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ABSTRACT

The Lifecycle of Regions

Major economic transitions, even when they are disruptive, do not occur instantaneously but rather occur over time, as regions within a country change at different rates. Accordingly, these dynamics may be reflected in a geographic lifecycle with different regions characterized by different phases analogous to the industry lifecycle model. In accordance with this argument, this paper tests the hypothesis that regions can be characterized as evolving over a predictable and well-defined lifecycle: (1) an initial entrepreneurial phases where Jacobs externalities and inter-industry start-ups prevail; (2) a routinized phase where innovation takes place within top-performing incumbents; (3) a second entrepreneurial phase characterized by Marshall-Arrow-Romer externalities, leading to intra-industry start-ups in niches; and (4) a second phase of routinization, in which no further innovation takes place, but is instead a phase of structural change. Using data on 74 West German planning regions, we find compelling evidence of a spatial lifecycle.

JEL Classification: O18, O31 and R12
Keywords: entrepreneurship, innovation, knowledge externalities, regional development and spatial lifecycle

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1. Introduction

Economic development certainly has a spatial dimension that leaves its mark on places. This is obvious in the transition from an agrarian to an industrial society, and equally true in the contemporary transition to a knowledge-based society. The former transition, from an agrarian to an industrial society, was accompanied by a rapid increase in urbanization. Depending on the industry, prime location was determined either by proximity to input factors such as timber, coal, wool, or water, or by proximity to markets with high demand for the produced goods (Weber 1909). The current transition to a knowledge-based society is largely driven by decreasing transportation costs with global sourcing. Production may be distributed over a large area of the globe, depending on particular regional advantages. For example, labor-intensive production migrates to developing regions and countries with comparatively low wages, whereas capital- and, especially, knowledge-intensive production is concentrated in developed areas and countries with a highly qualified labor force that can support innovation. According to Duranton and Puga (2001), the difference between the invention and creation of products on the one hand and pure production on the other hand has led to a spatial distribution of production where the former takes place in regions rich with knowledge-based location factors. In contrast, the later phase takes place in regions tailored to the demand of industrial production—relatively cheap industry parks and low wages, along with a specialized pool of qualified but not necessarily highly qualified workers. This suggests a division of economic fortune that is dependent on the characteristics of places and does not allow the fortune of places to change and evolve—a rather unsatisfying policy implication for lagging regions.

Given that the regional distribution of production does not reflect natural resource or transportation advantages, it may be dependent on structural characteristics of the prominent industry and mimic the industry lifecycle. In this paper, we argue that regional economic dynamics are reflected in a spatial lifecycle with different regions at different phases of the lifecycle. Some regions have evolved into centers of knowledge-based production, others are still dominated by industrial production, and yet others are in the process of structural change.

This conceptualization allows us to integrate literature on innovation, industry dynamics, and regional growth into a single theory—that of the spatial lifecycle. Basically, every region has an endowment of resources that determines its technological regime (Nelson and Winter 1984). Audretsch and Fritsch (2002) introduce the idea of four different regional growth regimes. Falck and Heblich (2008) organize these four technological regimes along a knowledge-based lifecycle, as proposed by Gort and Klepper (1982). In doing so, Falck and Heblich implicitly assume the existence of a spatial lifecycle where a region's position along the lifecycle is determined by the maturity of its industry structure. Implications for regional dynamics can then be deduced from Schumpeterian growth theory (Aghion and Howitt 1992). Accordingly, regions dominated by leading-edge technology industries will exhibit superior economic performance. Firms in these regions constantly face the threat of new firms entering the market and they thus have a strong incentive to innovate and keep pace with technological progress so as to prevent entry by competitors (Aghion et al. 2006). These regions are the archetype cluster, as defined by Porter (1998). In contrast, regions characterized by technology-lagging industries face a high risk of becoming victims of structural change as firms in this industry are likely to be forced out of the market.

The purpose of this paper is to provide an empirical test of regional evolution over a spatial lifecycle. Along this line, the paper is organized as follows. Section 2 introduces the concept of a spatial lifecycle and presents several hypotheses on the determinants of regional dynamics in terms of entry. We present our data in Section 3 and our method-ology in Section 4. On the basis of these, the hypotheses involving the existence of a spatial lifecycle are empirically tested in Section 5. We conclude with implications for further research in Section 6.

2. Theoretical Background

Schumpeter (1912, 1942) and the ensuing Schumpeterian growth theory (cf. Aghion and Howitt, 1992) highlight the importance of innovation for economic development. In a self-propelling process, the struggle for future rents induces actors to commercialize innovations that replace old products and, occasionally, also displace incumbent firms and existing industries. The constant struggle for future rents fuels a process of creative destruction that results in ongoing dynamics and growth. Along the product lifecycle, innovations have a twofold impact (Utterback and Abernathy, 1975; Abernathy and Utterback, 1978): *process* innovations increase the efficiency of production within a given lifecycle and thus support movement along the lifecycle; *product* innovations have the potential to initiate new lifecycles, especially if the innovative activity is radical in nature. However, at the beginning of a new lifecycle, there might be several new products competing to become the standard.[1] With time, this competition usually results in the emergence of a dominant product technology—in this fight to the death the other products will not survive beyond the earliest stage of the lifecycle. In Schumpeter's theory, product innovations are usually the work of independent entrepreneurs (Schumpeter 1912), whereas process innovations are the routine results of large enterprises with large and specialized research laboratories (Schumpeter 1942).

Cohen and Klepper (1996a, 1996b) formalize the nexus between firm size and innovation in a model that distinguishes between product and process innovation with respect to firm size. They argue that process innovation lowers the average cost of production: if the firm does not license its process innovation, the only way to benefit is to produce output. The higher the volume of production, the higher the total gross benefit of an innovation. Hence, larger firms are able to derive a higher return from a process innovation than are smaller firms, simply because the larger firms can spread this benefit over a greater production volume. The result is not obvious for product innovation that creates a completely new market. If there are no strong reasons for believing that the volume of sales on the new market is related to ex-ante size, there is obviously no reason for large (incumbent) businesses to spend much time or money on product innovation. It is partially for this reason that Aghion et al. (2006) stress the importance of firm entry for innovation.

