Essays on the growth and investment of small German firms

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Abbreviation	Explanation
ANOVA	Analysis of Variance
GMM	Generalized Method of Moments
LGH	Landes-Gewerbeförderstelle des Handwerks NRW e.V.
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne
NRW	Nordrhein-Westfalen
OLS	Ordinary Least Squares

1 Framework paper

1.1 Introduction

In 2013, the European Commission adopted the so called “Entrepreneurship 2020 Action Plan” to ease the creation of new ventures and to support the takeover of existing firms. The goal is to create a supportive environment for entrepreneurs to thrive and grow (European Commission 2013). This shows that the European Union puts its efforts to support small firms as they are seen as means for Europe’s sustainable economic growth. However, the successful processes of growth and investment are complex and depend on different determinants.

The present thesis focuses on the firm level and analyzes in three independent articles:

- how small firms invest over time,
- how new ventures grow and which variables influence growth,
- how small firms grow after business takeover and which variables influence growth.

The framework that connects these articles forms the content-related focus on the early stage of development of small firms and the methodological and analytical approaches that comply with up-to-date and adequate statistical analysis techniques. Supported by an extensive dataset, which is the foundation of all three articles, it is possible to investigate empirically different open research questions using bivariate and multivariate analysis techniques. Thus, this thesis also serves the research needs for more multivariate analyses for small firms, for which so far mainly cross-sectional studies have been conducted.

The framework paper is structured as follows. For each article the research question, the theoretical underpinning, the methods and the results are described. The conclusion explains the most important findings of the three articles, provides different implications, addresses limitations of the research and gives an outlook about further research on topics related to the growth and investment of small firms.

1.2 Illustration of the three articles

All three articles are based on data from nine panel waves of the Start-Up Panel NRW, beginning with Wave 5. The dataset is explained in detail detail in Annex and Annex 2 discusses the generalizability of the dataset. The first four waves are excluded because the survey period changed from six months to one year. It is not possible to compare the investment of six months, the number used in the first four waves, with investment of twelve months simply by multiplying by two. Investment by companies in general and entrepreneurs in particular are singular events that may occur throughout the entire year. The dataset contains 7,028 German entrepreneurs comprising 4,880 (69.4 percent) entrepreneurs who were establishing a new venture, 1,872 (26.6 percent) who were taking over a company, and 276 (4.0 percent) who were actively participating in an existing business between 2003 and 2012. The codeplan of the variables analyzed in the present thesis are summarized on page 83.

Explaining Investment Dynamics: Empirical Evidence from German New Ventures

Research question

The first article contributes to the investment literature by asking the following research questions: What is the nature of the investment process for small firms at the micro-level? Does the data provide evidence that supports the neoclassical and/or the newer investment theory? What are the aggregate and policy implications of the results?

Theoretical underpinning

The theoretical underpinning of this article is based on the discussion about neoclassical models of investment in contrast to the newer investment theory. Neoclassical models of investment assume that adjustment costs are convex, investment is reversible and indivisibility does not exist (Jorgenson 1963). A growing literature on investment models has criticized these three assumptions. Abel & Eberly (1996), Doms & Dunne (1998), Caballero et al. (1995), Dixit & Pindyck (1994) and Cooper & Haltiwanger (2006) develop an alternative theory, called the newer investment theory, highlighting the importance of irreversibility and indivisibility.

Method and data

In a first step, the proportions of ventures that do no invest during a period within the sample period are analyzed. In a second step, a cluster analysis is run and the median investment in each period is chosen as dependent variable and variables on the organizational- and individual-level, such as the legal form of organization, gender, ownership status and the skilled crafts trades are included.

Results

In line with Geylani (2015) and Bigsten et al. (2005), the first article finds evidence for both neoclassical and newer investment theory. The results show that between three and 15 percent of ventures decide not to invest at a certain point of time. These numbers point to convexity of adjustment costs, in line with the neoclassical investment model, which assumes continuous, small investment. The cluster analysis provides a more nuanced result and shows how certain investment patterns evolve over time. Five different development patterns are found. Due to the non-linear development pattern of investment in the data, non-convex capital adjustment costs seem to influence ventures in Cluster 1 and 4. In these clusters, the adjustment costs seem to be fixed because lumpy periods exist. In contrast, Cluster 2 and 3 seem to reflect ventures with convex adjustment costs because the pattern develops in a linear way. The clusters are explained in detail on pages 16 to 19 of the present thesis.

Analyzing non-linear dynamics of organic growth: Evidence from small German new ventures

Research questions

Which new ways of analyzing the growth pathways of new ventures are possible and how can these results be presented? Is the serial correlation of growth for small new ventures that do not have neither innovative nor technology-based business concepts in line with other results from the growth literature that are mainly based on the manufacturing sector? How do adjustment costs influence the growth of new ventures?

Theoretical underpinning

Existing theories of growth models can be classified into four groups (O'Farrell & Hitchens 1988) and are summarized into industrial economics, stochastic models, management perspective and stages of growth models. These stages of growth models are based on the assumptions that distinctively different stages of development can be identified, the sequence and order of development is predetermined and firms develop according to prefigured rules. In recent years, scholars have developed models, such as the dynamic states approach (Levie & Lichtenstein 2010) or trigger points (Brown & Mawson 2013), to show alternative ways to explain the growth of new ventures. By drawing on these studies criticizing stages of growth models, the serial correlation of growth for small new ventures is used as a theoretical underpinning for the analysis of the growth of German new ventures.

Method and data

This article analyzes 4,880 new ventures of the Start-Up Panel NRW founded between 2003 and 2012. Business takeovers and active participations are excluded. In a first step, a residual analysis is applied to describe the growth pathways of these new ventures. Growth is defined as the change in employment (measured as full-time equivalent) and sales (measured in nominal terms). The results are presented as mosaic plots. In a second step, a pooled OLS regression is run to show which variables influence the growth of new ventures.

Results

Consecutive periods of constant or negative growth can be explained by the need of a new venture for consolidation. Indivisibility, potential sunk costs and size adjustment costs prevent firms from growth at certain stages of development (Lockett et al. 2011). Thus, positive growth at time t is more likely to lead to negative growth at time t+1, and conversely, that negative growth at time t raises the probability of a subsequent positive growth. These results are in line with the literature on serial correlation of small firms. Growth in period t can be a rather good predictor for growth in period t+1.

Business takeovers and firm growth: Empirical evidence from a German panel

Research questions

The third article also distinguishes between new ventures and takeovers of an existing firm as ways to become an entrepreneur. The focus is on business takeovers and the question on how small firms develop after a change in ownership.

Theoretical underpinning

Due to adjustment costs, indivisibility and uncertainty the third article hypothesizes that employment growth is non-linear. Indivisibility of employment results from individual employment contracts. In Germany, these contracts need to be portioned or scaled in certain regulatory boundaries (Habermann & Schulte 2017). Furthermore, some responsibilities are subject to indivisibility. As German employees are protected by strict labor laws the simple termination of labor contracts is difficult and, therefore, small firms are carefully with the recruitment of new employees. Thus, small firms need to align additional capacity and increase demand step-by-step. Recruitment and termination of employees cause costs related to information and search, reorganization and contract design (Hamermesh & Pfann 1996; Cooper & Haltiwanger 2003; Hall 2004). Therefore, fluctuations in the growth of small firms can be expected. After positive growth, immediate subsequent further positive growth is rather unlikely. After decrease or stagnation positive growth can be expected to follow.

Neoclassic theory assumes that firms have a target size that they tend towards and that a perfect information situation exists, i.e. adjustment costs, indivisibility and uncertainty are not considered. A positive autocorrelation of growth rates is related to convex adjustment costs because they prevent firms from immediately attaining their chosen size and lead to a gradual adjustment over time. In contrast, non-convex adjustment costs prohibit firms from instantly attaining their ideal size and are more related to the empirical evidence that employment change is non-smooth (Hamermesh & Pfann 1996). If non-convex adjustment costs play an important role a negative autocorrelation in growth rates is expected (Coad & Hölzl 2009).

Method and data

As the growth process by takeover (Gilbert et al. 2006; Lockett et al. 2011; Burghardt & Helm 2015) is different from the process of organic growth (Delmar et al. 2003), this article distinguishes these two types of growth strategies. The dataset is based on 1,872 small firms of the Start-Up Panel NRW that were taken over.

Similar to the second article, a residual analysis is applied to analyze the growth trajectories of small firms after business takeover. The results are presented as mosaic plots. In a second step, a pooled OLS regression is run analyzing the serial correlation of growth after business takeover.

Results

So far, the literature on autocorrelation has been focused on organic growth. The third article shows that autocorrelation and the related adjustment costs also play an important role when it comes to growth after business takeover. It is likely that adjustment costs and indivisibility prevent firms from growth at certain stages of development (Habermann & Schulte 2017). Consecutive periods of constant or negative growth can be explained by the need of firms for consolidation. This result also suggests that variables for growth need to be included as lagged variables in models analyzing growth.

1.3 Conclusion and implications

The present thesis aims at investigating and closing research gaps regarding the early stage development of small firms based on the Start-Up Panel NRW.

The core results of the present thesis can be summarized as follows:

- Investment of small ventures shows both convex and non-convex components of adjustment costs, implying that both neoclassical and newer investment theories have practical validity,
- New ventures are subject to negative autocorrelation of growth making sustained growth a very rare occurrence. This result challenges the traditional stages of growth models,
- The present thesis complements the literature on the autocorrelation of growth rates by focusing on the dynamics of small firms after business takeover. Negative autocorrelation plays an important role when it comes to growth after business takeover.

A number of implications for research and practice can be obtained, which are presented at the end of each article in detail. Some important implications for practice are:

- The management of new ventures needs to consider growth trajectories in terms of the extent and timing. Because growth is subject to indivisibility, potential sunk costs, and size adjustment costs, options of continuous, incremental growth are limited, and this situation may lead to dramatic changes. This challenge, in turn, may lead to a loss of crucial resources. In light of these potential dangers, small ventures have to respond to internal and external changes in a measured manner. Small venture management and consultants can help entrepreneurs to achieve this difficult balancing act.
- As growth after business takeover cannot be guaranteed and as the period after business takeover binds resources of the business owner for the integration of new employees, small ventures need to calculate the risks and opportunities of this process. Consultants and chambers of commerce and handicrafts can support the decision if a business takeover is the best option for the future development of the small firm or if other options, such as cooperation with other small firms, exist.
- The adjustment cost structure of a firm is an important factor in predicting the impact of factor market policies on the aggregate level. In order to investigate these effects accurately, data on investment and cost structure at the micro level is required. Based on the data policy makers can develop new incentives for new ventures, such as investment tax credits that are geared towards encouraging investment. For example, the evidence of non-convex adjustment cost can inform policy makers why some firms may not take advantage of tax credits that encourages continuous investment.

The following implications for scholars can be derived:

- Growth in period t can be a rather good predictor for growth in period t+1. This implies that multivariate analyses of predicting growth should include growth as lagged variables.
- While the vast majority of previous findings have relied on cross-sectional designs, the longitudinal design of the present thesis leads to more nuanced results. It also shows that large-scale longitudinal data is crucial for future research because it can generate more reliable results.
- Although both indivisibility and irreversibility influence the investment decision of new ventures convex adjustment costs can be seen. This means that scholars who investigate investment patterns of new ventures should base their results on both neoclassical and newer investment theory.

The results have several *limitations*, which are discussed at the end of each article. There are two methodological limitations that are common to all three articles. First, surveys, such as the Start-Up Panel NRW, depend on the selective perception and on the memory of the participants. To minimize the risk of overestimating sales or investment data other collection techniques, such as time-use surveys, where participants take notes in a diary, can reduce this problem but has other disadvantages (such as high collection and control costs, data protection challenges and lower response rates). To minimize the problem of selective perception for each panel wave of the Start-Up Panel NRW plausibility checks were conducted to verify the data submitted by the participants.

Second, all three articles define the time span between the first survey and the establishment of the firm as Period 0. Each wave of the Start-up Panel is conducted once a year in summer, and if the business is established in spring of the same year, it still does not have one complete year in business. This Period 0, therefore, is shorter than twelve months and could influence the analyses. However, this assumption does not affect the research on sales and employment growth of small firms or investment because for example investment is made selectively mainly in the establishment stage and not on a regular monthly basis.

For each article topics for *further research* are defined to explain how the results of each article can be used to gain further insights into the development of small firms. One methodological approach seems to be very interesting and connects research on investment with literature on growth of small firms. If endogeneity appears between two variables, as is the case between growth and investment, Arellano & Bond (1991) propose a GMM estimator for panel data, which deals with potentially endogenous regressors in dynamic panel data models. GMM estimation for the relationship between growth and investment is an innovative and up-to-date methodology to analyze the endogeneity of both variables.

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Explaining Investment Dynamics: Empirical Evidence from German New Ventures

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2 Explaining Investment Dynamics: Empirical Evidence from German New Ventures

Abstract

So far, empirical evidence regarding investment patterns has focused almost entirely on established firms, and mainly in the manufacturing sector. No theory for investment has been empirically tested for new ventures. Using pooled panel data of 7,028 German new ventures, the present article documents the importance of zero-investment episodes and applies a cluster analysis to investigate if different investment patterns can be distinguished. The empirical results support the presence of both convex and non-convex components of adjustment costs, implying that both neoclassical and newer investment theories have practical validity.

Keywords: convex adjustment costs; investment pattern; panel data.

