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**Clustering as a Pattern of Expansion within
and across Industries**

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Clustering as a Pattern of Expansion within and across Industries

Summary:

The paper analyzes firms' expansion paths within and across industries and specifically different patterns along these paths. Using a procedure previously applied in statistical process control and employing longitudinal data on the expansion of 91 German firms, we analyzed firms' clustering behavior regarding different characteristics. Results reveal that expansion is a heterogeneous process: the clustering behavior along the expansion path does not only differ between firms, but also within one firm regarding different characteristics of its expansion path.

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1 Introduction

In a recent article Gary requested that “there is clearly a need to build a richer theory about diversification [...] capturing the dynamic nature of diversification profiles” (Gary, 2005: 644). The phenomenon of firm growth and expansion has been in the interest of management research for a long time (e.g. Brush, Bromiley, & Hendrickx, 2000; Mishina, Pollock, & Porac, 2004). Specifically, with the advancement of longitudinal research in recent years, scholars became more interested in different patterns of growth and expansion along the development paths of firms (e.g. Vermeulen & Barkema, 2002). However, whereas scholars have analyzed general firm growth (e.g. Baumol, 1962; Penrose, 1959; Tushman & Romanelli, 1985) and the internationalization process as one expression of growth (Henisz & Delios, 2001; Johanson & Vahlne, 1977; Kogut & Chang, 1991; Song, 2002; Vermeulen & Barkema, 2002), there is little dynamic research on the diversification phenomenon – which is another expression of growth.

Within the field of expansion research one characteristic of much interest is the continuity or discontinuity of the expansion path: Do firms expand their operations in a gradual manner or in bursts? Traditional research on firm growth, for example, has developed models explaining the existence of discontinuous firm growth (e.g. Churchill & Lewis, 1983; Greiner, 1972; Marris, 1971; Packer, 1964). These studies, however, did not distinguish different patterns of discontinuity. In the field of international business there are studies both advocating gradual and balanced internationalization paths (e.g. Johanson & Vahlne, 1977; Vermeulen & Barkema, 2002) and those pointing to internationalizing firms engaging in accumulations of international new ventures in concentrated periods of time (e.g. Knickerbocker, 1973; Nicholas, 1991). In diversification research there is, however, no such study dealing with patterns of continuity and discontinuity of firms’ expansion and diversification paths.

With this study, we want to fill that research gap and tie in with Gary’s demand to develop a more comprehensive understanding of a firm’s expansion and diversification path. Specifically, in this paper we try to shed some light on the open empirical question whether and why firms expand in a gradual manner or in spurts. Based on the procedure of statistical process control and based on longitudinal data

on the expansion path of 91 German firms we analyze firms' clustering behavior along the expansion path within and across industries.

The paper is structured in the following manner: The next section presents an overview of prior research. Thereafter, we will give information on our sample and variables. The method of statistical process control, which we use in our study to identify systematic expansion patterns, is specified in the methodology section. The following section provides and interprets the results of this study. We close with a discussion of our findings.

2 Background

2.1 Dynamic Research on Diversification

Although dynamic research on diversification has been requested for years (e.g. Ramanujam & Varadarajan, 1989), to date, there is only little research covering this topic. Most research on the diversification phenomenon depicts diversification as a firm's status at a certain point in time (see for example Palich, Cardinal, & Miller, 2000; Ramanujam & Varadarajan, 1989). A first approach to analyze the diversification process and the dynamic nature of the diversification phenomenon are studies dealing with individual diversification steps. Such research deals for example with expansion through mergers and acquisitions (e.g. Barkema & Vermeulen, 1998; Chatterjee & Singh, 1999; Montgomery, 1994; Singh & Montgomery, 1987), the mode of diversification steps (i.e. through greenfield investment or acquisition-based growth) (e.g. Busija, O'Neill, & Zeithaml, 1997; Chatterjee & Singh, 1999; Pennings, Barkema, & Douma, 1994; Salter & Weinhold, 1979; Salter & Weinhold, 1981; Sharma, 1998; Yip, 1982), or corporate refocusing steps (e.g. Bergh, 1995; Hoskisson & Johnson, 1992; Johnson, 1996; Markides, 1992; Markides, 1995). This kind of research, however, focuses only on single diversification steps and treats them as isolated events. In reality, a firm's diversification path may consist of several subsequent expansion steps. The analysis of the whole path and hence the way in which firms diversify and reach their level of diversity has received little attention. Only some noteworthy exceptions have truly examined a firm's diversification path. Chang (1996) for example analyzed a firm's path of entry and exit decisions. Based on organizational learning theory and the capability based view of the firm he showed that well-directed entries contribute to the improvement of a firm's performance. A

study by Kim and Kogut (1996) stressed that a firm's diversification program is a path-dependent process. They conclude that expansion is related to learning, and that firms diversify according to their current capabilities and past experience. Similarly, Teece, Rumelt, Dosi, and Winter (1994) noted that the level of diversification and specifically the degree of coherence one would expect at a particular point in time depends on the relationship between learning, path dependencies, technological opportunities, complementary assets, and selection. However, there is to our knowledge no study in diversification research investigating patterns on the timing of diversification steps and thus analyzing continuity and clustering along a firm's diversification path.

2.2 Research on Continuous and Discontinuous Firm Expansion

Whereas diversification research has not yet answered the question of how firms cluster their diversification activities over time, other streams of research also dealing with the expansion of firms can provide approaches to start from. In the field of general firm growth, scholars have touched on the phenomenon of continuity and discontinuity of firm growth (e.g. Baumol, 1962; Greiner, 1972; Marris, 1971; Packer, 1964; Tushman & Romanelli, 1985). Whereas some older models propose firm growth as a continuous process (e.g. Arrow, 1958; Chamberlain, 1956; Robinson, 1934), there are other models that can explain the occurrence of discontinuities of firm growth (e.g. Bensoussan, Hurst, & Näslund, 1974; Churchill & Lewis, 1983; Leibenstein, 1960; Mintzberg, 1984). These models, however, do not go beyond the explanation of discontinuity and continuity and do not provide more detailed patterns of firm expansion.