In Nelson and Winter's (1984) theory of technological regimes, product innovation is characteristic of what Winter (1982) terms the entrepreneurial regime, whereas the process innovation phase is more often found in what he terms as the routinized regime. Based on that idea, Gort and Klepper (1982) create a knowledge-based lifecycle which orders characteristics of these technological regimes with respect to time. This lifecycle is applied to a single product, but its basic assumptions are applicable to the industry lifecycle theory (Klepper, 1996).

Gort and Klepper concentrate on the chronology of the technological regimes; Audretsch and Feldman (1996) and Audretsch and Fritsch (2002) add a spatial

[1] E.g., a current example is the HD-DVD vs. Blueray Disc and HD-VMD contest to be successor to the

dimension and characterize regions according to the prevailing technological regime. Falck and Heblich (2008) put forward the idea of a regional lifecycle where regions are characterized by prevailing technological regimes that, in turn, are ordered along a lifecycle as in Gort and Klepper.

The regional lifecycle theory also takes into consideration the *geography* of knowledge. In the current Information Age characterized by innovative activity which is largely knowledge driven, innovators derive great benefit from former accumulated knowledge. The existing stock of knowledge is assumed to be a nonrival input so that everyone engaged in R&D has free access to the entire stock of knowledge at the same time. Along this line, Jaffe et al. (1993) found evidence that regionally developed knowledge is most likely to boost the accumulation of further knowledge within the same region. Similar evidence is found for the spatial distribution of innovative activity by Feldman (1994) who argues that the cost of innovation is lower in geographic agglomerations, hence resources are more productive. Audretsch and Feldman (1996) argue that tacit knowledge is, at least in part, bound to a certain region and embodied in skilled labor. Stam's (2006) empirical findings that entrepreneurs are not geographically mobile is additional support for the importance of location.

Assuming that a region's stock of knowledge is determined by interpersonal knowledge flows as well as by the prevailing industry structure and the degree of industry agglomeration, the literature distinguishes at least two types of knowledge spillover that may occur in a region. *MAR externalities* describe the intra-industry spillovers characteristic of industrial agglomerations dominated by one industry. In contrast, *Jacobs externalities* are found in regions with a diversified infrastructure,

DVD format.

usually urban agglomerations (Glaeser et al. 1992). According to Duranton and Puga's (2001) spatially distributed product lifecycle, the formative, innovative stages of the lifecycle are more likely to locate in regions with diverse economies and corresponding inter-industry spillovers, both of which will be of benefit to the creation of a new product. However, once the innovation has taken place and a product line or process is settled, the actual production is moved to more specialized localizations.

Industry and regional dynamics are thus closely linked. Economically diverse regions are most likely to be the home of products in the early stages of the lifecycle and inter-industrial knowledge spillovers or Jacobs externalities prevail. In more mature phases of the lifecycle when a dominant product is established, production becomes more specialized in regions and R&D effort becomes much more focused. Accordingly, there is less knowledge created to spill over. In this phase, innovation is more likely to be produced within large firms' specialized research laboratories for their own use.

However, specialization will ultimately lead to increasing consumer dissatisfaction with standardized products, which in turn provides an opportunity for niche producers (Hippel 2007). In this stage former industry experience can uncover incremental product variations, resulting in niche markets that complement incumbents. Thus, these product niches offer entrepreneurial opportunities where intra-industry spillovers (MAR externalities) prevail. In the final last phase of routinization entrepreneurial opportunities are exploited and a decreasing number of incumbents fight for the remaining rents in stagnating market.

This concept of a spatial lifecycle, suggests four unique stages:

1. The first entrepreneurial phase, during which both incumbents and entrepreneurs benefit from inter-industry spillovers.

2. The first routinized phase, during which R&D in large firms with specialized research laboratories becomes increasingly focused. In this phase, large firms are having the resources to push forward the technology frontier and, accordingly, entry is of minor importance.

3. The second entrepreneurial phase, during which specialization creates entrepreneurial opportunities in niche markets. In this phase, entrepreneurs benefit from intra-industry knowledge spillovers, especially in form of former industry experience that leads to the exploitation of potential niches.

4. The second routinization phase, during which no innovation occurs and a few incumbents survive on remaining rents in a stagnating market. This last phase of the spatial lifecycle is characterized by structural change and thus is accompanied by firm closure and its corresponding employment losses.

Implicit in these four stages is the endogeneity between a region's location factors and the dynamics along the spatial lifecycle. In the past, the most important location factors involved natural resources and factor endowments, but in this day of steadily decreasing transaction and transportation costs, human capital—the basis of knowledge and creativity have become increasingly important. However, building human capital to make a region attractive takes time, something that has not changed since Marshall's days as evidenced by his remark that location factors change slowly and gradually—*natura non facit saltum* (nature does not make jumps).[2] Thus a region's position along the lifecycle will manifest only over the long run and typically cannot be observed using available data. However, an interregional comparison of location factors within a relatively short timespan (i.e., 15 years) should be able to reveal important differences that lead to a particular region being dominated either by a diverse or a specialized industry structure, from which we may draw fairly solid conclusions as to the region's position along the regional lifecycle.

3. Data

To test the spatial lifecycle theory, we use data on 74 West German planning regions (excluding Berlin).[3] These regions were categorized by infrastructure, industrial specialization and economic diversity. The first category describes the quality of available *infrastructure* in the region, using indicators provided by the Office for Building and Regional Planning to characterize the quality of the available infrastructure (cf. Maretzke 2005): the accessibility of the nearest three national or international agglomerations via road and rail combined; the accessibility of European metropolises via road and air combined; and the availability of modern transportation systems.

These infrastructure indicators are modern in that they are not suitable for the transportation of heavy input factors such as coal or steel, which were crucial in the age of industrialization. However, today's knowledge-based society requires transportation facilities that link residents of a region to other regions, especially cities, and therefore allow for the exchange and the inflow of fresh knowledge. Our infrastructure indicators reflect accessibility in this latter conceptualization.

[2] Marshall (1890) adopted this motto for his *Principles of Economics*.
[3] Planning regions consist of several districts and include at least one core city and its surrounds.