JEL classification: G11, M13, M21

2.1 Introduction

Students in business schools are taught that an investment should be made if the present value of the expected cash flow is at least as large as its cost. This is the standard neoclassical investment theory, which ignores the irreversibility and uncertainty of investment. An alternative approach, highlighted in the work of Doms & Dunne (1998), Cooper et al. (1995) Abel & Eberly (1996), Caballero et al. (1995) and Bachmann et al. (2013), argues that non-convex adjustment costs, irreversibility and indivisibility of investment play an important role in the investment process (Cooper & Haltiwanger 2006). In the present article, this alternative approach will be called newer investment theory. Empirical evidence shows the importance of infrequent and large investment activities. Gelos & Isgut (2001) and Caballero et al. (1997) urge for further examination of data from different countries to ascertain the general validity of such a newer investment theory. So far, little empirical research that focused exclusively on established ventures (Bigsten et al. 2005; Bloom et al. 2003; Caballero et al. 1995; Cooper et al. 1995; Doms & Dunne 1998; Gelos & Isgut 2001; Nilsen & Schiantarelli 2003) followed. One reason explaining the small amount of research conducted so far could be that few data sets at the micro-level, which are required to analyze investment decisions, exist. Another reason could be that the net present value concept is more appealing because, based on its assumptions, it is easier to apply. The present article reemphasizes the need for more micro empirical research and uses for the first time panel data from Germany to examine the investment patterns of new ventures in different skilled crafts trades. The skilled crafts sector in Germany includes over 100 occupations, such as bricklayer, carpenter, etc., in different trades. Empirical investigation into investment patterns of new ventures could be interesting for both practical and theoretical reasons. Firstly, knowing the investment dynamics of new ventures would support the design of new policies for the development of a firm. Secondly, investment is seen as relevant important variable that spurs growth (Cooper et al. 1995; Geyani & Stefanou 2012). Therefore, knowing how investment develops over time seems to be information that supports the prediction of the growth of new ventures. Thirdly, finding evidence for certain investment patterns has practical relevance for consultancy and management of new ventures because it supports the optimization of early business performance. Fourthly, analyzing investment patterns helps to find differences between the investment of established firms and new ventures. Research into why differences in the investment patterns of these two groups exist could support the general validity of investment theories.

The present article contributes to the investment literature by answering the following questions: What is the nature of the investment process for new ventures at the micro-level? Does the data provide evidence that supports the neoclassical and/or the newer investment theory? What are the aggregate and policy implications of the results? The article proceeds as follows. In the first part, the assumptions of the neoclassical models and newer investment theory are explained. In the second part of the article, using data from a German Start-Up Panel, the investment patterns of the new ventures described by this data are empirically examined. Third, the empirical analysis identifies five clusters of firms with different investment patterns. Two clusters behave more in accordance with neoclassical investment theory, and two clusters behave more in accordance with newer investment theory. The present article concludes that both neoclassical and newer investment theory can be applied to explain certain investment patterns of new ventures.

2.2 State of Research

Issues of adjustment have been addressed in the economic literature, and scholars have mainly distinguished between frequent and infrequent adjustment (Bertola & Caballero 1990). Theory of infrequent adjustment can be applied to the marketing of a product (Baldwin & Krugman 1989), the durable goods consumption (Grossman & Laroque 1990), the Operations Research literature (Bather 1966), or the capital stock (Arrow 1968; Dixit & Pindyck 1994; Bertola & Caballero, 1990). The costs of adjusting the stock of capital reflect a variety of interrelated factors that are difficult to measure directly or precisely (Cooper & Haltiwanger 2006). Therefore, the present article analyzes the capital adjustment costs indirectly through studying the dynamics of investment itself. Dixit & Pindyck (1994:1) define investment as an "act of incurring an immediate cost in the expectation of future rewards." In line with this definition and the difficulty to measure the stock of capital, the present article understands investment as a change in capital stock over a period. Therefore, investment is used as a synonym for capital adjustment.

The neoclassical model of investment is seen as the orthodox theory of frequent adjustment of investment. Before the neoclassical model, no framework existed for investigating the determinants of investment. In this model, the firm maximizes the discounted flow of profits over an infinite horizon (Chirinko 1993). It assumes that capital depreciates at a geometric rate, while delivery lags and vintage effects are absent. A delivery lag is the time between the ordering of new capital goods and their installation. The vintage effect states that new capital is more productive than old capital due to technological improvement. The neoclassical model of investment also assumes that adjustment costs are convex, investment is reversible and indivisibility does not exist (Jorgenson 1963). Chirinko (1993) as well as Abel & Eberly (1996) provide an extended review on neoclassical investment theories. A growing literature on investment models has criticized these three assumptions. Abel & Eberly (1996), Doms & Dunne (1998), Caballero et al. (1995), Dixit & Pindyck (1994) and Cooper & Haltiwanger (2006) develop an alternative theory highlighting the importance of irreversibility and indivisibility. In the present article, the literature that criticizes the neoclassical assumptions is called the newer investment theory. The main differences in the assumptions of both theories are as follows:

Adjustment costs

Investment models of infrequent adjustment can be divided into models with fixed adjustment costs and models with adjustment costs kinked at zero. Kinked adjustment costs mean that the adjustment cost for the first unit of positive investment is less than the adjustment cost for the first unit of disinvestment. Adjustment costs arise in addition to the direct cost of buying new capital goods and can be divided into internal and external ones. Internal adjustments costs arise when the new capital is installed or workers are retrained to operate the new machines (Bigsten et al. 2005). Assuming a perfectly elastic supply of capital, external adjustment costs arise where the price of capital goods relative to other goods adjusts so that firms do not wish to invest or disinvest at infinite rates (Foley & Sidrauski 1970). The neoclassical investment model assumes convex adjustment costs, i.e. firms respond to external shocks by making continuous, small investment because large and rapid changes are extremely costly. In this model, zero-investment is very difficult to explain. The marginal adjustment cost is increasing in the size of adjustment (Hayashi 1982).

Empirical evidence, however, seems to indicate that firms do no continually invest every time conditions change. This means that zero-investment in particular periods can be optimal in models with either fixed or kinked adjustment costs. Adjustment costs seem more likely to have a large fixed and infrequent, also called lumpy or decreasing cost component (Bigsten et al. 2005). Therefore, the newer investment theory assumes non-convex adjustment costs and can explain zero-investment.

Irreversibility and indivisibility of investment

Irreversible investment acknowledges that the value of capital may not be fully recoverable when resold. This is partly caused by a lack of secondary markets for capital goods. Irreversibility changes the dynamics of investment by creating a threshold level of returns for positive investment. Below this threshold, investment is zero which means lumpy rather than continuous investment. If a firm does not invest, it retains the possibility of keeping its capital stock low, which means that a reverse of the investment, i.e. disinvestment, is less costly. If a firm invests, it commits itself to a high capital stock and possibly high costs of suspension (Dixit & Pindyck 1994). While the neoclassical investment theory assumes the reversibility of investment, the newer investment theory acknowledges irreversible investment. The newer investment theory also assumes indivisibility, which leaves firms with a choice of making a large investment or no investment at all (Bigsten et al. 2005). This could also lead to lumpy investment.

Small firms could be faced with problems of indivisibility and irreversibility of investment and, therefore, investment of this type of firm could be assumed to be lumpy in nature. In contrast to established firms, new ventures do not have an existing portfolio of capital stock that has to be rearranged or adjusted to an optimal level or size. Therefore, one has to be cautious to predict certain investment patterns of new ventures by analyzing investment of small but established firms. New ventures only face positive changes in capital stock alignments and ordinarily do not disinvest (Schulte 2015).

Micro data is required to truly understand the dynamics within new ventures (Doms & Dunne 1998) and to test the theoretical models. So far, the focus has been on established firms. For example, Doms & Dunne (1998), Cooper et al. (1995) and Caballero et al. (1995) provide evidence from the U.S. manufacturing sector that plant-level adjustments tend to occur at discrete times and that long spells of inactivity are followed by bursts in capital expenditure. These findings suggest the existence of indivisibility, irreversibility, and increasing returns in the adjustment cost function. Nilsen & Schiantarelli (2003) report similar findings for the Norwegian manufacturing sector, although their evidence for non-convexities is weaker. Dunne & Mu (2010) find 74 percent of investment in the U.S. petroleum refining industry to be non-zero. Bigsten et al. (2005) find empirical evidence for zero-investment episodes and lumpy investment at the firm-level for five sub-Saharan African countries. Bloom et al. (2003) show that uncertainty influences investment in the UK. Beyond these articles, the empirical evidence of capital adjustment patterns remains limited, and further examination of data from other countries and other business sectors is warranted to ascertain the general validity of investment theories.

2.3 Data and Methodology

Since 2000, the Start-Up Panel of the German federal state of North Rhine-Westphalia (NRW) has monitored annually young enterprises predominately belonging to the skilled crafts sector. The definition of age of new ventures varies from younger than eight years (Pellegrino et al. 2012; Miller & Camp 1985; Jennings et al. 2009) to younger than five years (Fackler et al. 2013). The present article defines a new venture as an economic enterprise that is not older than eight years. This definition provides a sufficient number of firms to run statistical analyses while still considering them as (relatively) new.

The skilled crafts sector can be seen as typical of many entrepreneurial activities in Germany in terms of size, business model, or legal type (Lambertz & Schulte 2013). In line with Davidsson & Gordon (2012: 19), who argue that “there is an obvious need for better theorizing and modeling of the drivers of the successful establishment of imitative, subsistence-oriented businesses”, the present article focuses mainly on ‘ordinary’ entrepreneurs. These new ventures have neither innovative nor technology-based business concepts (Lambertz & Schulte 2013). For example, a carpenter needs to invest in different circular saws, power drills or high-quality wood but does not need to invest in robots that lead to high industrial automation that is often required in technology-based new ventures.

Until 2013, this German panel data set, with response rates between 39.5 and 52.7 percent (Table 1), has observed more than 19,000 new ventures. In addition to de novo start-ups, the panel covers successions as well as active participations.[1] Active participation means the entry of an entrepreneur into an existing company. The data set is not biased by part-time businesses because it contains data solely on full time entrepreneurship (Lambertz & Schulte 2013). Part-time businesses cannot usually be compared with full-time ventures because they are often created only for auxiliary income. Thus, single person enterprises, which have become a very important part of today’s economies (Kessler et al. 2009), are only covered as far as they are run as a full-time job. The conceptual cornerstone of the Start-Up Panel NRW is a periodical survey based on standardized written questionnaires that pave the way for the long-term monitoring of a large number of young entrepreneurs and their enterprises, either newly created or acquired. This survey has no survivorship bias: No hidden market exit is possible because government authorities monitor the new ventures over a three-

[1] I recognize that successions and active participations are not new firms. However, the entrepreneurial activity in these businesses is new to the entrepreneur. The vast majority of firms in the sample (69.4%) are de novo start-ups though.

year period. Moreover, all exits can be verified by using a special crafts register, where all entries and exits have to be recorded (Lambertz & Schulte 2013).

Table 1: Response rates

Panel wave	Survey period	Number of questionnaires distributed	Number of responses	Response rate
5	summer 2004	6,881	3,627	.527
6	summer 2005	8,153	3,978	.488
7	summer 2006	9,149	3,610	.395
8	summer 2007	9,751	4,014	.412
9	summer 2008	7,265	3,231	.445
10	summer 2009	7,322	3,316	.453
11	summer 2010	7,880	3,272	.415
12	summer 2011	8,443	3,447	.408
13	summer 2012	8,805	3,653	.415

Source: Calculations based on the Start-Up Panel of the German federal state of North Rhine-Westphalia

The questionnaire of the annual panel wave always contains the same questions with regard to corporate development (sales volume, quantity of staff, investment volume, corporate earnings expectation, corporate profit situation, production activity, and achievement of profit goals) as well as questions focusing on specific topics that differ from panel wave to panel wave (counseling, entrepreneurial marketing, motivation, etc.) (Lambertz & Schulte 2013). The research is based on data from nine waves of the Start-Up Panel NRW between 2004 and 2012, beginning with Wave 5. The first four waves are excluded because the survey period changed from six months to one year. It is not possible to compare the investment of six months, the number used in the first four waves, with investment of twelve months simply by multiplying by two. Investment by companies in general and entrepreneurs in particular are singular events that may occur throughout the entire year. Starting with Wave 5, the Start-Up Panel NRW defines investment as the amount entrepreneurs have invested in the last twelve months.

The survey is conducted once a year in summer, and if the business is established in spring of the same year, it still does not have one complete year in business. For this reason, the time span between the first survey and the establishment of the new venture is defined as Period 0. This period, therefore, is shorter than twelve months. However, this does not affect the research on investment because investment is made selectively mainly in the establishment stage and not on a regular monthly basis. Because the present study investigates up to eight years of a given new venture, it covers Period 0 and eight periods, which are numbered 1 to 8 and are equal to a complete year of business activity following Period 0.

The data has been merged into one set of pooled cross-sectional data. Utilizing pooled data, potential biasing effects of different economic business cycles, cohorts, and outliers were reduced. Furthermore, the study utilizes a number of variables, such as the legal form of organization, skilled crafts trades, or gender to insure that the results are generally acceptable and not influenced by other effects (Lambertz & Schulte 2013).

The merged dataset contains 7,028 German entrepreneurs comprising 4,880 (69.4 percent) entrepreneurs who were establishing a new venture, 1,872 (26.6 percent) who were taking over a company, and 276 (4.0 percent) who were actively participating in an existing business between 1995 and 2012. 1,828 (26.0 percent) new ventures work in the electrical and metalworking trades, 1,790 (25.5 percent) in the building and interior finishing trades, 1,582 (22.5 percent) in the health and body care trades as well as the chemical and cleaning sector, 393 (5.6 percent) in the woodcrafts and plastic trades, and 211 (3.0 percent) in the food crafts and trades. There are 141 (2.0 percent) new ventures that work in other trades and there is no information available from 1,083 (15.4 percent) businesses. 74.3 percent are sole proprietorships and 77.7 percent are owned by men.

2.4 Results and Implications

Table 2 shows the proportion of new ventures that make no investment during a period within the sample period. The share of new ventures in the entire sample that make no investment during a period varies between 0.1 and 6.1 percent (last column). In an analysis of selected manufacturing companies in several African countries, Bigsten et al. (2005) find that 58 percent of the firms have zero investment episodes. According to a study by Gelos & Isgut (2001), where Mexican and Colombian manufacturing companies are analyzed, the number of zero-investment varies between 28 and 95 percent. These numbers are much higher than those presented in a study on manufacturing firms in Norway, according to which zero-investment varies between 20 and 61 percent (Nilson & Schiantarelli 2003). Cooper & Haltiwanger (2006) state that ten percent of British manufacturing firms that they analyzed have zero-investment, which closely resembles the results of the analysis, as shown in Table 2.