Research in the field of international business can provide further ideas of how to analyze detailed patterns on the timing of expansion. Analogous to diversification, internationalization is one expression of growth. However, it describes a different direction. Whereas internationalization deals with the expansion into new geographic markets, diversification refers to the expansion into new businesses or industries. In contrast to the underdeveloped stream of dynamic research on diversification, the investigation of the internationalization of firms has a rich tradition in the field of international business. Research dealing with this topic can be grouped into two distinct views on the internationalization process of firms (Maitland, Rose, & Nicholas, 2005). On the one hand, scholars analyze the entry into a particular country and the

development of established foreign ventures (e.g. Johanson & Vahlne, 1977). On the other hand, scholars are interested in the evolution of the international firm defined as a network of a parent firm and its subsidiaries (e.g. Bogner, Thomas, & McGee, 1996; Henisz & Delios, 2001; Kogut & Chang, 1991; Lord & Ranft, 2000; Song, 2002; Vermeulen & Barkema, 2002). Independent of the view on the internationalization process of the firm, different results exist regarding expansion patterns. Johanson and Vahlne's (1977) stage model, for example, suggests a gradual international expansion. Other research based on notions such as the liability of foreignness (Hymer, 1976; Zaheer, 1995), ignorance and uncertainty (Vernon, 1966), uncertainty premiums (Davidson, 1980), and information constraints (Martin, Swaminathan, & Mitchell, 1998) support this view. Vermeulen and Barkema (2002) analyzed different characteristics of the international expansion path and their impact on firm performance. They emphasized a positive influence of balanced patterns of international expansion. Specifically, they were able to show that speed of internationalization, spread of markets entered, and the irregularity of internationalization steps negatively affect performance gains from international expansion. In contrast to these studies advocating gradual and balanced internationalization paths, other research by Knickerbocker (1973) and Nicholas (1983; 1991) pointed to internationalizing firms engaging in accumulations of international new ventures in concentrated periods of time. A recent study by Maitland, Rose, and Nicholas (2005) combines these two views on internationalization patterns. They analyzed the clustering patterns of international U.S. manufacturing firms in the timing of their initial investments in foreign countries and identified firms which cluster their international investments over time as well as firms that continuously invested abroad.

2.3 Reasons for Continuous and Discontinuous Firm Expansion

There is a debate in the literature dealing with the question of how firms expand and whether their expansion is in a gradual manner or in spurts. So far earlier research has given some possible explanations for continuity and discontinuity in firm expansion. A first explanation for a discontinuous expansion path of firms can be given based on resource-based considerations. The expansion process is a complex task since it is associated with the replication, addition, and recombination of existing routines (Nelson & Winter, 1982). Complexity results from the disruption of tacit

coordination mechanisms for routines (Mishina, et al., 2004). A firm, however, is limited in its ability to manage this complexity since only a fraction of available managerial resources can be used for the execution of expansion (Penrose, 1959) and managers suffer bounded rationality and information processing limits (Cyert & March, 1963; Hoskisson & Hitt, 1988; March & Simon, 1958; Simon, 1959). If a firm expands extensively, it is likely that complexity associated with expansion taxes available managerial resources beyond their capacity (Gary, 2005; Mishina, et al., 2004). This results in premature decisions (Stinchcombe, 1965; Tan, 2003) and quality problems (Levitt, et al., 1999; Oliva & Stermann, 2001). Necessary adjustments in the next period require scarce resources that are consequently not available for expansion projects. Consequently, higher complexity of expansion steps will more likely lead to a slow down of the rate of expansion in the subsequent period (Slater, 1980; Tan & Mahoney, 2005). A second explanation can be based on organizational learning arguments. The amount of expansion and new experience a firm can successfully absorb within a certain period of time is limited (Cohen & Levinthal, 1990; Vermeulen & Barkema, 2002). If new experience from expansion comes too fast which happens for example if intervals between expansion steps are short and complexity in a certain period of time is too much, a firm is not able to absorb lessons learned and consolidate them for utilization in the future (Eisenhardt & Martin, 2000; Hayward, 2002). Consequently, firms expanding extensively in one period need a rest in order to absorb new experience. Whereas the first two explanations deal with limitations a firm is facing along its expansion path, a third explanation for infrequent actions and thus discontinuous firm expansion can be the existence of learning trials (Winter 2000).

The explanations given so far provided arguments for discontinuous patterns of firm expansion. There also exist arguments, why a firm wants to exercise a balanced expansion path. A balanced expansion path is characterized by continuously conducting the same amount and type of expansion steps, whereas an unbalanced path consists of peaks and idleness of expansion as well as an inconsistency in the mix of different expansion types and modes. It has been argued that both peaks of exposure and periods of idleness and less exposure lead to reduced absorptive capacity (e.g. Cohen & Levinthal, 1990; Eisenhardt & Martin, 2000; Huber, 1991; Vermeulen & Barkema, 2002). This, however, is less beneficial for firms and thus not desirable. Moreover, changing the characteristics of subsequent expansion steps is

also disadvantageous. This happens when mixing the mode of expansion (i.e. acquisitions and greenfield investment), the geographic scope (international and domestic expansion), or the product scope (relatedness of expansions). Such behavior complicates specialized learning. Experience gained from past actions will not be available for further application since infrequent experience and long time spans between actions promote forgetting previously learned lessons (e.g. Eisenhardt & Martin, 2000; Hayward, 2002; Nelson & Winter, 1982). Thus, a firm can benefit less from past actions and from potential efficiency gains (e.g. Argote, Beckman, & Eppler, 1990).