The second category describes *specialization* and thus characterizes MAR externalities in the region. All indicators are based on regional employment data derived from the German Social Insurance Statistics (see Fritsch and Brixy 2004 for a description of this data source). The Social Insurance Statistics requires every employer to furnish certain information (e.g., qualifications) about every employee subject to obligatory social insurance. The share of employees in manufacturing compared to the number of all employees subject to social security in the region describes the industry mix in the region. Based on this, we use the Herfindahl index, calculated as the sum of the squares of the employment shares of each industry in manufacturing, as an indicator for the concentration of manufacturing industries. Finally, the technological regime variable—calculated as the share of employees with a degree in engineering or natural science in small businesses compared to the total number of employees with a degree in engineering or natural science—describes the role of large firms in regional R&D.[4] Thereby, a small value signifies the predominance of large firms in regional R&D while a large number indicates the importance of small firms in regional R&D.

The third group of variables describes *diversity* in a region and therefore indicates Jacobs externalities. Bohemians, along with jack-of-all-trades small business employees characterize the diversity of the regional labor market. Further, the share of employees in business services, the share of patents applied for by residents, and the share of patents applied for by local research institutions are indicators of diversity in regional knowledge stock. To measure this, patent data are taken from the *German Patent Atlas*. The *German Patent Atlas* provides information on the number of patents applied for in a planning region and distinguishes between three groups of

[4] The share of employees with a degree in engineering or natural science is highly correlated (0.9079)

applicants—businesses, universities and research institutes, and natural persons (cf. Greif and Schmiedl 2002). Table 1 summarizes all three groups of variables.

<< Insert Table 1 around here >>

To determine whether this large number of indicators actually can reveal commonalities across our three dimensions—infrastructure, specialization, and diversity—we start with a principal factor analysis (cf. Fabrigar et al. 1999) of all the regional variables (cf. Table 1). All variables were standardized by calculating the mean and dividing by the standard deviation. The Kayser criterion (Cattel 1966) and the *scree test* on the eigenvalues of the factors suggest retaining two factors with eigenvalues larger than 1. In the eigenvalue graph there is a breakpoint after the second factor where the curve flattens out. To clarify the data structure, we used orthogonal rotation on the remaining factors. It turns out that all variables in the Diversity Group have important cross-loadings. Costello and Osborne (2005) argue that cross-loading indicators should be dropped from the analysis. Thus, we drop these variables and reran the factor analysis. Note that dropping some of the variables is meaningful in itself. For example, the cross-loading of the variable *share of bohemians* may be due in part to Germany's historical past; its system of mini-states created a high density of cultural facilities, for example, theaters. The results of this practice mean that the cultural facilities that attract bohemians are rather evenly distributed across the entire country, that is, there is not much regional variation in this respect. For a similar reason we drop the variable *business services*, which contains the banking sector. The tripartite German banking system consists of private, mutual, and public banks that guarantee a more or less even distribution of banks across all regions. Accordingly, this variable also does not exhibit much variation.

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with the region's share of employees in R&D. This suggests that engineers and natural scientists

After dropping these variables, two factors were retained that are orthogonally rotated to get a clearer structure. The results of this second factor analysis are displayed in Table 2.

<< Insert Table 2 around here >>

The remaining first factor is highly and positively correlated with the three infrastructure variables. Therefore, it is regarded as an indicator of the quality of the region's infrastructure that facilitates the inflow of knowledge. The second factor reflects agglomeration economics. This factor is positively correlated with the share of employees in manufacturing and with the Herfindahl index; however it is negatively correlated with the technological regime indicator.

Based on these two factors, we group West German planning regions by means of a hierarchical Ward's linkage cluster analysis (Ward 1963). Table 3 provides descriptive statistics of the two factors by group. The table reveals that Group 1 does not have an extreme value in either Factor 1 or Factor 2. Group 2 is characterized by the highest value of Factor 1, indicating the worst accessibility value, whereas Group 4 has the lowest value of Factor 1 and thus the best accessibility. Finally, Group 3 has the highest value of Factor 2, indicating an exceedingly high degree of agglomeration, while Group 5 has the lowest value of Factor 2 and thus is least agglomerated.

<< Insert Figure 1 around here >>

<< Insert Table 3 around here >>

Table 4 shows the results of pair wise tests on the equality of means across the five groups. This procedure helps to order the five groups with respect to the values of Factor 1 and Factor 2. Regarding Factor 1, we already know that Group 2 and Group

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represent a region's major source of R&D.

4 mark the upper and lower borders, respectively. Further, there is no significant difference between Group 1 and Group 3 or between Group 3 and Group 5. This suggests that all three groups have a fair accessibility: Group 1's accessibility is the worst among the three and Group 5's is the best of the three. Regarding Factor 2, Group 3 and Group 5 mark the upper and lower borders. In between, there is no significant difference between Group 1 and Group 4 or between Group 2 and Group 4. Accordingly, Group 1 tends to be relatively more agglomerated while Group 2 tends to be a bit less agglomerated.

<< Insert Table 4 around here >>

Figure 1 presents the corresponding dendrogram for the cluster analysis, where we identify five different geographic regions labeled as follows.

> Group 1—*Industrial Districts*. This group's accessibility values indicate that its members are located in rather rural areas and, as our map suggests, often near industrial agglomerations. Their tendency toward agglomeration further indicates a rather specialized spatial pattern of production. The industrial districts of this group evolve over time to become home to smaller manufacturers along the supply chain of large companies in industrial agglomerations. Included in this group is the well-known industrial district of metal producers south of Stuttgart.

> Group 2—*Periphery*. The regions in this group have the worst accessibility scores and a rather diverse industry structure. This group has either already experienced structural change or is in the process of it. One example of a region that belongs to this group is the area around Hof (Upper Franconia), in former times one of Europe's major textile industry locations, but now large

parts of these industries have moved to low wage countries and left a large structural gap of unemployment.

Group 3—*Industrial Agglomeration*. This group has the highest industry concentration and fair accessibility values. Included in this group are production facilities such as the one for BASF in Ludwigshafen, Volkswagen in Wolfsburg, or Audi in Ingolstadt.