Table 2: Zero investment of new ventures (in percent, number of firms in parentheses)

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Total
Investment 0	0	.021 (53)	.006 (5)	.002 (1)	.012 (4)	0.009 (61)
Investment 1	0	.049 (235)	.014 (11)	.012 (8)	.006 (1)	0.036 (254)
Investment 2	.045 (27)	.079 (381)	.005 (4)	.026 (17)	.018 (3)	0.061 (429)
Investment 3	.03 (18)	.076 (369)	.021 (16)	.006 (4)	.006 (1)	0.058 (408)
Investment 4	.028 (17)	.068 (326)	.01 (8)	.002 (1)	.031 (5)	0.051 (357)
Investment 5	.04 (24)	.05 (241)	.009 (7)	.002 (1)	.012 (2)	0.039 (274)
Investment 6	.022 (13)	.026 (126)	.004 (3)	.005 (3)	.025 (4)	0.021 (149)
Investment 7	.012 (7)	.019 (94)	.004 (3)	.002 (1)	.025 (4)	0.015 (108)
Investment 8	.003 (2)	.012 (60)	.001 (1)	.002 (1)	.006 (1)	0.009 (63)

Calculations based on the Start-Up Panel of the German federal state of North Rhine-Westphalia

In contrast to the findings in the present article, Nilson & Schiantarelli (2003) and Bigsten et al. (2005) argue that zero-investment episodes appear to be more important for small firms. They argue that the indivisibility of capital goods forces especially small firms, which most of the new ventures are, to make a choice whether to make a large investment or no investment at all. Bigsten et al. (2005) show that small firms tend to face credit constraints, which could prevent firms from making any investment in particular periods. However, the present article shows, on average, fewer cases with zero investment than other scholarships. There exist several reasons why few observations with zero-investment could be found in the data. Firstly, the data set does not focus only on the manufacturing sector. At least 23 percent of the new ventures are in the service sector, where huge investment in machines is not required. It is easier for ventures to invest on a regular basis because the cost for investment is on average lower than investment in the manufacturing sector. Secondly, when the new ventures are founded, entrepreneurs may not have the opportunity to decide whether to invest or not because they are forced to invest to establish the firm in the market. Thirdly, entrepreneurs may be trained to use the net present value as a decision tool to value their investment. This tool, however, does not account for irreversibility and uncertainty.

The present article proceeds by examining how new ventures invest once they decide to act. In contrast to other studies, due to lack of data the distribution of new ventures' investment rate or the capital growth rate is not analyzed. Firstly, an analysis of the investment pattern of the 7,028 new ventures is conducted. In a second step, a cluster analysis (K-means clustering using Euclidean distance) is applied because it allows describing, in a fairly nuanced manner, if the pattern of the median investment of the 7,028 new ventures can be distinguished into different investment patterns. Based on a dendrogram and a distance matrix of the median investment (Annex 3) five clusters are identified. For the cluster analysis the median investment in each period is chosen as dependent variable and variables on the organizational- and individual-level which are commonly used in entrepreneurship research (Carsrud & Brännback 2014) are also included. These variables are the legal form of organization, gender, ownership status, and the skilled crafts trades. Both the median investment of the 7,028 new ventures and the clusters of the investment patterns are shown in Figures 1 to 4 and described in detail below. Having found that a relatively low percentage (between three and 15 percent) of new ventures decide not to invest at a certain time period is a first hint that the neoclassical investment theory could be applied for new ventures.

The pattern of investment of the entire data set shows that investment behavior in new ventures is non-linear and happens by waves. A first (Periods 0 and 1) and a second wave (Period 8) of investment in the first nine periods after starting the business are identified. The ANOVA significance figures suggest that all clustering variables differ between clusters in the solution. The results of the Kruskal-Wallis one-way analysis of variance test lead to rejection of null hypotheses that median values for all characterization variables do not differ between clusters in the solution.

The clusters

The first cluster consists of 604 new ventures and represents a pattern with high investment in the beginning, which drops sharply in Period 2 (Figure 1). However, the median investment is higher than the median investment of the 7,028 new ventures for the first nine periods. The number of limited liability companies in the first cluster is nine percent points higher and the number of sole proprietorship is 15 percent points lower than in the survey sample of 7,028 new ventures. This difference in the legal form could explain the higher investment at the foundation of the new venture because in Germany at least 25,000 euro are required to set up a limited liability company. In this cluster, there are also eight percent points less than average of new ventures from the building and interior finishing trades. Over nine periods, the average total amount of investment for the new ventures in this cluster is more than four times higher than the average total amount of investment for the same time span for all new ventures in the data set. Almost 70 percent of the investment is made within the first two periods. Therefore, the investment seems to be lumpy within the first two periods. This result, however, has to be treated with caution because for Period 0, less than 100 observations are available.

The second cluster consists of 4,828 new ventures, and at first sight closely resembles the average pattern of investment for all new ventures (Figure 2). Upon closer inspection, it turns out, however, that investment for a given period in this cluster is, on average, slightly lower than the investment of the 7,028 new ventures and the pattern is linear which is in line with neoclassical investment theory.

Figure 1: Cluster 1: Median investment of new ventures (in euro) [2]

Calculations based on the Start-Up Panel of the German federal state of North Rhine-Westphalia

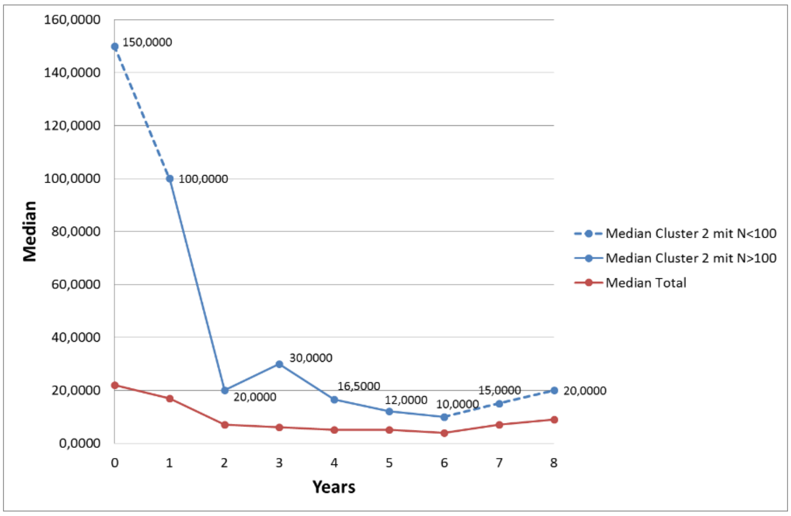
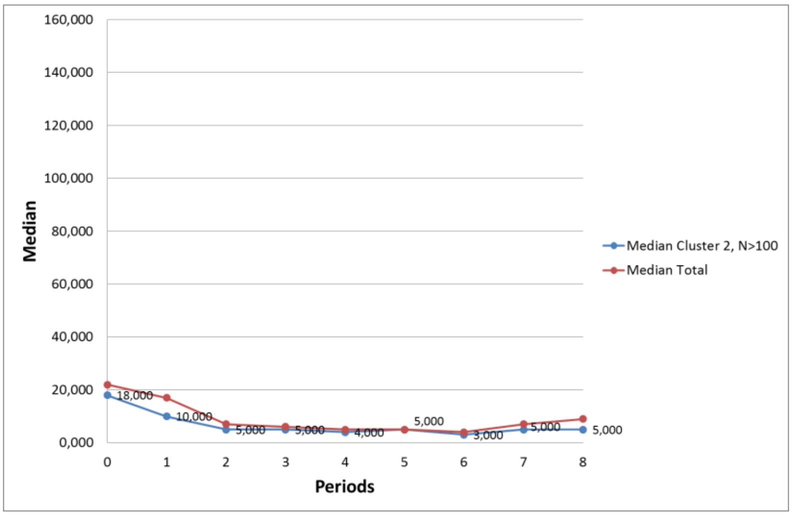


Figure 2: Cluster 2: Median investment of new ventures (in euro)



Calculations based on the Start-Up Panel of the German federal state of North Rhine-Westphalia

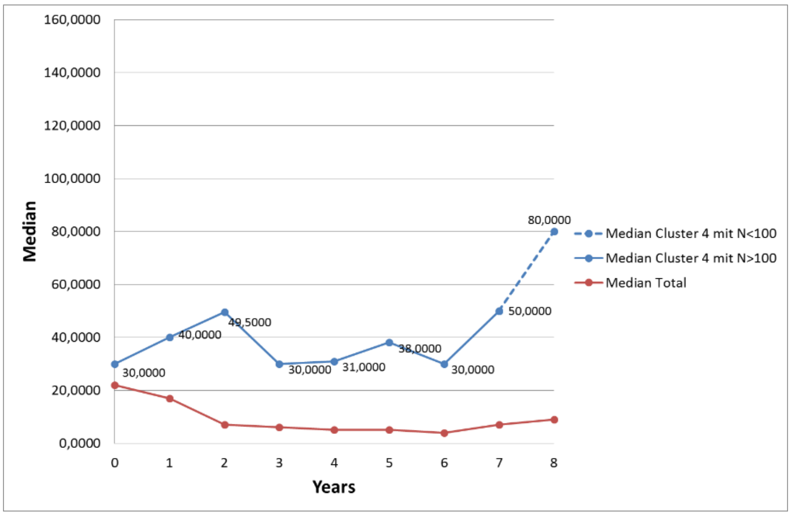
The third cluster consists of 780 new ventures and represents a pattern marked by higher-than-average investment in Period 0 and gradually increasing investment in subsequent periods (Figure 3). Although limited liability companies are, similar to Cluster 1, overrepresented, the initial investment is, compared to Cluster 1, around 120,000 euro lower. In contrast to the other clusters, the investment for a given period does not decrease after Period 3 but increases slowly but steadily. Over nine periods, the average total amount of investment for the new ventures in this cluster is more than four times higher than the average total amount of investment for the same time span for all new ventures in the data set. The average investment for a given period varies between 30,000 and 49,500 euro. Hence, this pattern does not show any lumpiness.

[2] If a variable has less than 100 observations for a given period, I use a dotted line.

Only the last period has, on average, high average investment. Because less than 100 observations are available for the last period, this result has to be treated with caution.

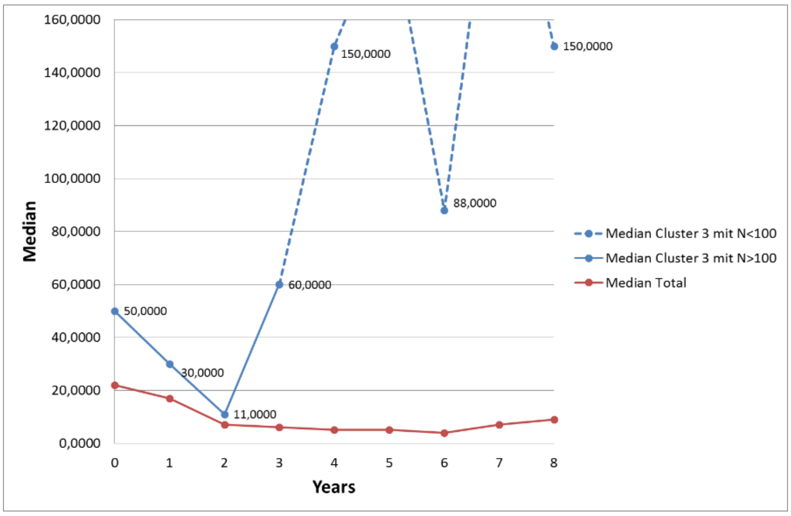
The fourth pattern consists of 653 new ventures and reflects a pattern with a higher than average investment at the beginning, which drops to 11,000 euro in Period 2 (Figure 4). After this period investment fluctuates heavily but after the first three periods the number of observations is less than 100 and, therefore, a trend for an investment pattern has to be made cautiously. Over nine periods, the average total amount of investment for the new ventures in this cluster is eleven times higher than the average total amount of investment for the same time span for all new ventures in the data set. More than 90 percent of the investment is made within four periods. This result indicates the lumpiness of investment in this cluster. However, this result has to be treated with caution because for the Periods 2 to 8, less than 100 observations for a given period are available

Figure 3: Cluster 3: Median investment of new ventures (in euro)



Calculations based on the Start-Up Panel of the German federal state of North Rhine-Westphalia

Figure 4: Cluster 4: Median investment of new ventures (in euro)



Calculations based on the Start-Up Panel of the German federal state of North Rhine-Westphalia

The fifth cluster consists of only 163 new ventures and, therefore, does not have enough observations to be included in the analysis. The analysis of median investment of the 7,028 new ventures shows two waves of investment. The related cluster analysis reveals five different development patterns and, therefore, offers a nuanced analysis of investment patterns. Caballero & Engel (1999) argue that non-convex capital adjustment costs help to explain certain non-linearities in investment fluctuations. Due to the non-linear development pattern of investment in the data, non-convex capital adjustment costs seem to influence new ventures in Cluster 1 and 4. In these clusters, the adjustment costs seem to be fixed because lumpy periods exist. In contrast, Cluster 2 and 3 seem to reflect new ventures with convex adjustment costs because the pattern develops in a linear way. The data also shows that periods with zero-investment exist (see Table 2). One possible explanation could be that uncertainty increases the separation between the marginal cost of capital that justifies investment and the marginal product of capital that justifies disinvestment. This increases the range of inaction: Firms prefer to "wait and see" rather than undertaking a costly action with uncertain consequences. In short, investment behavior becomes more cautious (Bloom et al. 2003).

2.5 Conclusion

The present article is a first attempt to apply investment theories to the field of new ventures by examining the capital adjustment patterns of 7,028 German entrepreneurs. Empirical studies of investment patterns have exclusively focused on established firms mainly in the manufacturing sector. So far, no theory for investment has been empirically tested for new ventures. Dixit & Pindyck (1994) argue that the neoclassical investment models ignore the interaction between irreversibility, uncertainty, and the choice of timing. Therefore, different scholars developed new investment theories that assume non-convex adjustment costs and tested them empirically. Empirical evidence shows, for instance, that plant-level adjustments tend to occur at discrete times and that long spells of inactivity are followed by bursts in capital expenditure. Geylani (2015) and Bigsten et al. (2005) find evidence for both convex and non-convex adjustment costs. The present article does not replicate earlier studies, in part because the data of this survey does not contain information on the return on investment.