3 Methodology

3.1 Sample and Data

The detection of patterns and the calculation of the clustering measure are based on longitudinal data on the expansion path of 91 German listed firms over the period from 1985 to 2004. To receive our sample firms we conducted a selection process consisting of several steps. We started our approach with all firms that have been included in the HDAX index, which is an index containing all segments of the German Stock Exchange, in at least one point in time between the initial composition of this index in 1994¹ and the end of 2004. We chose this approach in order to capture firms which declined and were dropped at some point from the index as well as firms which were established or grew and entered the index. From the resulting list of 195 firms we excluded all financial institutions, real estate firms, and purely financial holdings (34 firms). Moreover, we excluded all retailers (15 firms) as well as 11 cross-listed non-German firms (see for similar procedure Vermeulen & Barkema, 2002).² Out of the remaining 135 firms, 30 firms went bankrupt, merged or were taken over and could therefore not be contacted directly. We contacted all remaining ones and requested historical annual reports since 1985. In addition, we compiled historical annual reports for both active and non-active firms from different public sources for the same period of time. However, many firms were not able to provide their reports

¹ For those firms belonging to the HDAX in 1994 we collected data back to 1985 where possible.

² We excluded financial holdings, real estate firms, retailers, and financial institutions since they differ significantly in their business model. Moreover, we excluded cross-listed firms with headquarters outside Germany in order to homogenize the research object and to avoid mediating effects of external factors such as different taxes and labor costs (McDougall & Oviatt, 2000).

for the time prior to the mid-nineties and public sources were sometimes fragmentary. Moreover, annual reports of firms that went out of business were difficult to obtain. We ended up with 91 firms – still active ones as well as some of those that had gone out of business during our period of analysis – for which we were able to compile annual reports for at least five years.³ Our sample is not a random one. However, a means test indicated that the excluded firms did not significantly differ from the sample firms in terms of employees, total liabilities, total assets, and EBIT (see Carpenter & Fredrickson 2001 for a similar procedure; see table 1 for an overview).

Variables	Mean	S.D.	Mann-Whitney Test		t-Test	
			z	Sig.	t	Sig.
Employees	30,083.84	64,847.11	0.43	not	0.21	not
Sample Firms	30,895.70	67,043.24				
Excluded Firms	28,324.80	60,557.94				
Total Liabilities	5,248.93	16,638.63	-0.39	not	-0.80	not
Sample Firms	4,470.28	13,032.66				
Excluded Firms	6,898.92	22,564.05				
Total Assets	6,977.34	20,073.49	-0.31	not	-0.65	not
Sample Firms	6,195.29	16,632.17				
Excluded Firms	8,653.16	26,129.51				
EBIT	332.49	810.52	1.37	not	0.58	not
Sample Firms	360.09	841.78				
Excluded Firms	271.89	743.64				

Table 1: Comparison Sample Firms and Excluded Firms

The unit of analysis in this study was individual expansion steps of the sample firms during the time of analysis. Therefore, we extracted data on new subsidiaries from the annual reports of these firms (Barkema, Bell, & Pennings, 1996; Barkema, Shenkar, Vermeulen, & Bell, 1997; Vermeulen & Barkema, 2002). We included all new affiliates regardless whether they are greenfield investments/acquisitions as well as domestic/foreign subsidiaries. In order to be able to qualify each expansion step regarding its distance from already existing subsidiaries, we constructed a longitudinal database containing data on the annual portfolio of affiliates. Therefore,

³ We were able to gather data on 11 non-surviving firms while we were not able to compile annual reports for 19 non-surviving firms. Hence, although we tried to avoid a potential survivor bias by our approach to data collection, we still have a difference in percentages of non-surviving firms between our final sample of 91 firms and the sample of 135 firms for which we tried to obtain annual reports (12% of non surviving firms in the first, 22% in the latter).

we did not only collect expansions but also detected the portfolio at the beginning of the first period as well as dissolutions of subsidiaries. This information was originally sourced from announcements of expansion steps and dissolutions in the management report as well as from changes in the composition of the list of affiliates reported in the appendix of annual reports. Since the HGB (German Accounting Standard) requires listed firms to report all entities of which the firm owns at least 20 percent⁴ in the list of affiliates, we were able to create a comprehensive database of expansion steps. This complex and time-consuming approach of extracting expansion steps from annual reports was necessary as similar comprehensive data is not available for German firms from any kind of commercial database. After having completed our longitudinal database, we contacted the firms again and tried to verify our data. Eight firms were willing to check our data for completeness and accuracy. This check showed that we had only missed a few minor expansion steps. Table 2 provides an overview of expansion steps conducted by our 91 sample firms during 1985 and 2004. We were able to collect a total of 3,503 expansion steps, of which 1,996 have been conducted via acquisitions and 1,507 via greenfield investment. 61 percent (2,124) of the new affiliates were located abroad. On average, a firm conducted 3.6 expansion steps per year. Table 2(a) gives a breakdown of average annual expansion steps per firm for every year. This analysis is further divided by different modes and locations of expansion. Our data show that the ratio between acquisitions and greenfield investments as well as between international and domestic expansion varies during time. Table 2(b) displays the frequency of average annual expansion steps for different modes and locations of expansion. Each firm is carrying out expansion projects. However, there are five firms that did never acquire as well as seven firms that conducted all of their expansion steps via acquisition. Furthermore, there are four firms in our sample that did not internationalize at all during the time frame of our analysis as well as four firms that did all of their expansion steps abroad.

⁴ With the introduction of the KonTraG (regulatory standard) in 1998, listed firms in Germany even have to include those entities into their list of affiliates of which they own five percent or more.