Group 4—*Urban Agglomeration.* This group is characterized by the highest accessibility and an average degree of agglomeration. As illustrated in Figure 2, urban agglomerations include metropolises such as Munich, Frankfurt, Cologne, and Hamburg.

Group 5—*Urban Periphery.* This group is quite similar to Group 1. However, it is has slightly better accessibility and less industry agglomeration. In contrast to Group 1, Group 5 benefits more from the metropolis's infrastructure than from its industry structure. Group 5 regions offer centrality and nature-oriented living conditions at a reasonable price and are especially attractive to medium-sized companies of various industries.

<< Insert Figure 2 around here >>

An *establishment file* from German Social Insurance Statistics provides longitudinal information about regional establishments and their employees. The unit of measurement is the establishment, not the company and the empirical data include two categories of entities: firm headquarters and subsidiaries. Each establishment with at least one employee has a permanent individual code number, allowing startups and closures to be identified.[5] Our entry data consist of the number of entries in 23 manufacturing industries in 74 West German planning regions over time (1987–2000).

Because the concern of this paper is on endogenous regional dynamics our focus is on new firms founded by employees who previously worked in the region's incumbent firms. The potential pool of founders in a certain year t in planning region r and industry i is, therefore, the number of employees in region r in $t-1$. We are interested in estimating whether the propensity to start a business varies across the five regional groups. Therefore, we estimate the following count-data Poisson model with group (by region) robust standard errors:

$$\log(E(Entry_{irt})) = \alpha_s + \alpha_i + \beta_{1i} time + \beta_{2i} time? + \beta_{3i} time? + \delta_s empl_{rt-1},$$

where $entry_{irt}$ is the number of new establishments in manufacturing industry i in region r in year t, α_s are fixed effects for our five regional types, and α_i are industry-specific fixed effects. Furthermore, we control for industry-specific dynamics over time by adding *time*, $time^2$, and $time^3$. δ_s is the coefficient of interest. It gives us the group-specific propensity to start a business of regional employees *empl* in year $t-1$.

In a further step we added the share of employees *s_empl* in the respective industry i in region r at time $t-1$ to the model:

$$\log(E(Entry_{irt})) = \alpha_s + \alpha_i + \beta_{1i} time + \beta_{2i} time? + \beta_{3i} time? + \delta_s empl_{rt-1} + \varphi_s s\_empl_{irt-1}$$

[5] The appearance of a new code number is interpreted as a startup, and the disappearance of a code number is interpreted as a closure. New businesses with more than 20 employees in the first year of their existence are excluded. As a result, a considerable number of new subsidiaries of large firms contained in the database are not counted as startups because the foundation of new subsidiaries of large firms is likely to follow different rules than entrepreneurial startups. However, the share of new establishments in the data with more than 20 employees in the first year is rather small (about 2.5%). Ignoring size limits does not lead to any significant change in our results.

The regional group-specific coefficient φ_s can be interpreted as the influence of industry experience on the propensity to start a business, conditional on the number of employees in the region in year $t-1$.

4. Empirical Analysis

Table 5 displays the results of the Poisson model. The concept of a spatial lifecycle suggests that regions at different phases of the lifecycle will exhibit different characteristics. As described in Section 2, we classify the regional lifecycle into four phases where each phase is characterized by (1) the prevailing technological regime—entrepreneurial or routinized—and (2) its knowledge flows—interindustry or intraindustry. To illustrate, Column I of Table 5 shows the average propensity of the total regional population to start a business in a certain manufacturing industry. To this end, we expect entrepreneurial regimes to provide an overall atmosphere that is conducive to new business creation, whereas routinized regimes are less conducive to new business creation. This distinction is clearly reflected in the data, where the periphery (Group 2) and the industrial agglomerations (Group 3) represent routinized regimes, and industrial districts (Group 1), urban agglomerations (Group 4), and the urban periphery (Group 5) are entrepreneurial regimes.

Column II of Table 5 sets forth the one-year lagged share of employees with experience in a respective manufacturing industry, taking into consideration the regional creation of MAR externalities and the propensity that these externalities are commercialized by entrepreneurs who start a new firm in the same industry. Again, the empirical results show a clear pattern: industrial districts (Group 1) and urban peripheries (Group 5) are the most likely to engage in entrepreneurship, while industrial agglomerations (Group 3) are the least likely to do so. MAR externalities exist in the Group 1 and Group 5 regions and influence entrepreneurial intentions, whereas knowledge spillovers into entrepreneurship are of minor importance in industrial agglomerations. Peripheries (Group 2) and urban agglomerations (Group 4) fall in between as far as propensity toward entrepreneurship goes.

4.1. Robustness Checks

For robustness checks, we estimated a negative binomial model that allocates a higher density to the tails of the distribution. Furthermore, we estimated zero-inflated models to account for the fact that zero as an outcome is driven by forces other than the nonzero outcomes. In the inflation model, the number of employees in the respective region and manufacturing industry at the starting point $t = 0$ (1987) entered as explanatory variable. Here, the number of employees in a certain industry in a certain region at $t = 0$ is an indicator of whether industry i existed in region r at the beginning of the period of analyses. The rationale behind this idea is that there might be further barriers to entry in the situation where an industry did not exist at all in a certain region. In all of these specifications, the results are very similar to the basic Poisson model. However, for the sake of completeness, we report these results in the Appendix.

4.2. Results

Taken together, the findings give rise to the following descriptions of our four spatial lifecycle phases.

Phase 1: The Urban Agglomerations (Group 4)

Urban agglomerations provide the creative environment described by Florida (2002) and Glaeser et al. (2001) that attracts headquarters and R&D laboratories from the manufacturing sector. Important drivers of regional knowledge production are the incumbent (basic) research laboratories. However, regional production of knowledge is only a partial explanation; of equal importance is the region's ability to commercialize the new knowledge and create value instead of positive externalities. Urban agglomerations usually live up to these expectations and provide a fertile environment for the commercialization of new ideas—in incumbent firms and also in startups, as indicated by the relatively high propensity to start a business in a manufacturing industry with respect to the overall population. Further, a relatively low value for industry experience suggests that entry is driven more by interindustry spillovers (Jacobs externalities) than by intraindustry spillovers (MAR externalities).