Instead, the focus is on the importance of zero-investment episodes and the identification of different investment patterns over time. In a first step, the results show that between three and 15 percent of new ventures decide not to invest at a certain point of time. These numbers point to convexity of adjustment costs, in line with the neoclassical investment model which assumes continuous, small investment. In a second step, a cluster analysis is applied to show how certain investment patterns evolve over time. The analysis of median investment of the 7,028 new ventures shows two waves of investment. The related cluster analysis reveals five different development patterns and, therefore, offers a nuanced analysis of investment patterns. Caballero & Engel (1999) argue that non-convex capital adjustment costs help to explain certain non-linearities in investment fluctuations. Due to the non-linear development pattern of investment in the data, non-convex capital adjustment costs seem to influence new ventures in Cluster 1 and 4. In these clusters, the adjustment costs seem to be fixed because lumpy periods exist. In contrast, Cluster 2 and 3 seem to reflect new ventures with convex adjustment costs because the pattern develops in a linear way. In line with Geylani (2015) and Bigsten et al. (2005), the present article finds evidence for both neoclassical and newer investment theory. This is partly surprising because it could be assumed that indivisibility and irreversibility influences the investment decision of new ventures. However, the majority of new ventures in the data set follow a linear pattern with a low percentage of zero investment implying continuous, small investment. One explanation could be that for new ventures large and rapid changes are costly. The present article suggests three major directions for further research. Firstly, as indicated above, the differences with regard to investment patterns have yet to be explained. Further research on variables, for example legal status or the impact of events such as the financial crisis, is needed to understand the differences with regard to the patterns. Secondly, research on how infrequent and large investment influences the growth of new ventures could link investment theories to discussions on resource-based growth models. Relating the nature of investment to the growth of companies would be “extremely valuable” (Coad 2009: 38). Analyzing the reasons why investment strategies between fast- and slow-growing new ventures are different could be a methodology to investigate this investment-growth nexus. One explanation for the differences could be that fast-growing new ventures have more resources to invest than new ventures that grow on a smaller scale. One challenge for this type of research is to define and identify fast- and slow-growing new ventures. Another option could be to distinguish between imitative, subsistence-oriented and innovative businesses. Thirdly, small firms face problems of indivisibility and irreversibility of investment and, therefore, investment of this type of firm could be assumed to be lumpy in nature. However, the present article shows a mixed result and the investment patterns of the majority of new ventures are in line with neoclassical investment theory that does not assume lumpy investment. Therefore, further research on how investment behavior of new ventures differs from that of established ventures is required. Lack of relevant data will be one of the biggest challenges for future research. The current data, for instance, does not distinguish between initial, replacement, and extension investment, but each of these kinds of investment is likely to affect early business development in a different manner. A more comprehensive database that contains further information on the three different kinds of investment would be needed to gain a more nuanced perspective on investment patterns. The present article does not distinguish between start-ups, active participations and successions. Further research could focus just on start-ups to analyze if there are any differences to the results in the present article.

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Analyzing non-linear dynamics of organic growth: Evidence from small German new ventures

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3 Analyzing non-linear dynamics of organic growth: Evidence from small German new ventures

Abstract

This paper links theories of growth models with the literature on serial autocorrelation of growth. We study the serial autocorrelation of tendencies of growth trajectories of employment and sales for German new ventures over a nine-year period using mosaic plots as a conceptual framework. The autocorrelation of growth tendencies provides important information on firms growth processes. We find that growing new ventures are subject to negative autocorrelation of tendencies of growth trajectories making sustained growth a very rare occurrence. This indicates that the growth of new ventures is non-linear, prone to interruptions, amplifying forces, and setbacks. Therefore, we interpret the commonly used term 'stages of growth model' in a different manner. A stage cannot be defined as a time span but rather as a sort of conditions of circumstances that are all present at a point in time and that are conditionally linked to a preceding sort of circumstances.

Keywords: New ventures, autocorrelation, panel data, small firms

JEL classification: L25, L26, M21

3.1 Introduction

Growth of businesses is one of the central topics of entrepreneurship research (McKelvie & Wiklund 2010). Stages of growth models dominate this literature on the growth of businesses and are based on three main assumptions (Levie & Lichtenstein 2010; Greiner 1972). First, distinctively different stages of development can be identified. Second, the sequence and order of development is predetermined and thus predictable. Third, all ventures develop according to prefigured rules. In recent years, scholars began to criticize the linear models of business growth (Levie & Lichtenstein 2010) and suggest replacing assumptions of these models with principles from complexity science, such as complex adaptive systems (Anderson et al. 1999; Holland 1995; McKelvey 2004) and the non-linear dynamics of economics and management (Meyer et al. 2005; Chiles et al. 2007).

By drawing on these studies criticizing stages of growth models and the resource-based view, we examine the serial correlation of growth for small new ventures that do not have innovative or technology-based business concepts and are run as full-time businesses. We chose to study the relationship between measures of growth of this type of new venture for the following reasons. First, this type of new venture is typical of many entrepreneurial activities in Germany in terms of size, business model, or legal type (Lambertz & Schulte, 2013). Second, so far the focus has been on research of new ventures in the manufacturing sector (Bottazzi et al. 2009; Coad & Hölzl 2009; Daunfeldt & Halvarsson 2015). To validate the theory of negative autocorrelation of growth other sectors than the manufacturing sector need to be investigated. Third, established theories originating from economics, sociology or management may be well suited for explaining the creation of innovative ventures. However, empirical results show that for imitative new ventures a different conceptual framework is required to build models that have the same explanatory power than models that include innovative new ventures (Samuelsson & Davidsson 2009).

We suggest that small firms typically are subject to negative serial correlation of annual growth rates (Daunfeldt & Halvarsson 2015). Put differently, we theorize that recent positive growth is more likely to lead to negative growth, and conversely, that a recent negative growth raises the probability of a subsequent positive growth. The findings of our analyses based on longitudinal data obtained from the Start-Up Panel of the German state of North Rhine-Westphalia support our hypotheses.

Our study contributes to the literature in the following ways. First, our findings provide new insights concerning growth measures by focusing on tendencies of growth trajectories instead of average growth rates. Empirical analysis often prefers a method that measures trajectories in terms of average size or average growth rates for prolonged periods. However, this approach says little about the individual economic growth over time. Second, we add to the literature that shows that measures of growth are not interchangeable. Growth of sales and the growth of employment are not equivalent measures of the performance of new ventures and lead to different results (Chandler et al. 2009). Third, our results support the findings of critics of stages of growth models. We show that recent positive growth is more likely to lead to negative growth, and conversely, that a recent negative growth raises the probability of a subsequent positive growth. Therefore, traditional growth models that assume a linear development over time cannot be validated by our data. Fourth, we add to the literature on drivers of the successful establishment of imitative, subsistence-oriented businesses. Similar to other new ventures, imitative, subsistence-oriented new ventures have negative serial correlation of growth. Thus, growth in period t can be a rather good predictor for growth in period t+1.

In the remainder of this paper, we present our theory, hypotheses, methodology, and results, followed by a discussion of the implications and limitations of our study.

3.2 Existing theories of growth models

Business growth theories can be classified into four groups (O'Farrell & Hitchens, 1988) and are summarized in Table 3: (1) industrial economics, (2) stochastic models, (3) management perspective and (4) stages of growth models. The group of industrial economics research is represented by Penrose (1959) who argues that unused productive services facilitate the introduction of new combinations of resources in a firm: ''The new combinations may be combinations of services for the production of new products, new processes for the production of old products, new organization of administrative functions'' (Penrose 1959: 85). This approach recognizes the importance of periods of stability because growth is seen as episodic and occurring in spurts (Derbyshire & Garnsey 2014).

Second, stochastic models of business growth explain that the process of random growth leads to a skewed size distributions of companies, which means that few large and many small companies exist (Gibrat, 1931). However, the view that business growth is predominately random is criticized because if this were the case entrepreneurs would not be able to influence the outcomes of new ventures (Derbyshire & Garnsey 2014). Thus, there would be little room for government policy stimulating business growth. Empirical evidence shows mixed results if Gibrat's law can be rejected or not. The industry context matters for whether Gibrat's law holds or not (Daunfeldt & Elert 2013).

Third, the management perspective argues that the growth and development of businesses depend on the internal and external environment of entrepreneurs and how quickly they can adapt to these circumstances (Milne & Thompson 1982).

Fourth, there are stages of growth models. These models distinguish different stages of venture growth (Tatikonda et al. 2013), and the change from one phase to another depends mainly on time. Greiner (1972), Christensen & Scot (1964), Lippitt & Schmidt (1967) and Norman (1977) are foundational theoretical sources for the literature on stages of growth models (Levie & Lichtenstein 2010). The core assumption of these stages of growth models is that 'Organizations grow as if they are developing organisms' (Tsoukas 1991: 575). From this basic statement, three assumptions are made about the growth of ventures (Kimberly & Miles 1980): First, distinctively different stages of development can be identified. Second, the sequence and order of development is predetermined and thus predictable. Third, all ventures develop according to prefigured rules. Taken together, there is a need for models of growth that reflect the non-linearity dynamic of development over time.

Table 3: Existing theories of growth models (O'Farrell & Hitchens 1988)

Theory of growth	Definition	Author name (year)
Industrial economics	Unused productive services facilitate the introduction of new combinations of resources in a firm.	Penrose (1959)
Stochastic models	The process of random growth leads to a skewed size distributions of companies, which means that few large and many small companies exist.	Gibrat (1931)
Management perspective	The growth and development of businesses depend on the internal and external environment of entrepreneurs and how quickly they can adapt to these circumstances.	Milne & Thompson (1982)
Stages of growth models	Three assumptions are made about the growth of ventures: First, distinctively different stages of development can be identified. Second, the sequence and order of development is predetermined and thus predictable. Third, all ventures develop according to prefigured rules.	Greiner (1972), Christensen & Scot (1964), Lippitt & Schmidt (1967), Norman (1977)

3.3 Theory development and hypotheses

Non-linearity of growth of new ventures

Although stages of growth theories have different shortcomings, it could be empirically shown that businesses tend to operate in some definable state for some period of time (Levie & Lichtenstein 2010) and then change. This change is sometimes gradual (Churchill & Lewis 1983) and sometimes dramatic (Romanelli & Tushman 1994). In their 'Terminal Assessment of Stages Theory' Levie and Lichtenstein (2010) develop a framework that pays attention to this empirical outcome but is not limited by the assumptions of stages of growth models. They suggest replacing assumptions of these models with principles from complexity science, such as complex adaptive systems (Lichtenstein 2010; Anderson et al. 1999; Holland 1995; McKelvey 2004) and the non-linear dynamics of economics and management (Meyer et al. 2005, 2005; Chiles et al. 2007). This so-called dynamic states approach is also influenced by Penrose (1959) who argue that new combinations of resources need to be introduced into the company, and by Milne & Thompson (1982) who define success of a new venture as its ability to adopt quickly to the internal and external environment of the entrepreneur. Businesses are not predetermined by an unchangeable genetic program, and there is no way to predict how many stages a company will go through during its lifecycle. The main assumption of the dynamic states approach is that each state represents an entrepreneur's attempt to most efficiently and effectively match internal resources with external ones.

The dynamic states approach focuses on the growth of new ventures without accepting assumptions of life cycle models (Furlan et al. 2014), for example continuous or linear growth (Hamilton 2011; Davidsson et al. 2010; Brännback et al. 2014). Stages of growth models link the age and size of a firm to its stage of development. However, not all ventures grow and multiple potential stages for ventures of all ages and sizes exist (Wales et al. 2011). Storm (2011), as one of the few scholars to do so, empirically operationalizes the dynamic states approach to establish a link between drivers of individual behavior and complexity theory. His results validate the use of complexity theory in entrepreneurship research. These alternatives to the stages of growth models show theoretically and empirically the non-linear dynamics of growth trajectories and are summarized in Table 4.

Table 4: Alternative theories of growth models

Theory of growth	Definition	Author name (year)
Dynamic states approach	The main assumption is that each state represents an entrepreneur's attempt to most efficiently and effectively match internal resources with external ones. Growth is defined as a convergence to a resource stock that fits to market optimally.	Levie & Lichtenstein (2012)
Trigger points	Bursts of rapid growth of new ventures often occur after important events, so called trigger points. They have the potential to turn moderately performing businesses into high-performing ones.	Brown & Mawson (2013)
Complexity science	Agent models explain order creation, i.e. non-linear outcomes resulting from (1) rapid phase transitions caused by adaptive tensions and (2) coevolutionary processes.	McKelvey (2004), Derbyshire & Garnsey (2014), Dooley & Van de Ven (1999)

Autocorrelation of growth rates of new ventures

The growth of new ventures is considered to depend on past events (Barney & Zajac 1994; Dierckx & Cool 1989). Heterogeneity of findings regarding the serial correlation of growth rates can be found in the literature. Positive autocorrelation has been found in studies for UK quoted firms (Chesher 1979; Geroski et al. 1997), for manufacturing firms in Germany (Wagner 1992), for Austrian farms (Weiss 1998) or for US manufacturing firms (Bottazzi & Secchi 2003). Negative serial correlation has been shown for German firms (Boeri & Cramer 1992, Schulte 2002), for quoted Japanese firms (Goddard et al. 2002) and for Italian and French manufacturing firms (Bottazzi et al. 2009). Other studies failed to find any significant autocorrelation in growth rates, e.g. for selected Italian manufacturing sectors (Bottazzi et al. 2002) or for the US automobile industry (Geroski & Mazzucato 2002). Therefore, it seems that overall there is no clear pattern emerging regarding the autocorrelation of firm growth rates. However, this changed with the findings of Coad (2007) and Coad & Hölzl (2009).

They show that small firms typically are subject to negative serial correlation of annual growth rates (Daunfeldt & Halvarsson 2015), whereas larger firms exhibit positive serial correlation. Consequently, the inconclusive results of the research on serial correlation of growth rates can be explained that previous studies have used databases that include both small and large companies. In addition, serial correlation is strongly negative for small firms that have just experienced a large growth event in the recent past (Coad 2013).

In line with this empirical finding, we hypothesize that employment growth proceeds in batch, where expansion follows contraction, and contraction follows expansion. A positive incremental, point-to-point growth is rather followed by zero or negative growth and a negative or zero incremental growth is rather followed by positive growth.

Employment growth in new ventures proceeds in batch because of indivisibilities, uncertainty and adjustment costs. In contrast, fine-grained adjustment to actual capacity needs are made for instance by temporal work overtime of given staff, contract workers, outsourcing to freelance staff, etc. Indivisibilities of employment result from individual employment contracts. In Germany, these contracts need to be scaled or portioned in a given frame of regulatory boundaries, set by law. Moreover, some responsibilities are subject to inseparability. Staff-related measures require regularity of capacity needs and a well predictable increase in demand. Because termination options are limited, careful restraint caused by uncertainty guides implementation of an additional unit. Therefore, new ventures need to align additional capacity and increase in demand step-by-step. Staff recruitment and termination cause cost of information and search, cost of reorganization, cost of contract design, etc. (Hamermesh & Pfann 1996; Cooper & Haltiwanger 2003; Hall 2004).

