0.08** (0.04)	0.04 (0.03)
Employment share of small businesses	0.20 (1.22)			
Change in employment share of small businesses	2.30 (1.54)	2.79* (1.48)		
Level of industry diversity	-0.00 (1.26)		0.21 (1.26)	
Change in level of industry diversity	3.26* (1.65)	1.64 (0.99)	2.93* (1.68)	1.54 (0.97)
Self-employment rate			-2.40 (3.85)	
Change of the self-employment rate			8.42* (5.02)	10.31** (4.51)
Regional wage level	0.01 (0.01)		0.01 (0.01)	
Change in regional wage level	-0.04*** (0.01)	-0.03*** (0.01)	-0.03** (0.01)	-0.02* (0.01)
Share of manufacturing employment	-0.34 (0.59)		-0.30 (0.48)	
Change in share of manufacturing employment	-0.12 (0.74)	-0.17 (0.73)	0.08 (0.77)	-0.05 (0.72)
Population density (log)	0.13 (0.08)	0.17** (0.08)	0.12 (0.08)	0.16** (0.08)
Dummy (bottom 10 positions)	0.11 (0.10)	0.15 (0.09)	0.09 (0.10)	0.14 (0.09)
Dummy (top 10 positions)	-0.08 (0.10)	-0.09 (0.08)	-0.06 (0.11)	-0.14* (0.08)
Constant	-1.45 (1.78)	-1.04* (0.40)	-1.38 (1.66)	-1.20*** (0.40)
Federal State dummies	Yes*	Yes**	Yes	Yes*
Number of observations	71	71	71	71
R2	0.7	0.66	0.71	0.67
Variance inflation factor (vif)	3.74	2.07	3.92	2.12

*Notes:* Dependent variable: Rank mobility index, Standard errors in parentheses;  
 \*: statistically significant at the 10 percent level; \*\*: statistically significant at the 5 percent level; \*\*\*: statistically significant at the 1 percent level.

Table A7: Determinants of change in rank positions (Tobit estimates)

<i>Indicator</i>	Model I	Model II	Model III	Model IV
Share of private sector R&D employment	8.75 (8.94)		6.75 (9.15)	
Change in private sector R&D employment	0.07** (0.03)	0.06** (0.03)	0.07** (0.03)	0.07** (0.03)
Employment share of small businesses	2.56** (1.05)			
Change in employment share of small businesses	2.16* (1.16)	2.35* (1.18)		
Level of industry diversity	0.82 (0.98)		0.66 (0.98)	
Change in level of industry diversity	3.92*** (1.25)	2.00*** (0.79)	3.81*** (1.32)	1.82** (0.75)
Self-employment rate			5.24 (3.54)	
Change of the self-employment rate			6.85* (3.90)	10.66*** (3.55)
Regional wage level	0.00 (0.01)		0.00 (0.01)	
Change in regional wage level	-0.02*** (0.01)	-0.03*** (0.01)	-0.02** (0.01)	-0.02** (0.01)
Share of manufacture employment	0.09 (0.46)		-0.28 (0.36)	
Change in share of manufacture employment	-0.01 (0.56)	0.09 (0.58)	0.01 (0.59)	0.29 (0.56)
Population density (log)	0.12** (0.06)	0.13** (0.06)	0.11* (0.06)	0.11* (0.06)
Rank (initial position)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)	-0.01*** (0.00)
Constant	-2.16 (1.34)	-0.58* (0.34)	-1.50 (1.27)	-0.71** (0.33)
Federal State dummies	Yes***	Yes***	Yes***	Yes***
Number of observations	71	71	71	71
Variance inflation factor (vif)	3.75	2.07	3.92	2.12

*Notes:* Dependent variable: Rank mobility index, Standard errors in parentheses;  
\*: statistically significant at the 10 percent level; \*\*: statistically significant at the 5 percent level; \*\*\*: statistically significant at the 1 percent level.

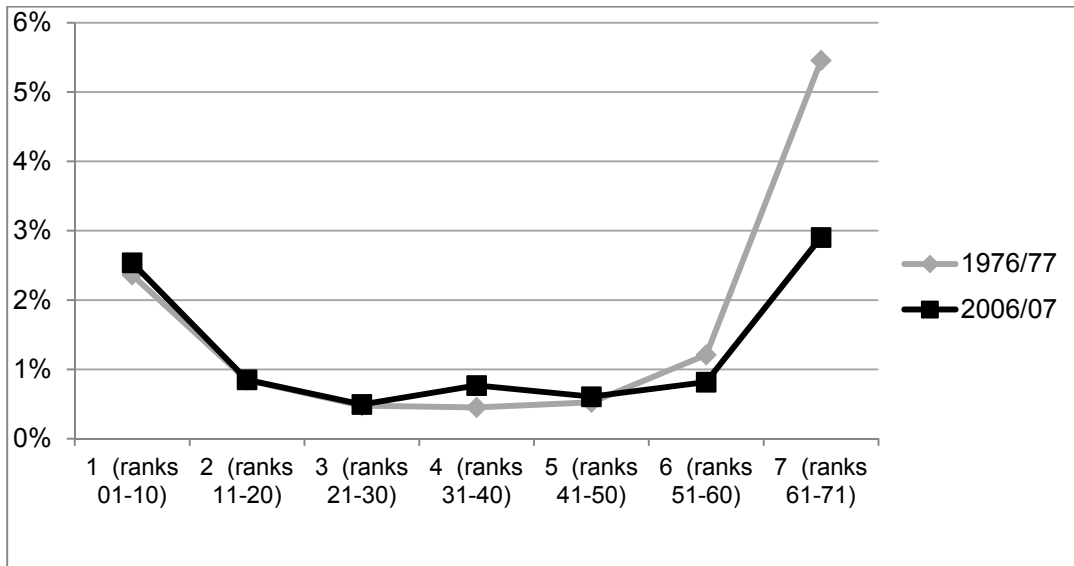


Figure A1: Percentage change of start-up rate that is necessary to increase by one rank position