These regional characteristics suggest that urban agglomerations are generated during the first phase of a spatial lifecycle when a rather diverse industry structure along with corresponding Jacobs externalities stimulate a creative atmosphere supportive of leading-edge technological innovation.

Phase 2: The Industrial Agglomerations (Group 3)

Industrial agglomerations are characterized by a high degree of specialization. According to Markusen (1996), these regions are dominated by few large incumbent firms, often called hubs, because there is a concentration of spokes—the suppliers—surrounding them. In industrial agglomerations, workers' loyalties are to the core firms first, then to the district and only after that to small firms. If jobs open up in hub firms, workers will often abandon smaller employers to get onto the hub firm's payroll (Markusen 1996, p. 303). This results in a routinized regime with a low propensity to start a business. Additionally, the low value of the industry experience coefficient suggests that knowledge is processed within incumbent firms and is not likely to spill over into entrepreneurship. However, this routinization does not mean that these large incumbents are not pushing at the technology frontier. They are drivers of innovation in competitive industries, but the large amount of capital needed, along with the importance of specialization and routinization, act as entry barriers.

Given these characteristics, the industrial agglomerations can be regarded as routinized but still innovative regimes at the technology frontier. They are in the second phase of the spatial lifecycle, where innovation is driven by routinized top-performing incumbents.

Phase 3: Industrial Districts and Urban Peripheries

Industrial Districts (Group 1)

Industrial districts are rather specialized regions located in more peripheral areas. However, they benefit from their proximity to centers of industrial production where actual and potential clients are located. Typically, industrial districts are characterized by firms that have specialized in a market segment along the supply chain and in these niche markets they often hold a leading position. This phenomenon is discussed in more detail in Simon's (1996) work on hidden champions, which was recently updated by Venohr and Meyer (2007) with a special focus on Germany. According to these authors, Germany's hidden champions are most likely to be family owned and located in small towns; yet, they may hold as much as 90% of the market share in a niche market. These regions' entrepreneurial atmosphere is reflected in the high propensity of their residents to start a business. Further, MAR externalities are important in these regions because new firms are likely to start in niche markets where they specialize in the further development of an existing product. In doing so, they benefit from the tendency of vertical disintegration that occurs when specialized suppliers cooperate closely with downstream firms.

Given that firms in industrial districts are not creating new products but are, instead, further developing or optimizing existing ones, we place industrial districts in the third phase of the spatial lifecycle. In this phase, mass markets create room for incremental innovations in niche markets.

Urban Peripheries (Group 5)

Urban peripheries are the least agglomerated and can be found in proximity to urban agglomerations. This suggests that urban peripheries profit from proximity to urban agglomerations but retain certain advantages of not being part of the urban agglomeration itself, for example, lower real estate prices. Therefore, they are likely to be the home of specialized small and medium-sized companies. Similar to industrial districts, these regions are likely to produce hidden champions. However, whereas the hidden champions of industrial districts seemingly benefit from their proximity to centers of industrial production and the accompanying specific demand, the hidden champions of urban peripheries appear to benefit from their connection to an urban agglomeration and its correspondingly diverse demands. This is reflected in the tendency of urban peripheries to be less agglomerated and thus less specialized. Further, we know that the intense dynamics of an urban agglomeration spreads to supplier markets where the need for flexibility creates an entrepreneurial atmosphere. And, in fact, there is a high degree of entrepreneurship in urban peripheries. Moreover, the high importance of former industry experience suggests that startups in the urban peripheries rely on existing knowledge and experience instead of being radically innovative. This supports our assumption that urban peripheries are also home to businesses that concentrate on improving existing products for niche markets.

We place urban peripheries in the third phase of the spatial lifecycle and for the same reasons as we placed industrial districts in that phase. They are characterized by entrepreneurship, but it is an entrepreneurship grounded in incremental innovations based on intraindustry experience, instead of one more focused toward the truly new.

Phase 4: Peripheries (Group 2)

Peripheries are regions located in less accessible geographic areas—they have the lowest accessibility scores. Further, the propensity for these regions to be less agglomerated suggests that they are lacking distinct industry structure. When we examine a few of the regions classified as peripheries, one explanation for this lack of industry structure becomes clearer: these regions are or have been subject to massive structural change and are about to realign. Take, for example, Higher Franconia, formerly the European center of textile and pottery production. However, globalization, and all that the term implies regarding wage and transportation costs, led to this region losing its competitiveness, leaving behind an enormous population of low-skilled workers. This type of region is hit exceptionally hard by structural change, as it does not have a large enough or appropriate stock of regional knowledge that could act as the basis for a new, competitive industry. Unsurprisingly, residents of this type of region have a very low propensity for starting a business. Nonetheless, the relatively high importance of the share of employees with industry experience suggests that former industry experience and the corresponding MAR externalities could support at least some start-up activity in this type of region. However, such startups, to be successful, urgently need to broaden their previous industry experience by combining it with the latest high-tech knowledge (e.g., former cloth producers who have a great deal of experience with textiles could combine this experience with new technology to produce high-tech textiles for the aerospace industry).

We place peripheries in the fourth and last phase of the spatial lifecycle to emphasize that these regions are at the end of their current life. Their only hope is to be reincarnated in the future, but the shape of their reincarnation will have less to do with karma, and everything to do with creativity and a corresponding commercialization of entrepreneurial opportunities.

5. Conclusions

Our results demonstrate the saliency of the regional lifecycle. We demonstrate that regional dynamics are affected by the stage at which a region is operating. The finding allows us to make a general distinction between entrepreneurial and routinized regions. We find two types of entrepreneurial and two types of routinized regions that vary along a spatial lifecycle. The first phase of the lifecycle is characterized by an entrepreneurial atmosphere and interindustry spillovers, the second one by routinization and innovation by incumbents, the third by a type of aging entrepreneurship that is more concerned with the creation of niche markets than with the development of new products, and, finally, the fourth phase, which is one of structural change. Here, new structures must be developed eventually the region's position along the lifecycle.

We add to the literature in three ways: First, we integrate the literature to provide a spatial lifecycle model. Second, we categorize regions along this spatial lifecycle with regard to their knowledge creation capability; third, we test the importance of the existence of knowledge spillovers for start-up dynamics along the regional lifecycle.