Therefore, oscillating fluctuations in growth of new ventures can be expected, independent from the assumption that long term growth is subject to certain stages, consistent trajectories or development trends. That means incremental growth of new ventures is lumpy and batch-like. After an initial growth spurt, there is little expectation of an immediate subsequent further growth but rather remaining the level yielded, or even a decrease. This applies in reverse as well: After decrease or stagnation growth can be expected to follow.

Concerning sales, although being an output measure, contrarily to employment as an input measure of new ventures, there is a corresponding argumentation not only because of the interrelation of sales and workforce. Change of sales structures calls for adjustment costs, such as personnel training in or recruitment for new distribution channels, new customers or change in the service range. Moreover, sales processes are subject to indivisibilities caused by product range or sales personnel because sales directly depend on the value chain, which in turn is subject to indivisibilities given by production and procurement. Therefore, sales of new ventures are not supposed to change continuously but in incremental batches as well as employment.

Following these argumentation line and in line with the findings that growth rate autocorrelation varies with firm size we propose the following hypotheses 1 and 2.

Hypothesis 1: After a period of positive growth, a given small venture is more likely to enter a period of negative growth in a subsequent period.

Hypothesis 2: After a period of negative growth, a given small venture is more likely to enter a period of positive growth in a subsequent period.

Derbyshire & Garnsey (2014) consider stable periods in the growth trajectories of new ventures. They show that the typical state for a firm is neither growth nor decline but stability. 99.5% of all UK firms included in their dataset have at least one period of stability over the period under analysis. Penrose (1959) explains stable periods with adjustment costs. These costs of growth consist of the time and effort required to adapt managers and operations to the expansion of activities of a given venture. The development of managerial resources takes time, which influences the growth of new ventures (Lockett et al. 2011). To address the importance of stable periods in the growth process of new ventures we propose the following hypothesis

Hypothesis 3: A given small venture experiencing zero growth is more likely to experience more zero growth than either negative or positive growth in a subsequent period.

Towards a new measure of growth

Employment and sales are the most commonly used indicators to measure average business growth (Delmar 2006; Gilbert et al. 2006). In our study, we compare the growth of sales (measured in nominal terms) to employment (measured as full-time equivalent). Employment data offers standardized, comparable data on the rate and direction in which new ventures have been expanding (Garnsey et al. 2006). In contrast, sales are influenced by price effects, productivity effects, exchange rate effects, and taxes (Brenner & Schimke 2014). For further discussion of the advantages and disadvantages of each indicator we refer to Coad (2009). So far, growth measures have been used interchangeably, although correlations between the indicators growth of sales and growth of employment are relatively small. Delmar et al. (2003) find a very weak correlation of .09 between absolute growth of sales and employment, and Weinzimmer et al. (1998) show a correlation of .57 between the relative growth of sales and employment. Thus, the growth of sales and the growth of employment are not equivalent measures of the performance of new ventures (Chandler et al. 2009; Coad & Guenther 2014).

Empirical analysis often prefers a method that measures trajectories in terms of average size or average growth rates for prolonged periods. However, we define the growth of new ventures as the comparison of date-related tendencies of growth indicators between two consecutive periods. Our understanding of constant growth is that the total number of employees or the total amount of sales did not change from one year to the other. We will explain this approach in more detail in the following chapters. Measuring growth in terms of average size says little about the individual economic growth over time. First, static comparisons cannot explain whether a particular development was achieved with constant, decreasing, or increasing growth rates. Different growth trajectories can lead to the same average trajectory. Second, assuming that a cohort includes both fast-growing ventures and ventures that are close to market exit due to stagnation (Garnsey et al. 2006) one could argue, the average growth rate masks tremendous differences between these two groups. We argue that the average trajectory cannot be used especially in case of early-development of new ventures. Therefore, we will provide a conceptual framework to overcome these shortcomings.

Cross-sectional data

'Little evidence is available on the growth paths of firms over time' (Garnsey et al. 2006: 9). Cross-sectional designs may be able to identify some of the variables of growth trajectories of new ventures. A meta-analysis of studies of firm growth published between 1992 and 2006 shows that 'rarely did a study use two or more time spans for calculating growth' (Shepherd & Wiklund 2009: 108). After 2006, only few longitudinal studies on dynamics of new ventures in general (Lejárraga & Oberhofer 2015; Federico & Capelleras 2015; Triguero et al. 2014) and particular on growth trajectories (Anyadike-Danes et al. 2015) were published. This shows that the literature on growth trajectories of new ventures is quite sparse (Brenner & Schimke 2014). However, more robust empirical studies to develop theories for entrepreneurial growth (Blackburn et al. 2013) or to explain how internal and external factors contribute to sustainable growth in SMEs are necessary (Gupta et al. 2013). We argue that a longitudinal research design is crucial to trace growth trajectories of new ventures.

3.4 Research design

Data

One limitation of the existing literature about new ventures is that much of it focuses on the manufacturing sector (Neumark et al. 2011). We use data from the Start-Up Panel of the German state of North Rhine-Westphalia (NRW) which annually monitors young enterprises in the skilled crafts sector. We define a new venture as an economic enterprise that is eight years or younger consistent with Fackler et al. (2013), Jennings et al. (2009), Miller & Camp (1985), Pellegrino et al. (2012) and Short et al. (2009).

We use data from the skilled crafts sector, which is typical of many entrepreneurial activities in Germany in terms of size, business model, or legal type (Lambertz & Schulte, 2013). Furthermore, this sub-sample adheres to Davidsson and Gordon's (2012: 19) call for 'better theorizing and modeling of the drivers of the successful establishment of imitative, subsistence-oriented businesses.' Hence, we focus on 'ordinary entrepreneurs' that do not have neither innovative nor technology-based business concepts (Lambertz & Schulte 2013).

Table 5: Response rates

Panel wave	Survey period	Number of questionnaires distributed	Number of responses	Response rate
5	Summer 2004	6,881	3,627	0.527
6	Summer 2005	8,153	3,978	0.488
7	Summer 2006	9,149	3,610	0.395
8	Summer 2007	9,751	4,014	0.412
9	Summer 2008	7,265	3,231	0.445
10	Summer 2009	7,322	3,316	0.453
11	Summer 2010	7,880	3,272	0.415
12	Summer 2011	8,443	3,447	0.408
13	Summer 2012	8,805	3,653	0.415

Table 5 provides response rates ranging from 39.5 to 52.7 percent, which correspond to rates which allow valid and reliable results (Baruch 1999). In addition to start-ups, the panel covers successions as well as active participations. The data set is not biased by part-time businesses because it contains data solely on full time entrepreneurship (Lambertz & Schulte 2013). In general, part-time businesses cannot be compared with full-time ventures because they are often created only for auxiliary income. Thus, single-person enterprises, which have become a very important part of contemporary's economies (Kessler et al. 2009), are only covered as far as they are run as a full-time business. The conceptual cornerstone of the Start-Up Panel NRW is a periodical survey based on standardized questionnaires that pave the way for the long-term monitoring of a large number of young entrepreneurs and their enterprises, which are either newly created or acquired. This survey has no survivorship bias: As all new ventures in our data set are required to report to a governmental authority (Landes-Gewerbeförderungsstelle), we can monitor and control for the survival of these new ventures within the first two years after foundation. Therefore, we can exclude survivorship bias for first this time span (Lambertz & Schulte 2013). For a longer time period, literature shows that the mortality of new ventures in the craft sector is much lower than in other sectors (Paulini 1999; Albach & Hunsdiek 1987).

The questionnaires of the annual panel wave always contain the same questions with regard to corporate development (sales volume, number of employees, investment volume, expected corporate earnings, corporate profits, utilization, and achievement of profit goals) as well as questions focusing on specific topics that differ from panel wave to panel wave (counseling, entrepreneurial marketing, motivation, etc.) (Lambertz & Schulte 2013).

Our study is based on data that includes nine waves of the Start-Up Panel NRW, and begins with Wave 5. The first four waves are excluded because the survey period changed from six months to one year. The survey is conducted once a year in summer, and if the business is established in spring of the same year, it still does not have one complete year in business. For this reason, the time span between the establishment of the new venture and the first survey is defined as Year 0. This time span, therefore, is shorter than twelve months. Year 1, therefore, marks the first full year of business activitites within the panel waves. We assume that the total number of employees of a given new venture in Year 0 equals the total number of employees at the foundation of a given venture. Because this study investigates up to eight years of a given new venture, it covers Year 0 and eight years, which are numbered 1 to 8 and are equal to an entire year of business activity following Year 0. For example, 1 refers to the age of a given new venture, e.g. this new venture is at least one year (min.) and up to one year and eleven months (max.) old. It is important to mention that we distinguish between periods and points in time. In general, we relate absolute numbers of employment or sales from one date to absolute numbers in the preceding date. For Period 0, we relate the total number of employees or the total amount of sales of date 0 to date 1. This allows us to define state changes, e.g. if the total number of employees or the total amount of sales increases, decreases or grows constantly in a given Period. We will explain the concept of state changes in more detail below.

We merge the data into one set of pooled cross-sectional data. Utilizing pooled data, we reduce potential biasing effects of different economic business cycles, cohorts, and outliers. As it is important to distinguish growth through business takeover (Gilbert et al. 2006; Lockett et al. 2011; Burghardt & Helm 2015) from organic growth (Delmar et al. 2003), we do not analyze business takeovers or active participations. Our dataset contains information on 4,880 newly established ventures between 2003 and 2012 (Table 4). 78 percent are sole proprietorships, and 79 percent are owned by men. The dataset contains information about the sector for 3,977 new ventures. Out of these 3,977, 1,465 (37 percent) new ventures work in the building and interior finishing trades, 1,178 (30 percent) in the electrical and metalworking trades, 953 (24 percent) in the health and body care trades as well as the chemical and cleaning sector, 250 (6 percent) in the woodcrafts and plastic trades, and 55 (1 percent) in the food crafts and trades. There are 76 (1 percent) new ventures representing other trades. On average, the new ventures start up with 2.77 employees (including the entrepreneur). We compare these data with official data from the Register of Craftsmen (Müller 2014) to analyze if our data set is representative for new ventures in the German craftsman sector. This analysis shows that the numbers are comparable, for example in 2009 the average size of German new ventures was 2.1 employees (including the entrepreneur), 85 percent of all new ventures were sole proprietorships, and 79 percent were male.

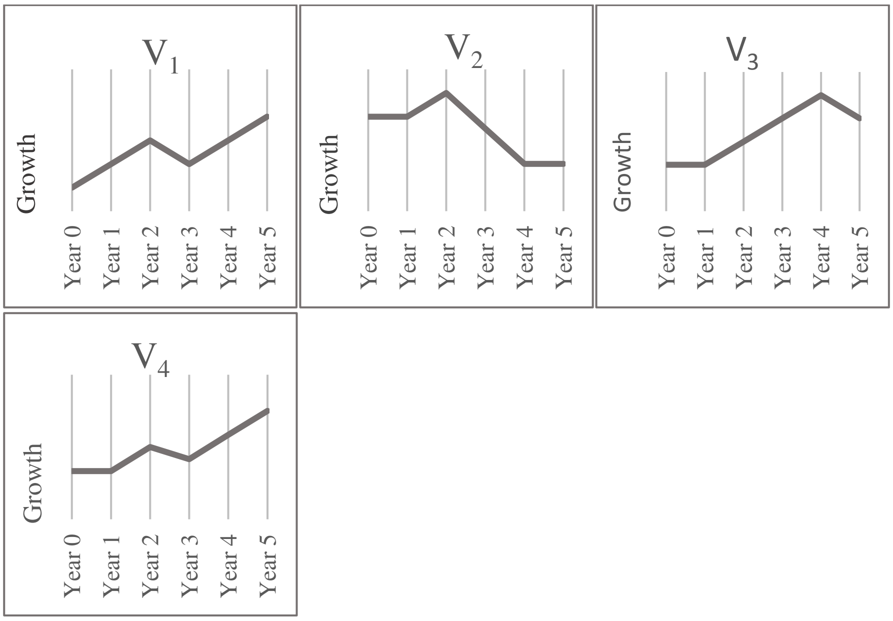
Table 6: Descriptives

Variable	Mean	Standard deviation
Number of employees (incl. entrepreneur, at foundation)	2,77	3.140
Gender: male	0.79	0.407
Form of organization		
Unlimited private company	0.08	0.270
Sole proprietorship	0.78	0.414
Limited liability company	0.14	0.348
Age (in years)		
Age of new venture (in 2012)	5,80	2.489
Age of entrepreneur (in 2012)	41,79	8.332
Sector		
Building and interior finishes trades	0.37	0.482
Electrical and metalworking trades	0.30	0.457
Woodcrafts and plastic trades	0.06	0.243
Clothing, textiles and leather crafts and trades	0.01	0.107
Food crafts and trades	0.01	0.117
Health & body care trades and chemical & cleaning	0.24	0.427
Others	0.01	0.087

Date-related tendencies

Our literature review shows that the field of new venture growth is still fragmented. However, more and more researchers agree that the stages of growth models do not adequately describe the growth trajectories of new ventures. We enter the debate by focusing on the empirical analysis of growth trajectories, and not on an empirical test for a specific model. To do so, we analyze the growth of new ventures by focusing on what we call date-related tendencies. Based on the work on the development of new ventures in terms of development tendencies, we examine long-term developments divided into state changes between time points. This approach allows us to define state changes, e.g. date-related tendencies, and to identify the trajectory of a given venture's development. We exemplify this approach in Figure 5: V_i represents different new ventures with individually specific growth trajectories over time. In our example, we explain the approach of state changes by four different new ventures (V1 to 4). The transition from Year 1 to Year 2 is in this case for all V1 to 4 non-negative. During the transition from Year 4 to Year 5, half of V1 to 4 have a positive rate of change, while the other half has a negative or stable one. It is possible to consider individual temporal interdependencies of development and to discern patterns of growth. In line with Derbyshire & Garnsey (2014), we argue in favor of an empirical model that also considers stable periods in the growth trajectories of new ventures. We define the growth of new ventures as the comparison of date-related tendencies of growth indicators between two consecutive periods.