(a) Average Annual Expansion Steps per Company

	Expansion Steps per Year (per Company Average)																						Total
	1985		1986		1987		1988		1989		1990		1991		1992		1993		1994		1995		
	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD	
Mode																							
Acquisition	2.3	4.9	1.3	1.8	1.2	1.4	1.4	1.8	2.3	4.2	3.8	7.3	3.5	6.0	2.5	5.5	1.7	2.1	1.5	1.7	2.1	2.6	
Greenfield	0.8	1.2	0.9	1.9	1.3	3.1	1.4	3.4	1.2	1.5	2.3	2.7	2.5	5.8	2.1	2.8	1.3	1.8	1.4	2.2	2.2	7.5	
Location																							
International	2.0	4.9	1.1	2.3	0.8	1.1	1.3	2.1	1.8	2.3	2.2	3.3	3.1	5.2	2.5	3.9	2.3	2.2	1.7	1.8	2.0	2.8	
Domestic	1.1	1.7	1.1	1.5	1.7	3.3	1.5	3.3	1.6	3.3	3.9	5.5	2.9	6.6	2.2	4.2	0.7	0.8	1.2	2.8	2.4	7.6	
Total Steps	3.1	4.9	2.2	3.3	2.5	3.9	2.8	4.1	3.4	4.7	6.1	8.4	6.0	10.9	4.7	7.5	2.9	2.4	2.9	3.5	4.4	8.1	
	Expansion Steps per Year (per Company Average)																		Total				
	1996		1997		1998		1999		2000		2001		2002		2003		2004						
	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD	av	SD					
Mode																							
Acquisition	1.8	2.3	2.5	5.1	2.1	2.5	2.5	4.0	2.9	5.2	1.9	2.3	1.6	2.8	1.6	4.8	1.1	1.9			1996		
Greenfield	2.1	7.0	1.6	2.2	1.8	4.2	2.0	3.3	1.6	2.6	1.2	1.8	1.1	2.3	1.4	2.7	1.0	2.3			1507		
Location																							
International	2.1	3.0	2.5	3.9	2.3	2.5	3.3	4.8	2.9	4.6	2.2	2.8	1.9	3.8	2.3	5.1	1.2	2.0			2124		
Domestic	1.8	6.5	1.7	4.3	1.6	4.4	1.2	1.8	1.7	3.4	0.9	1.3	0.8	1.3	0.6	1.4	0.8	3.0			1379		
Total Steps	3.9	7.2	4.2	5.8	3.9	5.4	4.5	5.4	4.5	6.5	3.1	3.2	2.7	4.2	2.9	5.8	2.0	3.5			3503		

(b) Frequency of Average Annual Expansion Steps per Company

Frequency of Expansion Steps per	Number of Companies					Total
	Mode		Location			
	Acquisition	Greenfield	International	Domestic		
0	5	7	4	4	0	
0.1 - 0.9	30	37	27	55	12	
1.0 - 1.9	22	21	19	12	23	
2.0 - 2.9	15	14	14	9	14	
3.0 - 4.9	14	9	19	7	24	
5.0 - 10.0	4	2	6	3	13	
> 10.0	1	1	2	1	5	
Total number Companies	91	91	91	91	91	

Table 2: Overview Expansion Steps

3.2 Variables

To obtain a rich characterization of firms' expansion paths, we considered a number of variables that capture different aspects of a firm's expansion. Specifically, we constructed the following variables: *number of expansion steps*, *total product scope of expansion*, *average product scope of expansion*, *number of internationalization steps*, *degree of internationalization*, *number of acquisitions* and *degree of acquisition*.

Number of expansion steps. This variable is a yearly measure that counts the number of investments of the firm into new entities.

Total product scope of expansion and average product scope of expansion. The *product scope of expansion* of one expansion step is a measure of relatedness of that expansion step with the business portfolio of the diversifying firm. We measured relatedness using 4-digit SIC-codes.⁵ Our measure is based on prior work by Halebian and Finkelstein (1999) who measured relatedness between two acquisitions. Following their conceptualization we compared 4-digit SIC-code(s) of the diversification step with those of the existing businesses⁶ and constructed a weighting scheme. Matches on more levels of the SIC-code indicate higher relatedness. Thus, greater weight was assigned to the case of no match, followed by 1-digit SIC-code matches, 2-digit, 3-digit and then 4-digit matches indicating that the case of no match has the lowest relatedness.⁷ To measure the *total product scope of expansion*, we summed up the scores of all expansion steps during one year; *average product scope of expansion* was calculated as the total product scope of expansion divided by the number of expansion steps in that year.

Number of internationalization steps. This variable counts the number of yearly expansion steps that have been conducted abroad.

Degree of internationalization. We calculated the *degree of internationalization* by dividing the number of expansion steps into foreign geographic markets in a given year by all expansion steps of that firm in the same year.

Number of acquisitions. This variable counts the number of yearly expansion steps a firm conducts via acquisition.

Degree of acquisition. We calculated this measure as the percentage of expansion steps exercised by acquisitions on all expansion steps within any given year.

⁵ Measuring relatedness by using SIC-codes is a common practice in diversification research (Morck, et al., 1990; Palepu, 1985).

⁶ Thereby, we compared the SIC-code of the new entity only with the most similar entity in the portfolio (Teece, Rumelt, Dosi, and Winter, 1994). Consequently, we computed for every new entity the distance to all already existing businesses and took only the minimum into account.

⁷ We assumed a linear distribution for the weighting scheme over different SIC-code matches. We applied the following values for matches: if the SIC-codes of the new expansion step and of one of the firm's already existing businesses matched, the expansion step was assigned a 1 at the 4-digit level, a 2 at the 3-digit level, a 3 at the 2-digit level and a 4 at the 1-digit level. No match was assigned a score of 5.