Within entrepreneurial regions, we argue that one type, the Urban agglomerations, benefits from interindustry spillovers (Jacobs externalities), leading to radical product innovations while the other tow types, Urban Peripheries and Industrial Districts, both benefit from intraindustry spillovers (MAR externalities), leading to incremental innovations in niche markets. Regarding the two routinized groups of regions, we argue that in one type**,** the industrial agglomerations, knowledge is both created and absorbed by highly specialized incumbents. Their efficient knowledge production contributes to their competitiveness, but it also prevents the emergence of externalities. In the second type of regions, the peripheries, knowledge flows are of high importance but very scarce. This situation arises when a structural change leads to a high depreciation of the regional knowledge stock and thus very little potential for spillover.

Applying a regional count-data model for the number of startups in a region, we find that dynamics influenced by entry are high in urban agglomerations, urban peripheries, and industrial districts. In contrast, dynamics influenced by entry are of minor importance in industrial agglomerations and peripheries. In entrepreneurial regions, new firm entry drives dynamics; in routinized regions, dynamics spring—if at all—from incumbent firms. In our analyses, we emphasized the importance of the regional knowledge stock and its creation and diffusion. Depending on the phase of a region's routinization, knowledge creation is accompanied by a varying degree of spillovers. Further, the degree of agglomeration determines whether knowledge spillovers will be contained within the same industry and lead to improvements or inspire radical innovations in other industries.

These initial findings provide a rich basis for further research. Does mobility between regions mean that knowledge may be imported, and, if so, what are the ramifications of this on economic growth and diversity? How, exactly, does a regional knowledge stock develop? How do historic events, cultural linkages, or geographic characteristics influence its development? Does supply and demand play any part in the accumulation of regional knowledge stock? We are well aware that proper use of customer feedback can drastically decrease the time needed to get a desirable product to market, but might it not be the case that customer feedback could have an impact on a company's position on the spatial lifecycle, too? We hope these questions spark an interest, and in doing so, simulate further research.

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Figure 1: Regional Groups in West Germany