Figure 5: Individual growth trajectories of four new ventures (V_1 to V_4)



Residual analysis and mosaic plots

We apply a residual analysis to test our hypotheses (please refer to p. 31 and 32). We identify categories relevant for a significant Chi-square statistic. This approach involves calculating the standardized residual for each cell of the contingency table of date-related tendencies (Haberman 1973):

$$e = \frac{\mathrm{O} - \mathrm{E}}{\sqrt{\mathrm{E}}}$$

Where e represents a standardized residual, O is the observed count in the cell and E is the expected count in the cell (Tredoux & Durrheim 2002: 375) and defined as:

$$E = \frac{(\text{sum of data in that row}) \times (\text{sum of data in that column})}{\text{total data}}$$

A significant standardized residual indicates that the cell made a significant contribution to the Chi-square statistic (Agresti 2013).

Under the null hypothesis that is the assumption that variables are independent, the standardized residuals will have a standard normal distribution. A standardized residual larger than 1.96 indicates that the number of cases in that cell is significantly larger than would be expected if the null hypothesis were true, with a significance level of .05. A standardized residual less than -1.96 indicates that the number of cases in that cell is significantly smaller than would be expected if the null hypothesis were true (Agresti 2013).

To illustrate the results of our residual analysis we use mosaic plots, which graphically show percentages of cross-classified categorical variables (Friendly 2002; Hofmann 2000). The areas of rectangular tiles are proportional to the percentages in the cells of the contingency table (Cox 2008).

3.5 Results

Descriptives of non-linear growth

Table 6 briefly describes the merged data of the 4,880 new ventures between 2003 and 2012. We use date-related tendencies regarding employment and sales to explain how these newly established ventures grow within the first eight periods. All results of the Chi-square test are significant throughout the bivariate analysis. In Period 8, more than twenty percent of the expected counts are less than five for both growth measures and, thus, the Chi-square test may be invalid (Wildemuth 2009). Therefore, we focus on date-related tendencies for periods 0 to 7.

The numbers given on the horizontal axis at the very bottom of Figures 6 to 8 refer to the periods explained above. '0 and 1' means that we compare the date-related tendencies in Period 0 with the ones in Period 1. Thus, the columns of Figures 6 to 8 show growth trajectories considering the conditionality of date-related tendencies of preceding periods. In Figure 6, the 33 per cent of Periods '0 and 1' of the left table about employment can be read as follows: 33 percent of all new ventures that increased their employment in Period 0 reversed their decision and decreased their total number of employees in Period 1.

From our analysis we derive the following results: First, the growth of new ventures is not as positive, as suggested by the stages of growth models. For both growth measures, the probability that a new venture continues to grow in a period following an earlier period of growth varies between 29 and 53 percent (Figure 6). Second, the growth of new ventures is uneven, and distinct stages cannot be identified as claimed by stages of growth models. Third, different measures of growth lead to different results. The tendency that sales or employment of new venture increases in period t+1 after it decreased in period t is, for the sales measure, up to 20 percentage points higher than for the employment measure (Figure 7). The probability of a new venture to remain at the same size after a period of constant growth is between eleven and thirty percentage points higher for the employment measure than for the sales measure (Figure 8).

To highlight the differences in the measurement of growth of new ventures, we define increase-decrease-ratios (IDRs). Let IDR be the increase-decrease-ratio of a given part of the growth trajectory with:

IDR = date-related tendency of positive growth / date-related tendency of negative growth For the left table of Figure 6, we exemplify this ratio. We relate the 42 percent to the 33 percent to receive an IDR of 1.27.

After an increase in period t (Figure 6), at period t+1 four out of seven IDRs of employment are less than 1 indicating that the percentage of negative growth is larger than the percentage of growth in these periods (Figure 6, table on the left side). In contrast, for sales in period t+1 all periods, except the comparison between Period 3 and 4, show a IDR value larger than 1 indicating that the percentage of growth is larger than the percentage of negative growth (Figure 6, table on the right side). After zero growth in period t (Figure 8), in period t+1 IDRs of sales range from 1.34 to 3.24, which means that the percentage of increase is always larger than the percentage of decrease. Constant growth in period t is followed by a range of fluctuating sales figures throughout the periods (Figure 8, table on the right side). In period t+1, the IDRs of employment vary even more between 1.05 and 5.25 (Figure 8, table on the left side).

Figure 6: Date-related tendencies regarding employment (left figure) and sales (right figure) conditional on positive growth in period t

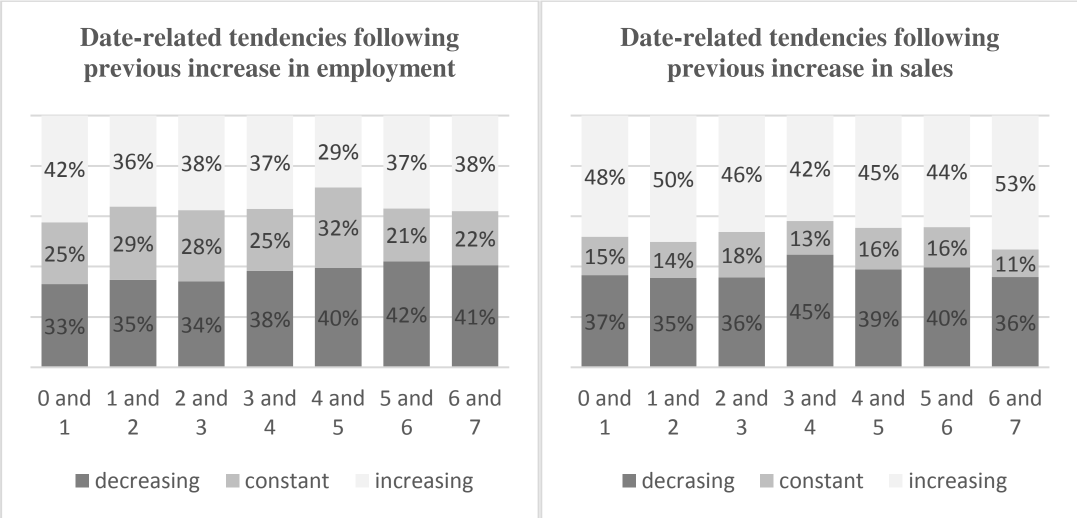


Figure 7: Date-related tendencies regarding employment and sales conditional on negative growth in period t

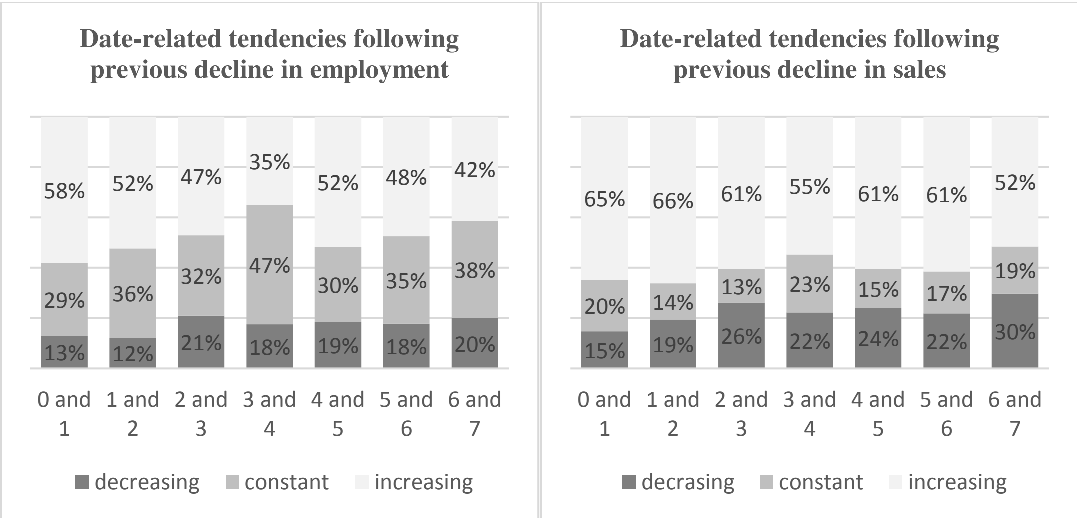
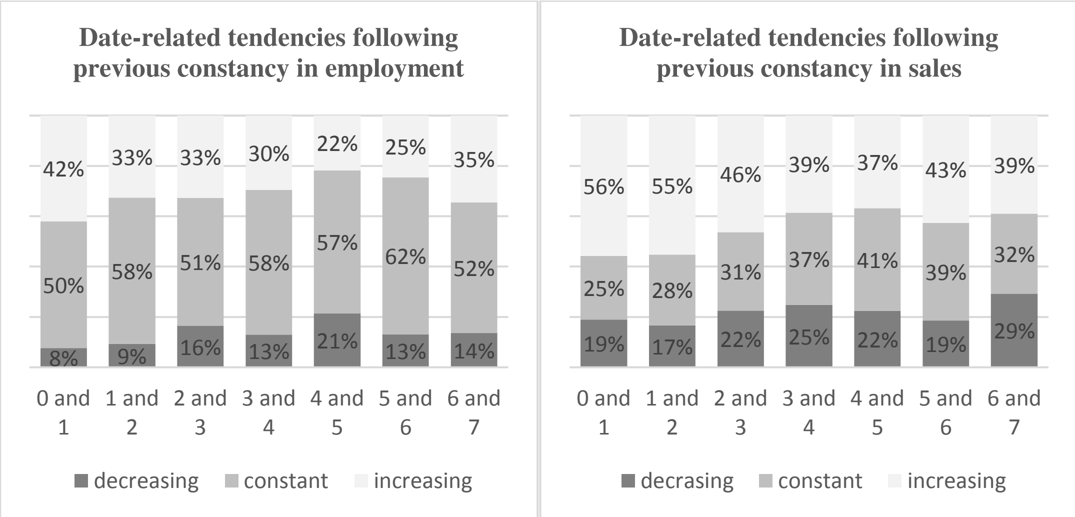


Figure 8: Date-related tendencies regarding employment and sales conditional on zero growth in period t



Mosaic plots

As we introduce mosaic plots as a new approach to test hypotheses of growth trajectories, we exemplify how to read Mosaic plot 1 regarding employment (Figure 9, first table on the left side). The percentages on the horizontal axis refer to the percentages of new ventures that decreased, increased, or hold their number of employees constant in Period 0. Similarly, the numbers on the left side (0, 25, 50, etc.) refer to the percentage of new ventures and its change in employment in Period 1. As date-related tendencies in Period 1 are conditional on date related-tendencies in Period 0, the results can be read as follows: Out of all new ventures that decreased their number of employees in Period 0, 12.9 percent continue to decline their total number of employees in Period 1.

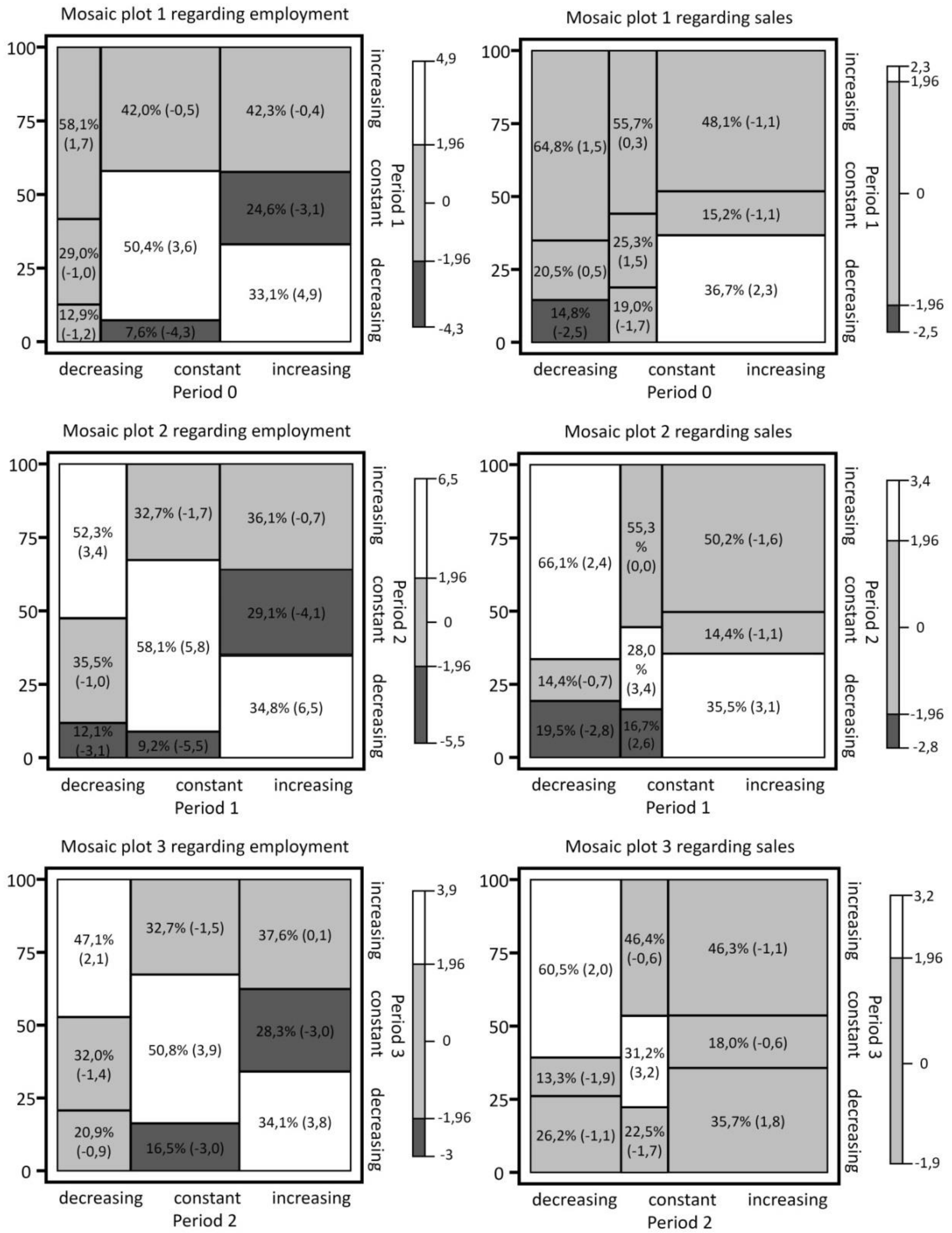
The number in parenthesis and the colors refer to the residual analysis. White refers to standardized residuals larger than 1.96, grey to the ones between -1.96 and 1.96, and black to standardized residuals smaller than -1.96. In our example, the standardized residuals have a value of -1.2 and the cell is, therefore, grey. This means that the number of cases in this cell is not significantly larger or smaller than expected and, thus, this result does not provide evidence for our hypotheses.