3.3 Measurement Technique

The identification of patterns in data is a difficult endeavor. In a first step it is often done by case study research whereby within and across case patterns are analyzed (for an overview see for example Eisenhardt, 1989). Whereas this approach is justifiable for theory building, it is not applicable to generate measures which can be used for statistical comparison of expansion patterns between firms. Moreover, when dealing with time-series data, the visual assessment of patterns in this longitudinal data is overly complex and difficult to accomplish. One way to overcome these problems is the creation of measures that map certain characteristics of the expansion program. This was for example done by Maitland, Rose, and Nicholas (2005) who investigated clustering behavior along firms' internationalization paths with the help of a procedure drawn from statistical process control theory (SPC). We follow their approach for the examination of clustering patterns along the diversification path of our German sample firms.

The method of statistical process control (SPC) is most often applied to quality control in manufacturing (Shewhart, 1931). However, due to its primary function of identifying patterns over time it can be applied to any type of measurable time-series process (Roberts, 1993). Thus, it is also applicable for our purpose of analyzing diversification paths. The building block of SPC is the differentiation of two types of variation over time: common cause and special cause. Common cause variation is the variation associated with a stable process which shows no statistically significant differences; whereas special cause variation is typical for non-stable, atypical processes which exhibit statistically significant differences (Maitland, et al., 2005). SPC tries to balance over-reaction to common cause variation and under-reaction to special cause variation. Translated into our context of clustering patterns along the diversification path, over-reacting to common cause variation would lead to incorrectly identifying a non-significant cluster (Maitland, et al., 2005).

Following Maitland et al. (2005), the development of our clustering measure is based on zone charts which are one of several control charts in SPC. This type of chart allows the derivation of a clustering measure based on the history of expansion steps along the diversification path. Moreover, this measure allows the inclusion of both within- and between-year variation. We speak of within-year clustering if a firm sets up several new entities in one year, whereas between-year clustering deals with the

accumulation of expansion steps in consecutive years. Furthermore, the measure is robust against different lengths of the period of analysis. Thus, firms with varying periods of analysis can be made comparable. For the computation of the clustering measure several steps have to be taken. In the following we will briefly describe them:

First, for each firm the time-series of expansion steps per year has to be generated. In the following, x_{it} represents the number of expansions steps by firm i in year t . Each x_{it} constitutes one observation in the zone chart. Moreover, based on these figures, the mean of expansion steps per year (\bar{x}_i) and the standard error (se_i) have to be calculated for each firm.

Second, for each firm an individual zone chart has to be constructed. Based on the figures \bar{x}_i and se_i calculated before, seven lines are included into each zone chart: \bar{x}_i , $\bar{x}_i \pm se_i$, $\bar{x}_i \pm 2se_i$, and $\bar{x}_i \pm 3se_i$. The position of observations within these lines is one determinant of the assignment of points to each observation.

Third, each observation will be assigned a point value. These points will later be used for the calculation of the clustering measure. The point value of each observation is assigned by two determinants. On the one hand, the point assignment is determined by the position of the observation within the lines mentioned above and thus the distance from the mean ($|x_{it} - \bar{x}_i|$). Point values for different zones regarding the distance from the mean are given in table 3. This way of determining points captures within-year variation. On the other hand, point values for each observation further depend on earlier observations and the relative position to them. This allows capturing of between-year variation. Therefore, a valuation scheme is applied in which point values of single observations also depend on accumulated points of earlier observations. To put it another way, each point value assigned consists of two components: the value concerning the observation's position relative to the mean (see table 3) and the value of accumulated points of earlier observations. If one observation is situated on the same side of the mean (\bar{x}_i) in the zone chart as its previous observation, then the point value assigned to the respective observation is calculated as the addition of the point value depending on the position relative to the mean and the point value from the prior year's observation. This addition continues until one observation crosses the mean line. When the mean line is crossed, the accumulation process restarts from zero, meaning that for the first observation after

the crossing the point value consists only of the component determined by the position relative to the mean.

Zone	Position in Zone Chart (relative to mean)	Point Value
1	Within 1 standard error from both sides of mean	0
2	Between 1 and 2 standard errors below or above mean	2
3	Between 2 and 3 standard errors below or above mean	4
4	3 or more than 3 standard errors below or above mean	8

Table 3: Assignment of Point Values for Calculation C_i

Fourth, after having assigned the point values for each observation, the clustering measure can finally be computed. Thereby, one clustering measure C_i can be calculated for each firm by averaging the point values of each observation. This is equivalent to calculating the fraction consisting of the sum of all value points assigned per firm over the period of analysis (numerator) and the number of years of the period of analysis (denominator).

In order to clarify the calculation of the clustering measure we will give an example using the expansion path of one of our sample firms (Altana). The number of expansion steps in each year and the assignment of points to each observation are given in table 4. Moreover, we graphically illustrate the procedure in figure 1. Altana established at least one new entity in each of the 20 years observed. On average, it undertook $\bar{x}_{Altana} = 2.50$ expansion steps per year, with an estimated standard error of $se_{Altana} = 1.57$. The six expansion steps in year 1 are between two and three standard errors above the mean. Therefore, the first observation is assigned a value of four points. In year two Altana undertook only one expansion step, which is within one standard error of the mean. The point value for this zone is zero.

Furthermore, the mean was crossed and thus accumulated points of earlier observations are not credited. A transfer of points takes place with observations nine and ten. In those years Altana set up five new entities in each year. Observation nine is between one and two standard errors above the mean and therefore receives two points. The observation in year ten is also located between one and two standard errors above the mean. This location also gives two points. However, since the mean was not crossed between year nine and ten, the total point value is the summation of two points due to the location regarding the mean and another two points transferred from earlier observations. The summation, however, was stopped at this point since the next observation crossed the mean again. In total, Altana collected 10 points

(4+2+4=10) during 20 years. Hence, the clustering measure for Altana can be calculated as $C_{Altana} = 10/20 = 0.5$.