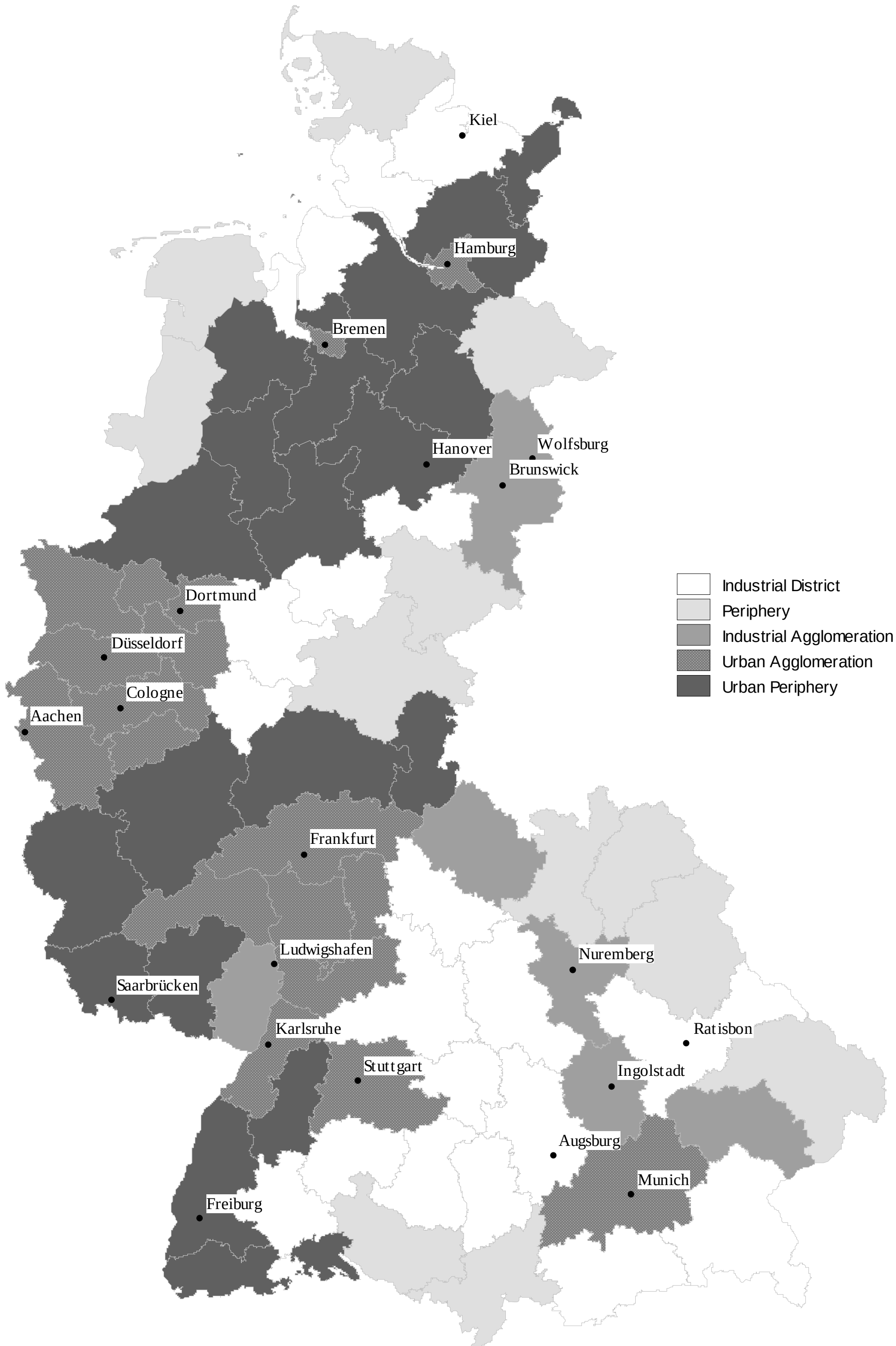

Figure 2: Dendrogram

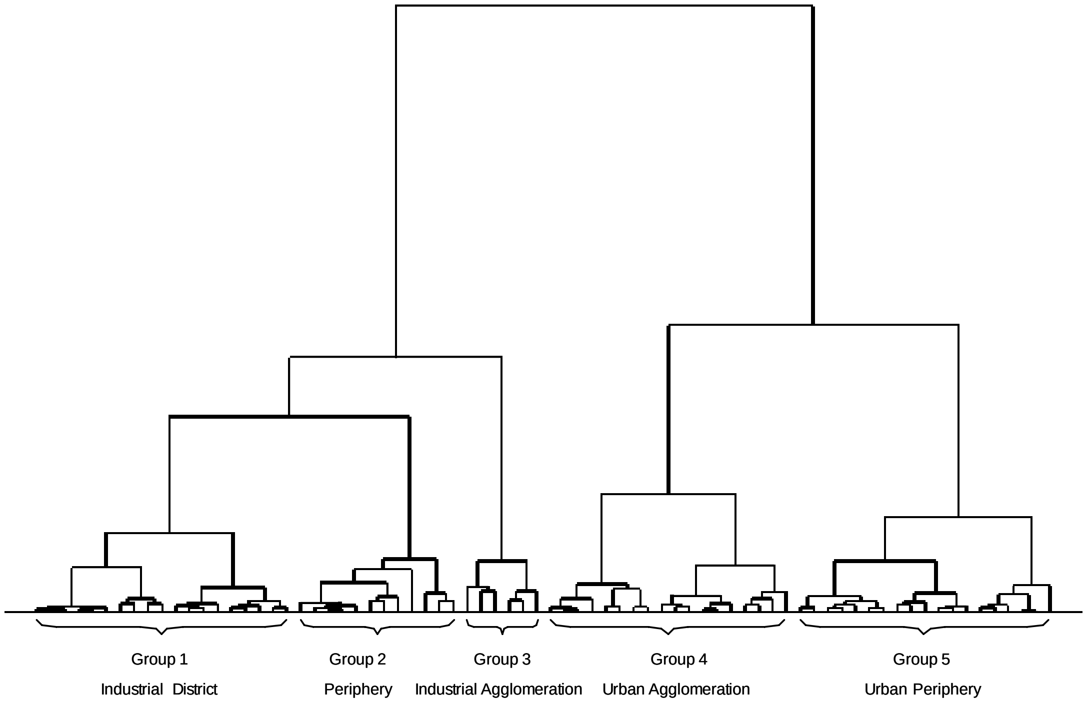

Table 1: Regional variables entering the factor analysis

Variable	Description Source	
Infrastructure 1	Accessibility of the nearest three national or international agglomerations via road and rail combined (in minutes); 2004 *Federal Office for Building and Regional Planning*	Quality of regional infrastructure
Infrastructure 2	Accessibility of European metropolis via road and air combined (in minutes); 2004 *Federal Office for Building and Regional Planning*	
Infrastructure 3	Availability of modern transportation system (accessibility in minutes); 2004 *Federal Office for Building and Regional Planning*	
Share of employees in manufacturing	Share of employees in manufacturing compared to total number of employees subject to social security; average over the timespan 1987–2000 *Social Insurance Statistics*	Agglomeration economies
Herfindahl index in manufacturing	Sum of the squares of the employment shares of each industry in manufacturing; average over the timespan 1987–2000 *Social Insurance Statistics*	
Technological regime	Share of employees with a degree in engineering or natural science in small businesses compared to total number of employees with a degree in engineering or natural science; average over the timespan 1987–2000 *Social Insurance Statistics*	
Share of small business employment	Share of small business employment (businesses with at most 50 employees); average over the timespan 1987–2000 *Social Insurance Statistics*	Diversity /Jacobs externalities
Share of employees in business-related services	Share of employees in business services compared to total number of employees subject to social security; average over the timespan 1987–2000 *Social Insurance Statistics*	
Share of bohemians	Share of publicists, musicians, actors, painters, and designer compared to total number of employees subject to social security; average over the timespan 1987–2000 *Social Insurance Statistics*	
Share of patents applied for by natural persons	Share of patents applied for by natural persons; average over the timespan 1995–2000 *German Patent Atlas*	
Share of patents applied for by research institutions	Share of patents applied for by universities and research institutes; average over the timespan 1995–2000 *German Patent Atlas*	

T**able 2**: Factor analysis after elimination of variables with important cross-loadings (orthogonal rotation)

	Factor 1	Factor 2
Infrastructure 1	0.76	0.01
Infrastructure 2	0.81	-0.10
Infrastructure 3	0.82	0.11
Share of employees in manufacturing	0.15	0.40
Herfindahl index in manufacturing	0.01	0.53
Technological regime	0.01	-0.68
Eigenvalue	2.03	1.00
Eigenvalue of following factor	1.00	0.27

Table 3: Descriptive statistics

	N° of planning regions	Factor 1		Factor 2	
		Mean	Std. Dev.	Mean	Std. Dev.
Group 1	19	0.39	0.25	0.21	0.33
Group 2	12	1.36	0.39	-0.19	0.47
Group 3	6	0.07	0.72	1.75	0.41
Group 4	18	-1.19	0.28	-0.01	0.57
Group 5	19	-0.14	0.32	-0.63	0.42
Overall	74	0.00	0.91	0.00	0.75

Table 4: Test for equality of mean (t test, Factor 1, Factor 2)

	Group 1	Group 2	Group 3	Group 4	Group 5
Group 1		-8.43*** 2.83***	1.69 -9.25***	17.80*** 1.50	5.74*** 6.78***
Group 2			5.00*** -8.50***	20.66*** -0.90	11.69*** 2.63**
Group 3				6.29*** 6.89***	1.06 11.93***
Group 4					-10.33*** 3.69***
Group 5					
Factor 1: Equality of all means			F-statistic: 101.61***		
Factor 2: Equality of all means			F-statistic: 32.88***		