As illustrated in Figure 9, mosaic plots show evidence for Hypothesis 1. The value of standardized residuals shows that observations for growth of employment in period t and decline in period t+1 are, as shown in the bottom right corner of the mosaic plots in Figure 9, overrepresented within the entire period under observation. In addition, all periods which see an increase in period t and constant development in period t+1 are underrepresented. We find a similar result for growth of sales.

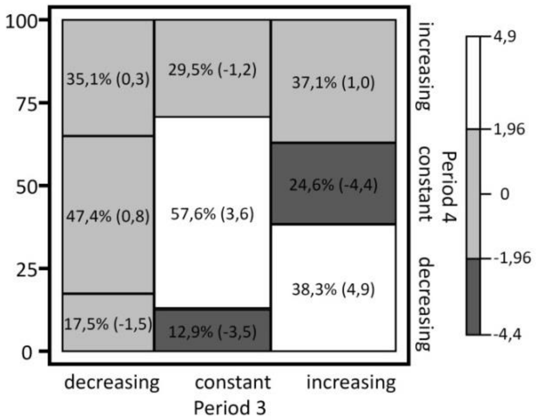
As shown in Figure 9, mosaic plots show partly evidence for Hypothesis 2. The value of standardized residuals shows that observations for decline of employment in period t and increase in period t+1 are, as shown in the upper left corner of the mosaic plots in Figure 9, overrepresented for mosaic plots 2, 3, 5, and 6. For mosaic plots 1, 4 and 7 we do not find evidence that the number of cases in that cell is significantly larger than would be expected. For growth of sales we find statistical evidence for our hypothesis for mosaic plots 2, 3, and 5.

As presented in Figure 9, mosaic plots provide evidence for Hypothesis 3. The value of standardized residuals shows that observations for constant growth of employment in period t and constant growth in period t+1 are, as shown in the rectangle in the middle of the mosaic plots in Figure 9, overrepresented within the entire period under observation. Except mosaic plot 1, we find a similar result for growth of sales.

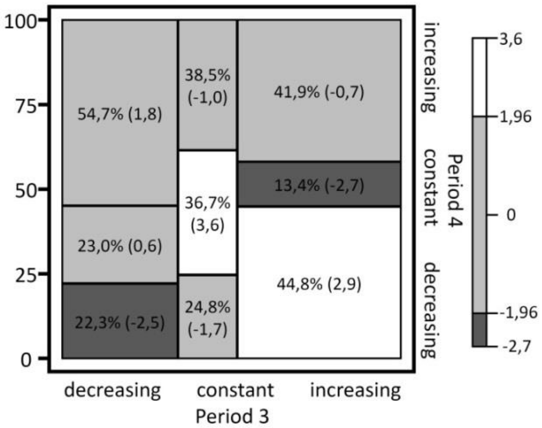
Figure 9: Mosaic plots regarding growth of employment and sales (please refer to p. 40, second paragraph for the explanation of the colours)



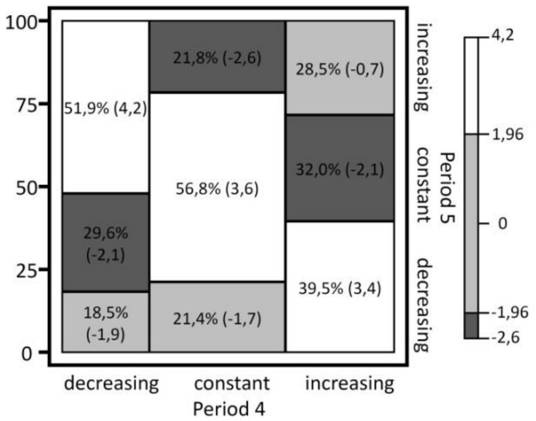
Mosaic plot 4 regarding employment



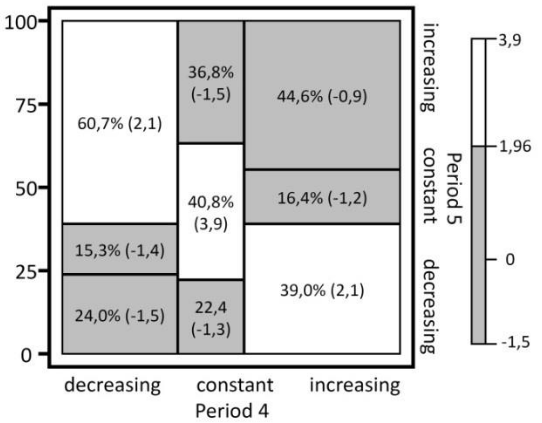
Mosaic plot 4 regarding sales



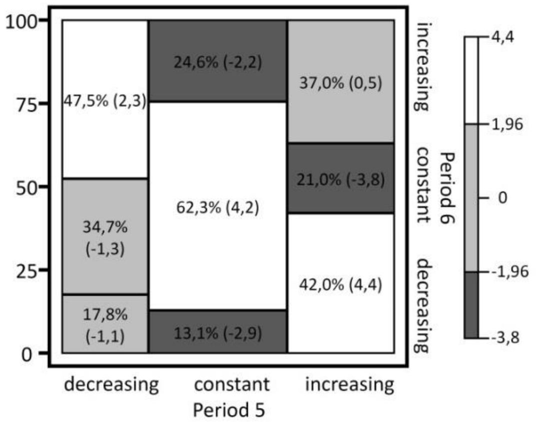
Mosaic plot 5 regarding employment



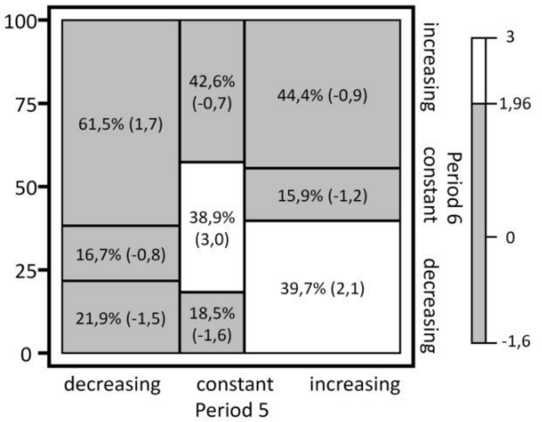
Mosaic plot 5 regarding sales

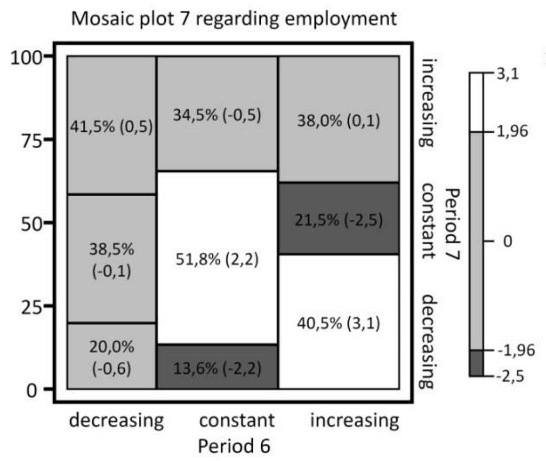


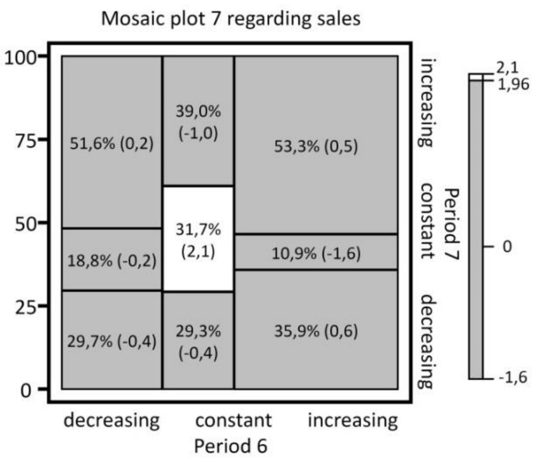
Mosaic plot 6 regarding employment



Mosaic plot 6 regarding sales







Multivariate analyses

We run a pooled OLS regression to support our findings of the residual analysis and show which variables influence the growth of new ventures. OLS regression may yield biased and inconsistent estimators but are widely applied in the entrepreneurship research. To compare our results with other research we decide for an OLS regression. Annex 4 compares the OLS with the GMM method. As sales are influenced by price effects, productivity effects, exchange rate effects, and taxes (Brenner & Schimke 2014) the pooled OLS regression is not estimated for sales. Furthermore, to facilitate comparability with other studies related to growth of new ventures (Bottazzi et al. 2009; Federico & Capelleras 2015) growth of employment (and not sales) is chosen as dependent variable calculated by taking the differences of the logarithms of size, exemplified on employment (The transformation allows to interprete changes in the explanatory variables in terms of percentage changes in the dependent variable):

$GROWTH_{it}=\log(SIZE_{i,t})-\log(SIZE_{i,t-1})$

where $SIZE_{it}$ is measured by employment for firm i at time t.

In order to analyze the autocorrelation between growth of new ventures, we estimate the following equation with Cluster-robust Huber/White standard errors (Rogers 1993; Williams 2000). It allows controlling for intraclass[3] correlation between the new ventures in the data set:

$$(\log(empl_{i,t})-\log(empl_{i,t-1})) = \alpha_0+\alpha_1(\log(empl_{i,t-1})-\log(empl_{i,t-2})) + \alpha_2(\log(empl_{i,t-2})-\log(empl_{i,t-3})) + \alpha_3 Legalform_{i,t} + \alpha_4 Age_{i,t} + \alpha_5 Sex_{i,t} + \alpha_6 Totalemployment_{i,t} + \alpha_7 Performance_{i,t} + \alpha_{8\text{-}9} IndustryDummy_{i,t} + \varepsilon_{i,t}$$

This equation represents our GROWTH model, where current growth is estimated using a set of lagged values of growth of employment to test for the autocorrelation of growth rates. The numbers in Table 7 refers to the number of lags used and show that the serial correlation of the growth of new ventures is consistently significant for t-1 and t-2. Adding further lags will also reduce critically the number of observations and may not imply an improvement in the explanatory power of the model. The approach of lagged variables is different to our analysis of the mosaic plots, where we compare t and t+1 instead of focusing on all past growth rates. It serves to check for autocorrelation of longer periods of development than just two subsequent measuring points. However, our findings show that significant autocorrelation is strictly restricted to a lag of up to two years.

[3] Intraclass correlation refers to the correlation of the observations within the panel set.

Table 7: Serial Correlation between growth of employment (p-values in parentheses)[4]

	0lag	1lag	2lag	3lag	4lag	5lag	6lag	7lag
0lag	1							
1lag	-0.2448 (0.0000)	1						
2lag	-0.0486 (0.0128)	-0.2466 (0.0000)	1					
3lag	-0.0202 (0.4014)	-0.0333 (0.0927)	-0.2482 (0.0000)	1				
4lag	0.0052 (0.8614)	-0.0244 (0.3205)	-0.0385 (0.0624)	-0.2530 (0.0000)	1			
5lag	0.0434 (0.2548)	0.0093 (0.7602)	-0.0201 (0.4412)	-0.0413 (0.0644)	-0.2522 (0.0000)	1		
6lag	-0.0215 (0.6755)	0.0174 (0.6018)	0.0174 (0.6018)	-0.0193 (0.5058)	-0.0594 (0.0169)	-0.2865 (0.0000)	1	
7lag	-0.057 (0.9450)	-0.0477 (0.3924)	0.0340 (0.4723)	0.0147 (0.7139)	-0.0172 (0.6237)	-0.0818 (0.0076)	-0.3432 (0.0000)	1

As control variables we add firm age, legal form of new ventures, sex and industry dummies. In addition, we add the total number of employees and expected business situation as independent variables. The expected business situation is based on a self-evaluation of the entrepreneur regarding the question "What are your expectations regarding the business situation for the next six months?" Firm age is observed to have a negative effect on growth, as a large number of studies have shown, for example Evans (1987a, b) for US manufacturing firms, Variyam & Kraybill (1992) for US manufacturing and services firms, Liu et al. (1999) for Taiwanese electronics plants, Geroski & Gugler (2004) for large European companies and Yasuda (2005) for Japanese manufacturing firms.

Harhoff et al. (1998) examine the growth of West German firms and observe that firms with limited liability have significantly higher growth rates in comparison to other ventures. However, these firms also have significantly higher exit hazards. These results are in line with theoretical contributions that emphasize that the limited liability legal form provides incentives for managers to pursue projects that are characterized by both a relatively high expected return and a relatively high risk of failure (Stiglitz & Weiss 1981).

Firms in mature industries are likely to have lower average growth rates because of the lower level of opportunity in mature industries. In contrast, firms in new sectors may have high growth rates due to the rapid pace of technological progress and the emergence of new products (Coad 2009). To address these industry-related differences we add industry dummies to the equation.

Current total number of employment and performance of a new venture are supposed to be a major influence for incremental growth. A top performing business is much more able to add size than an underachieving one, because profit enables the new firm

[4]For example 1lag refers to ($\log(empl_{i,t-1})-\log(empl_{i,t-2})$) and 2lag refers to ($\log(empl_{i,t-2})-\log(empl_{i,t-3})$)

to fund additional staff. Therefore, the profit situation is a major prerequisite for incremental growth. For this reason, we add ‘expected business situation’, as an independent variable for performance into the regression.