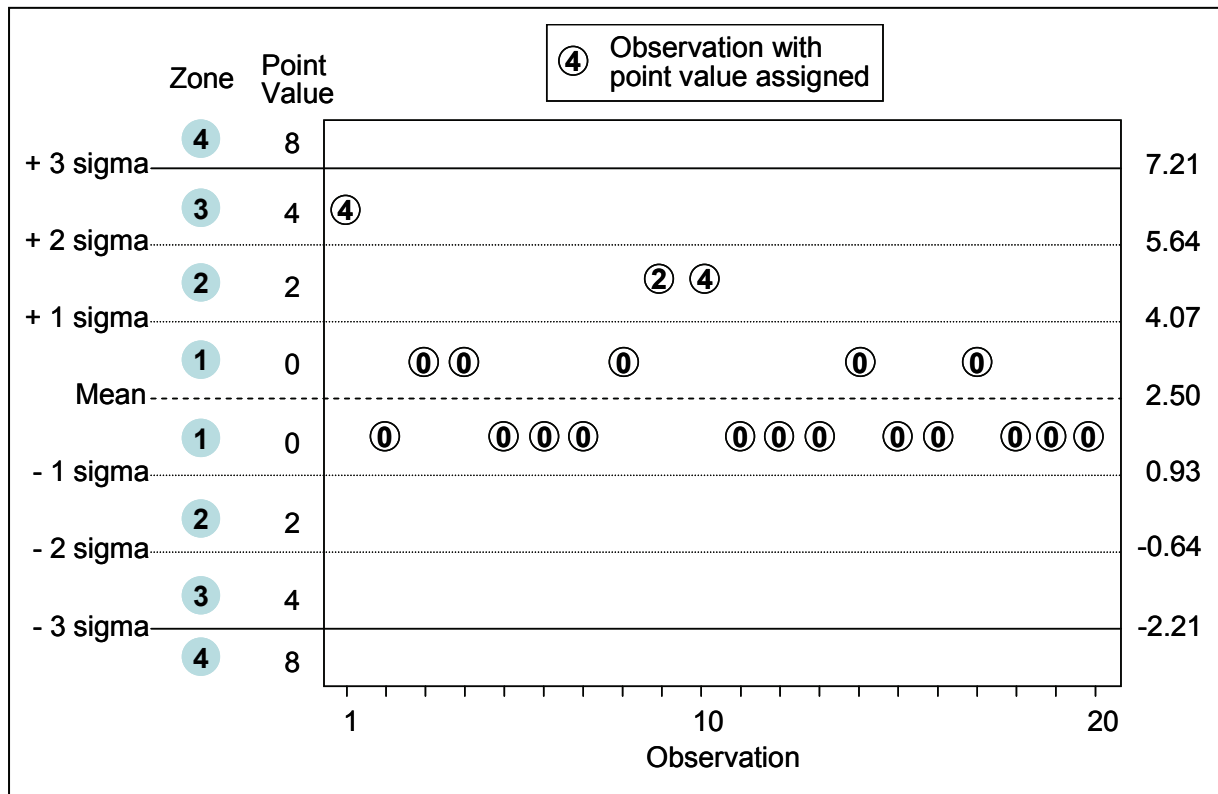


Figure 1: Example Zone Chart for firm Altana

In sum, the clustering measure C_i is high when a firm engages in bursts of activities, interspersed by lulls, i.e. if there are years in the expansion history in which the firm showed far more or far less expansions (+/- 1 sigma) than on average. This is intensified if the peaks and lulls of activities have a longer duration, i.e. if there are consecutive years in which these occasions of expansions far above or below the average exist.

1 st column	2 nd column	3 rd column	4 th column	5 nd column	6 nd column	7 nd column
Year (t)	Number expansion steps ($X_{Altana,t}$)	Position within the zone chart	Point value of observation due to	Accumulated points if no mean crossing	Mean crossing	Total point value of single observation
1	6	Zone 3	4			4
2	1	Zone 1	0	0	Yes	0
3	3	Zone 1	0	0	Yes	0
4	3	Zone 1	0	0	No	0
5	2	Zone 1	0	0	Yes	0
6	1	Zone 1	0	0	No	0
7	1	Zone 1	0	0	No	0
8	4	Zone 1	0	0	Yes	0
9	5	Zone 2	2	0	No	2
10	5	Zone 2	2	2	No	4
11	1	Zone 1	0	0	Yes	0
12	2	Zone 1	0	0	No	0
13	2	Zone 1	0	0	No	0
14	3	Zone 1	0	0	Yes	0
15	1	Zone 1	0	0	Yes	0
16	1	Zone 1	0	0	No	0
17	4	Zone 1	0	0	Yes	0
18	2	Zone 1	0	0	Yes	0
19	2	Zone 1	0	0	No	0
20	1	Zone 1	0	0	No	0
Mean	2.50					
S.D.	1.57					
Zone 1	$0.93 < X_{Altana,t} < 4.07$					
Zone 2	$-0.64 < X_{Altana,t} \leq 0.93$ or $4.07 \leq X_{Altana,t} < 5.64$					
Zone 3	$-2.21 < X_{Altana,t} \leq -0.64$ or $5.64 \leq X_{Altana,t} < 7.21$					
Zone 4	$X_{Altana,t} \leq -2.21$ or $X_{Altana,t} \geq 7.21$					

Table 4: Example for Assignment of Point Values for Firm Altana

4 Results

For all of our 91 sample firms we calculated the clustering measure C_i . According to our variables characterizing a firm's expansion path, we were able to create seven different clustering measures for each firm. Separate measures for *number of expansion steps*, *total product scope of expansion*, *average product scope of expansion*, *number of internationalization steps*, *degree of internationalization*, *number of acquisitions*, and *degree of acquisition*, respectively, give us the opportunity to construct a multi-faceted and more comprehensive picture of the clustering behavior along a firm's expansion path within and across industries.