Results: Poisson Model

	Propensity to start a business	Agglomeration economics
Group 1		
Number of employees in the respective planning region (log, lagged one year)	0.9068** (9.47)	0.8905** (8.98)
Share of employees with industry experience (lagged one year)		0.1067** (6.31)
Group 2		
Number of employees in the respective planning region (log, lagged one year)	0.7187** (13.24)	0.6342** (9.27)
Share of employees with industry experience (lagged one year)		0.0877** (5.79)
Group 3		
Number of employees in the respective planning region (log, lagged one year)	0.7143** (12.61)	0.7334** (14.53)
Share of employees with industry experience (lagged one year)		0.0256** (6.43)
Group 4		
Number of employees in the respective planning region (log, lagged one year)	0.8934** (14.51)	0.8934** (14.30)
Share of employees with industry experience (lagged one year)		0.0793** (3.65)
Group 5		
Number of employees in the respective planning region (log, lagged one year)	0.9385** (13.84)	0.9005** (17.22)
Share of employees with industry experience (lagged one year)		0.1126** (6.94)
Stats		
Equality of the added coefficients over the 5 clusters (Chi²)	12.17*	53.32**
Number of obs	33670	33670
Log pseudolikelihood	-66380.40	-64229.09

Dependent variable: number of startups (35 manufacturing industries x 74 planning regions x 14 years)
Controls: 5 group dummies, industry dummies, industry-specific time path (time, time², time³)
Planning regions robust standard errors; z values in parentheses
Inflation model: logit, independent variable: log of number of businesses in 1987
** 1% significance level, * 5% significance level

Appendix: Different Count-Data Models

Appendix 1: Zero-Inflated Poisson Model

	Propensity to start a business	Agglomeration Economics
Group 1		
Number of employees in the respective planning region (log, lagged one year)	0.8684** (9.33)	0.8577** (8.81)
Share of employees with industry experience (lagged one year)		0.1018** (6.03)
Group 2		
Number of employees in the respective planning region (log, lagged one year)	0.6708** (11.26)	0.5941** (8.03)
Share of employees with industry experience (lagged one year)		0.0815** (5.88)
Group 3		
Number of employees in the respective planning region (log, lagged one year)	0.6807** (13.08)	0.6991** (15.13)
Share of employees with industry experience (lagged one year)		0.0241** (5.89)
Group 4		
Number of employees in the respective planning region (log, lagged one year)	0.8803** (14.27)	0.8809** (14.04)
Share of employees with industry experience (lagged one year)		0.0800** (3.71)
Group 5		
Number of employees in the respective planning region (log, lagged one year)	0.9184** (13.68)	0.8830** (17.23)
Share of employees with industry experience (lagged one year)		0.1103** (6.92)
Stats		
Equality of the added coefficients over the 5 groups (Chi^2)	14.87**	50.88**
Number of obs	33670	33670
Nonzero obs	21707	21707
Zero obs	11963	11963
Log pseudolikelihood	-65543.03	-63508.74

Dependent variable: number of startups (35 manufacturing industries x 74 planning regions x 14 years)
Controls: 5 group dummies, industry dummies, industry-specific time path (time, $time^2$, $time^3$)
Planning regions robust standard errors; z values in parentheses
Inflation model: logit, independent variable: log of number of businesses in 1987
** 1% significance level, * 5% significance level

Appendix 2: Negbin Model

	Propensity to start a business	Agglomeration economics
Group 1		
Number of employees in the respective planning region (log, lagged one year)	0.9542** (9.00)	0.9101** (8.55)
Share of employees with industry experience (lagged one year)		0.1374** (6.30)
Group 2		
Number of employees in the respective planning region (log, lagged one year)	0.7286** (13.54)	0.6484** (10.96)
Share of employees with industry experience (lagged one year)		0.1177** (5.99)
Group 3		
Number of employees in the respective planning region (log, lagged one year)	0.7524** (11.44)	0.7579** (12.83)
Share of employees with industry experience (lagged one year)		0.0301** (5.92)
Group 4		
Number of employees in the respective planning region (log, lagged one year)	0.9001** (14.21)	0.9054** (15.85)
Share of employees with industry experience (lagged one year)		0.1241** (6.12)
Group 5		
Number of employees in the respective planning region (log, lagged one year)	0.9492** (13.74)	0.9214** (16.78)
Share of employees with industry experience (lagged one year)		0.1589** (5.93)
Stats		
Equality of the added coefficients over the 5 groups (Chi²)	10.67*	52.51**
Number of obs	33670	33670
Log pseudolikelihood	-61327.49	-60128.36

Dependent variable: number of startups (35 manufacturing industries x 74 planning regions x 14 years)
Controls: 5 group dummies, industry dummies, industry-specific time path (time, time², time³)
Planning regions robust standard errors; z values in parentheses
Inflation model: logit, independent variable: log of number of businesses in 1987
** 1% significance level, * 5% significance level

Appendix 3: Zero-Inflated Negbin Model

	Propensity to start a business	Agglomeration economics
Group 1		
Number of employees in the respective planning region (log, lagged one year)	0.9070** (8.38)	0.8730** (8.35)
Share of employees with industry experience (lagged one year)		0.1288** (4.77)
Group 2		
Number of employees in the respective planning region (log, lagged one year)	0.6745** (12.17)	0.6025** (9.56)
Share of employees with industry experience (lagged one year)		0.1056** (4.85)
Group 3		
Number of employees in the respective planning region (log, lagged one year)	0.7161** (11.85)	0.7231** (12.83)
Share of employees with industry experience (lagged one year)		0.0277** (4.85)
Group 4		
Number of employees in the respective planning region (log, lagged one year)	0.8695** (13.67)	0.8804** (15.35)
Share of employees with industry experience (lagged one year)		0.1236** (4.65)
Group 5		
Number of employees in the respective planning region (log, lagged one year)	0.9195** (13.41)	0.8956** (16.60)
Share of employees with industry experience (lagged one year)		0.1512** (4.42)
Stats		
Equality of the added coefficients over the 5 groups (Chi^2)	12.79**	24.85**
Number of obs	33670	33670
Nonzero obs	21707	21707
Zero obs	11963	11963
Log pseudolikelihood	-60852.74	-59711.32

Dependent variable: number of startups (35 manufacturing industries x 74 planning regions x 14 years)
Controls: 5 group dummies, industry dummies, industry-specific time path (time, $time^2$, $time^3$)
Planning regions robust standard errors; z values in parentheses
Inflation model: logit, independent variable: log of number of businesses in 1987
** 1% significance level, * 5% significance level