Our 91 firms have values for C_i (number of expansion steps) ranging from 0.22 to 2.40, with a mean of 0.98 and a standard deviation of 0.55. The clustering measures

(C_i) for the variable total product scope of expansion (average product scope of expansion) spread from 0.31 (0.00) to 2.56 (22.00) with a mean of 0.89 (2.44) and a standard deviation of 0.48 (4.46). Statistics for C_i for the other variables can be found in table 5.

The values for C_i differ between various variables. This is mainly due to different clustering behavior for various characteristics describing an expansion path. These differences can be visualized using histograms of C_i (see figure 2). It can be seen that the distribution of C_i for *number of expansion steps* differs from the distribution of C_i for other variables. Their distributions are quite skewed. Thus, firms' clustering patterns based on *number of expansion steps* display a more heterogeneous picture.

Based on the calculated values for C_i we are able to distinguish between clustering and non-clustering firms. Those firms with C_i values exceeding the upper limit of the 95% confidence interval for the mean (i.e. C_i [number of expansion steps] > 1.10) are defined as clustering firms. 36 of 91 of our sample firms show temporal clustering regarding their number of expansion steps. For other variables we could find other firms that display temporal clustering behavior (n=32 for total product scope of expansion; n= 10 for average product scope of expansion; n=5 for number of internationalization steps; n=16 for degree of internationalization; n=11 for number of acquisitions; and n=16 for degree of acquisition). Table 5 also provides descriptive statistics for the clustering and non-clustering sub-samples. The values of the 95% confidence intervals for the means do not show overlaps for any of our variables providing a good indication for a clear separation between the two sub-samples.

Variable	Group	N	Mean	Median	SD	95% confidence interval for mean	Minimum	25th percentile	75th percentile	Maximum
Number of Expansion Steps	All	91	0.984	0.857	0.547	(0.87; 1.10)	0.222	0.513	1.243	2.400
	Clustering	36	1.548	1.407	0.388	(1.42; 1.67)	1.111	1.200	1.912	2.400
	Non-Clustering	55	0.616	0.571	0.226	(0.56; 0.68)	0.222	0.400	0.800	1.091
Total Product	All	91	0.894	0.800	0.483	(0.79; 0.99)	0.308	0.526	1.143	2.556
	Clustering	32	1.420	1.240	0.405	(1.28; 1.56)	1.000	1.143	1.579	2.556
	Non-Clustering	59	0.608	0.571	0.195	(0.56; 0.66)	0.308	0.400	0.800	0.941
Average Product	All	91	2.442	1.000	4.458	(1.53; 3.36)	0.000	0.536	1.500	22.000
	Clustering	10	14.240	14.000	4.565	(11.41; 17.07)	4.400	12.500	16.000	22.000
	Non-Clustering	81	0.985	0.800	0.682	(0.84; 1.13)	0.000	0.500	1.333	3.125
Number of Internationalization Steps	All	91	1.552	0.800	4.094	(0.71; 2.39)	0.000	0.500	1.156	36.000
	Clustering	5	14.333	10.000	12.512	(3.37; 25.30)	3.667	10.000	12.000	36.000
	Non-Clustering	86	0.809	0.697	0.457	(0.71; 0.91)	0.000	0.441	1.000	2.222
Degree of Internationalization	All	91	2.151	0.800	4.303	(1.27; 3.03)	0.000	0.571	1.889	36.000
	Clustering	16	8.227	5.856	7.814	(4.40; 12.06)	3.143	4.650	8.342	36.000
	Non-Clustering	75	0.854	0.667	0.674	(0.70; 1.01)	0.000	0.571	1.100	3.000
Number of Acquisitions	All	91	1.537	0.700	2.846	(0.95; 2.12)	0.286	0.500	1.143	16.000
	Clustering	11	7.343	4.000	5.445	(4.13; 10.56)	2.222	2.497	12.000	16.000
	Non-Clustering	80	0.739	0.623	0.368	(0.66; 0.82)	0.286	0.493	0.889	2.000
Degree of Acquisition	All	91	2.295	1.111	3.355	(1.61; 2.98)	0.000	0.703	1.923	16.000
	Clustering	16	8.194	7.417	4.519	(5.98; 10.41)	3.000	4.114	12.000	16.000
	Non-Clustering	75	1.036	0.889	0.649	(0.89; 1.18)	0.000	0.641	1.333	2.941

Table 5: Descriptive Statistics for C_i

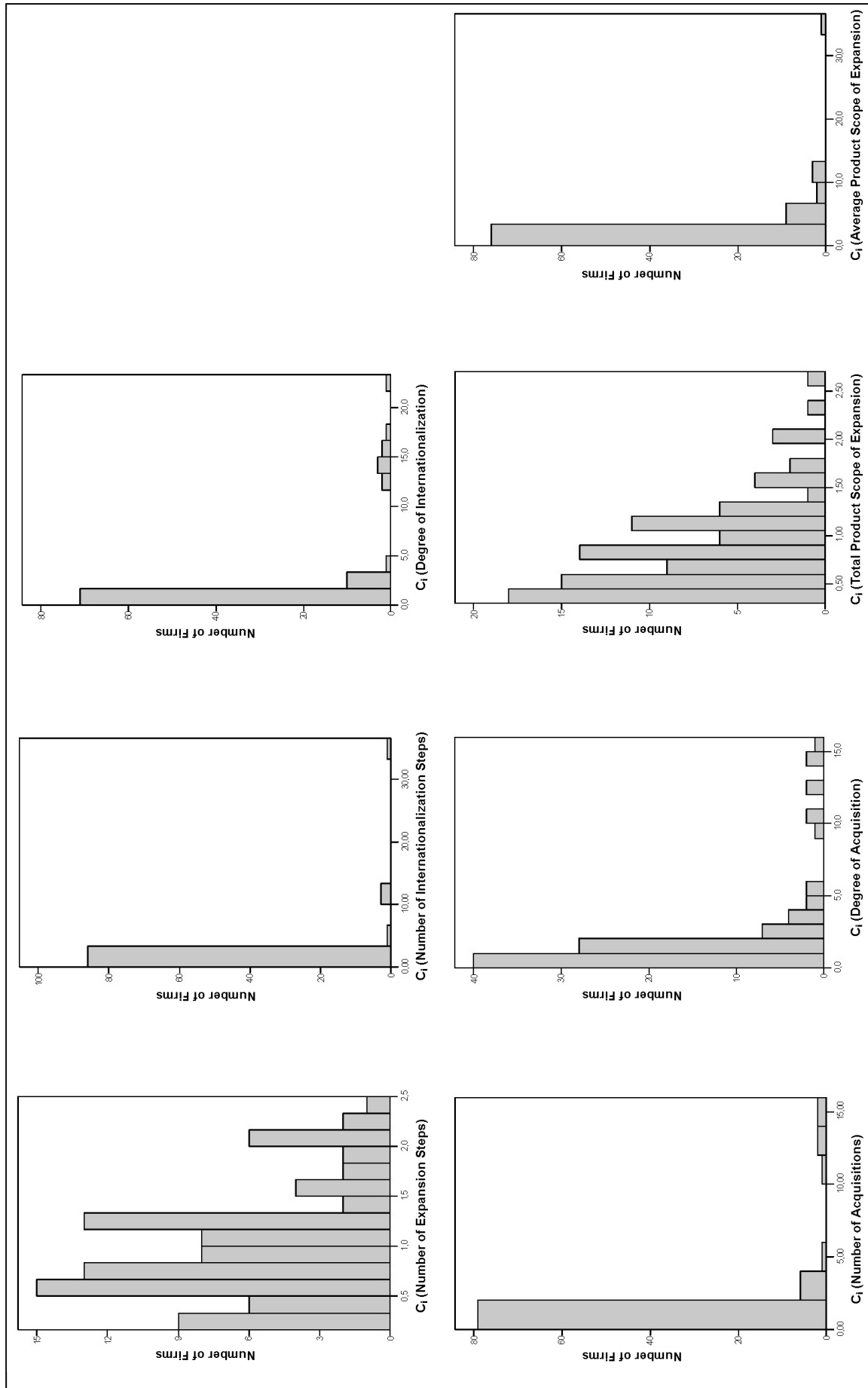


Figure 2: Histograms for C_i

5 Discussion

The expansion path within and across industries is a heterogeneous process. The firms in our sample did not follow the same expansion pattern. Whereas some firms expanded continuously with a similar amount of expansion steps in each period, other firms clustered their expansion activities over time. These firms showed either periods of inactivity or periods with an especially high/low level of activity.

To further qualify the expansion behavior within and across industries we introduced the variable *total product scope of expansion*. This variable not only captures the number of expansion steps but also their level of relatedness. A firm reducing its number of expansions in several periods due to a higher level of complexity associated with higher unrelatedness would show a discontinuous expansion pattern in terms of pure number of expansions. These cases would be captured with our scope variable. However, even after this adaptation of the measurement there are firms in both categories of continuous and discontinuous expansion. One reason for this is that the average product scope of expansion is not continuous. The clustering measure of this variable reveals this fact since the majority of cases (81 of 91) are non-clusterers. Thus, most firms keep their level of relatedness with which they are engaged in expansions on a more or less constant level. This finding can be grouped into a stream of research that highlights the advantages of related expansions (e.g. Chang, 1996; Haleblan & Finkelstein, 1999; Markides 1995; Pennings, Barkema, & Douma, 1994). However, there are also firms clustering their average product scope of expansion. These firms show periods in which their level of relatedness of expansion steps is especially high.

A further interesting fact becomes obvious when analyzing the cross-tabulation of the allocation of clusterers and non-clusterers. Figure 3 visualizes the cross-tabulation regarding the two variables *number of expansion steps* and *total product scope of expansion*.

The clustering behavior of firms differs regarding to these two variables. A firm exhibiting clustering behavior regarding the variable number of expansion steps does not necessarily belong to the group of clusterers based on total product scope of expansion. A similar picture can also be drawn for other combinations of the variables included in the analysis. Thus, the clustering behavior along the expansion

path does not only differ between different firms, but also within one firm regarding different characteristics of its expansion path. Hence, no contingencies regarding the behavior along the expansion path could be shown. In order to receive a deeper understanding of expansion steps, their interdependencies along the expansion path and other characteristics of this path, more comprehensive data and variables as well as more qualitative analyses are necessary.

		Total Product Scope of Expansion	
		Clusterer	Non-Clusterer
Number of Expansion Steps	Clusterer	21	15
	Non-Clusterer	11	44

Figure 3: Cross Tabulation of Clustering Pattern

6 Conclusion

This paper analyzed the clustering behavior of firms along their expansion paths within and across industries. The paper is thus a step to get a deeper understanding of the dynamic nature of diversification profiles. In contrast to previous research on continuity/discontinuity of expansion, this paper was more focused on the expansion path within and across industries, it incorporated more fine-grained and a wider scope of variables, and applied a different methodological approach to describe continuity/discontinuity. The results reveal that expansion within and across industries is a very heterogeneous process – the clustering of firms does not only differ between firms but also within one firm regarding different characteristics. On this level of analysis we could not find clear contingencies for continuous/discontinuous expansion behavior. Therefore, future research could for example follow more qualitative approaches to gain a deeper knowledge of the expansion path and its drivers.

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