Table 8: OLS regression results for growth of employment, taking 2 lags (standard errors in parentheses)

Dependent variable: $growth_{it}$	
$Growth_{it-1}$	-0.2672*** (0.0346)
$Growth_{it-2}$	-0.1243*** (0.0315)
Legal form	-0.0014 (0.0374)
Firm age	0.0159*** (0.0051)
Manufacturing	0.0177 (0.0157)
Services	-0.0110 (0.0139)
Sex	0.0230 (0.0337)
Total employment	0.0181** (0.0077)
Business outlook	-0.0090 (0.0165)
Constant	-31.99
R-squared	0.13
Obs.	2093

*p ≤0.1, **p ≤0.05, ***p ≤0.01

Regression results are reported in Table 8. We observe a negative autocorrelation for the first lag and a smaller autocorrelation for the second lag. These results highlight some important features. First, the results of the pooled OLS regression support the results of the mosaic plots that firm growth rates are not random and non-linear. Second, in line with Coad & Hölzl (2009), Coad (2007), Fotopoulos & Giotopoulos (2010) and Hölzl (2014), we show that small firms are subject to negative serial correlation of growth rates. For new ventures experiencing high dismissal of employees at time t, the negative coefficient implies that in the previous period t-1 these new ventures were probably experiencing positive growth. Similarly, for those fastest-growing firms at time t, the negative coefficient indicates that these firms probably performed relatively poorly in the previous period t-1. An explanation for the negative autocorrelation could be that new ventures hire more than the required number of employees with the expectation of keeping only top performers. This may lead to a mechanical effect of negative autocorrelation. We analyze micro and small new ventures, thus these types of firms do not have the necessary resources to apply such a forward-looking strategy.

The significance and the positive sign of the firm age mean that the younger the firm the higher the growth rate of employment. This negative dependence of growth rate on age appears to be a robust feature of industrial dynamics in our data set. Sole proprietorships have the expected negative sign but the results are not significant. In addition, total number of employment and is positive and significant.

3.6 Discussion and Conclusion

Our study of German new venture development over time highlights the importance of longitudinal data to trace the growth of new ventures. Growth is non-linear, prone to interruptions, amplifying forces, and setbacks (Garnsey et al. 2006). Therefore, our results support Penrose's (1959) view that growth is episodic and occurs in spurts. However, the literature so far seldom focuses on non-linear phenomena. Instead, the growth of new ventures is modeled as if it were linear. Dynamic processes, such as resource problems or shifts in terms of opportunities, result in variations in the timing, magnitude, duration, and rate of change of growth (Derbyshire & Garnsey 2014). Our article supports scholars such as Levie & Lichtenstein (2010), Brown & Mawson (2013) or Davidsson et al. (2009) who have challenged traditional stages of growth models. In line with scholars who introduce complexity science to the literature on growth of new ventures (McKelvey 2004; Derbyshire & Garnsey 2014; Dooley & Van de Ven 1999), we argue for theoretical models that capture complex and non-linear dynamics of growth (Steffens et al. 2009). Future research on new venture growth should focus on a more flexible approach, such as the dynamic states approach, to understand the dynamics of hyper-growth companies (Cassia & Minola 2012). This study also seeks to complement the existing literature on growth rate autocorrelation by focusing on the dynamics of new ventures. After a period of growth, more than 29 percent of the new ventures investigated here seem to enter a phase of consolidation because they may not want to grow further or even decide to reverse their decisions. These results are in line with Penrose's focus on the adjustment costs of further growth. Consecutive periods of constancy or negative growth can be explained by the need of a new venture for consolidation. Indivisibility, potential sunk costs, and size adjustment costs prevent firms from growth at certain stages of development (Lockett et al. 2011). Even growing firms devote more than 65 percent of their time to consolidation (Hamilton 2011).

In contrast to Coad et al. (2013), who do not consider stable periods, our results show that stable periods exist and, therefore, need to be considered. This indicates that periods of growth are not necessarily followed by periods of growth, as suggested by the findings by Garnsey et al. (2006) for the UK, Netherlands, and Germany. We agree with Garnsey et al. (2006), however, that an important determinant of year-to-year growth seems to be the growth in the preceding year.

Data and findings add a new and different view to the assumption of a staged development of new ventures. When creating new combinations of resources and adapting to their environment, new ventures do not generally contradict staged development presumptions. But stages, if existent, are not constant or steady. Development is not continuously incrementing but intermitted, lumpy and not always in line with a steady state stages assumption. Moreover, findings question the determination and inevitability of stage sequences in a typical new venture setting.

Consistent with other work on growth measures (Delmar 2006; Shepherd & Wiklund 2009), we argue that it is important that scholars clearly explain why they use a certain growth measure because results depend on this decision. Standard cross sectional measures and average growth rates fail to describe important dimensions of the course of growth of firms (Garnsey et al. 2006).

Our findings have the five following implications: First, it makes sense to study growth trajectories in a non-linear way and not constrained by the concept of stages, highlighting point-to-point changes to identify development patterns. We introduce mosaic plots as a new approach to visualize growth tendencies and evidence for our hypotheses.

Second, our data shows that recent positive growth is more likely to lead to negative growth, and conversely, that a recent negative growth raises the probability of a subsequent positive growth. Therefore, traditional growth models cannot be validated by our data. To put it differently, the commonly used term 'stage model' has to be interpreted in a different manner. Stage would not be defined as a time span, but rather as a sort of conditions of circumstances that are all present at a point in time and that are conditionally linked to a preceding sort of circumstances. In this sense, our understanding of stages reveals the opportunity tension between stability and change identified by Levie & Lichtenstein (2010).

Third, growth in period t can be a rather good predictor for growth in period t+1. This suggests that variables for growth need to be included as lagged variables in models predicting growth. Our suggestion implies further research on growth determinants. While the vast majority of previous findings have relied on cross-sectional designs, our longitudinal design leads to more nuanced results. It also shows that large-scale longitudinal data is crucial for future research because it can generate more reliable results.

Fourth, the different findings concerning sales and employment growth call for some reflections on their distinctions. Business founders have an effect on the growth of their firms due to their intentional behavior, but do not affect employment and sales in the same manner. While growth in terms of employment is directly affected by the intentional behavior (Bingham et al. 2007), growth in terms of sales depends on market demand. As Delmar & Wiklund (2008) point out, the latter reflects market-driven output gains while the former is related to adjustments of the resources available for a firm (Penrose 1959).

Fifth, a more practical implication of this paper's findings is that the management of new ventures and consultants need to consider growth trajectories in terms of the extent and timing. Because growth is subject to indivisibility, potential sunk costs, and size adjustment costs, options of continuous, incremental growth are limited, and this situation may lead to dramatic changes. This challenge, in turn, may lead to a loss of crucial resources. In light of these potential dangers, new ventures have to respond to internal and external changes in a measured manner. New venture management and consultants can help entrepreneurs to achieve this difficult balancing act.

This article has some limitations. We do not have data on growth intensions, and, therefore, we cannot distinguish between ventures that cannot grow, do not have to grow, or do not want to grow (Autio & Acs 2010). We analyze new ventures predominately in the skilled crafts sector. These new ventures cover different occupations and sectors but a precise breakdown into certain sectors (for example as defined by NACE code) is not possible.

A more panel-specific limitation results from decreasing case numbers with longer periods. As shown above, the case number of ventures analyzable decreases with venture age. Therefore, the period of observation is limited to the first eight years of early development. Because consolidation periods of new ventures go up to five years on average (Lambertz & Schulte 2013), this is supposed to be an adequate period of time. However, as panel mortality can lead to successor bias, meaning that more successful ventures are more likely to report their development, later period estimations might be overestimated because of underperforming non-respondents. However, this issue seems to be negligible as respondents do not report growth but current size. Another problem in this respect can be survivorship bias because only ventures still in business can be surveyed. However, the data set allows controlling for exits for at least the first two years of business activity of each firm because of respective notations in the central state government data base. Afterwards, exit rate of these full-time businesses is demonstrably lower than average. The results of the mosaic plots focus on the sign of the autocorrelation.

Future research could shed light on attractive alternatives to organic growth of new ventures. One of these alternatives to discuss may be acquisitions because it may enable a firm to take advantage of growth opportunities by accessing resources that are complementary in nature to the resources that the new venture already controls (Lockett et al. 2011). Further empirical research on the value creation process could also provide new insights into the heterogeneous growth trajectories of new ventures and the validation of Levie & Lichtenstein's (2010) dynamic states approach.

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Business takeovers and firm growth: Empirical evidence from a German panel

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4 Business takeovers and firm growth: Empirical evidence from a German panel

Abstract

The present article links business takeovers to the literature on serial autocorrelation of growth rates. The aim of the study is to identify the effects of successions on the performance of small German firms by analyzing the growth pathways over a period of eight years after business takeover. Using panel data from 1,872 firms, the present article shows that for the first two years after business takeover, small firms are subject to negative serial correlation of growth rates regarding employment. The analysis underlines the importance of longitudinal data to provide evidence on changes in the behavior of a firm following a business takeover.

Keywords: Business takeovers, successions, autocorrelation, panel data, small firms

JEL classification: L25, M13, M21

4.1 Introduction

As the population in many industrialized countries ages and many business owners approach retirement (Levesque & Minniti 2011), the relevance of business takeovers will increase in the next years. An increasing amount of business owners will search for a successor outside of the family or their business (Scholes et al. 2009; Van Teeffelen 2010). The demographic change also affects the supply of potential entrepreneurs, as studies show an inverse U-shaped relationship between age and the decision to become an entrepreneur (Bönte et al. 2009; Evans & Leighton 1989; Levesque & Minniti 2011). Estimates (Müller et al. 2011) suggest that the number of business takeovers will rise continuously until 2020, whereas the potential of future successors tends to decline at the same time. If business owners do not find successors for their firms, the economic value of these businesses may be lost, with negative implications for employment, entrepreneurial experience and economic growth (Block et al. 2013).

However, little research has been conducted on the development of a firm after such a takeover. As Block et al. (2013: 1116) state that "it would be intriguing to learn more about firm […] performance across […] modes of entry. […] A longitudinal design can help to answer these questions". Thus, the research question of the present article is how small firms develop after a change in ownership.

The present article divides between new venture start-ups and taking over an existing firm as ways to become an entrepreneur. For taking over an existing firm different options are available (Scholes et al. 2008; Stavrou 1999; Zellweger et al. 2011; Block et al. 2013): First, transition of ownership and management within a family; second, the firm can be sold to another firm through a trade sale; third, the firm can be floated on a stock exchange; fourth, the firm can be sold to members of the existing management team (MBO) and finally, the firm can be sold to an external management team (MBI).Whereas studies on the performance of new ventures are primarily found in the entrepreneurship literature, studies of takeovers are mainly found in the family business literature related to firm successions (Bennedsen et al. 2007; Chua et al. 2003; Molly et al. 2010). To the best knowledge of the author there are no articles about the firm performance of small firms after MBI respectively MBO. This could be due to the fact that MBI and MBO are feasible options for larger firms but not for small ones. Therefore, the literature review focuses on family businesses bearing in mind that other forms of takeovers exist.

The present article defines business takeover as the process of transfer of ownership of an owner-managed firm to an individual including personnel change in the management (Ullrich & Werner 2013). This definition includes both within- and outside family takeovers. Due to data restrictions the different modes of takeovers cannot be distinguished in the empirical section of the present article.

Using the Start-Up Panel of the German state of North Rhine-Westphalia (NRW), the present article contributes to the literature on business takeovers, adjustment costs and serial correlation in three ways: First, the literature on business takeovers so far has mainly focused on the reasons for the mode of entrepreneurship. The present article provides first empirical evidence of the growth pathways of firms that were taken over by an individual. It is likely that adjustment costs influence this growth process.

Second, a major shortcoming of past empirical studies on business takeovers is that they tend to rely on cross-sectional data. A meta-analysis of studies of firm growth published between 1992 and 2006 shows that "rarely did a study use two or more time spans for calculating growth" (Shepherd & Wiklund 2009: 108). After 2006, only few longitudinal studies on the dynamics of new ventures in general (Lejárraga & Oberhofer 2015; Federico & Capelleras 2015; Triguero et al. 2014) and particular on growth trajectories (Anyadike-Danes et al. 2015) were published. This shows that the literature on growth trajectories is quite sparse (Brenner & Schimke 2014; Habermann & Schulte 2017). Cross-sectional data can only provide a static description of a succession but cannot analyze the dynamics behind such a process. A longitudinal research design is crucial to understand the relationship between business takeovers and firm performance. Therefore, the present article follows such a longitudinal approach based on panel data.

Third, the present article adds to the literature on serial correlation of imitative, subsistence-oriented firms. Similar to the results on organic growth (Habermann & Schulte 2017), after a business takeover a negative serial correlation is observed showing a picture of erratic growth dynamics. This means that after a business takeover, small firms that grew rapidly in one year are unlikely to repeat this kind of performance the following year. Thus, growth in period t-1 can be a rather good predictor for growth in period t.

In the remainder of this paper, the theory, hypotheses, methodology and results are presented followed by a discussion of the implications and limitations of the study.

4.2 Literature review on firm performance after business takeover

The present article analyzes the growth of small firms after business takeover and does not compare the development of new ventures with the development of business takeovers. Therefore, the literature review focuses entirely on firm performance after business takeover. So far, empirical studies on the growth after business takeover compared the performance of firms that were handed over to a family member to firms that were transferred to a non-family member. The empirical results for the firm performance after business takeover are mixed.

Using data from 335 publicly traded companies, Perez-Gonzalez (2006) shows that firms, where the incoming Chief Executive Officer (CEO) is related by blood or marriage to a founder or a large shareholder, underperform relative to firms that promote unrelated CEOs. The study finds that within the first three years after business takeover returns on assets are for a firm with a related CEO 18 percent and market-to-book ratios 14 percent lower than firms with unrelated CEOs. Smith & Amoako-Adu (1999) find a similar result for 124 family controlled firms in Canada. Stock prices declined by 3.20 percent during a three-day event window when family successors are appointed. In contrast, no significant change in stock prices was found when non-family successors were appointed. Using a dataset with 5,334 business takeovers in Denmark, Bennedsen et al. (2007) observe that family successions have a negative impact on firm performance. Operating profitability on assets fell by at least four percentage points around CEO transitions. Cucculelli & Micucci (2006) analyze small- and medium-sized private firms in Italy, which run as family businesses and show a decrease in the performance after takeover. This decrease appears to be mainly concentrated within firms that, before the succession, outperformed the sectoral average profitability. Morck et al. (2000) find that Canadian firms controlled by heirs of the founder show lower profitability than firms, which are run by individuals outside of the family. Using data on all Fortune-500 firms during 1994 and 2000, Villalonga & Amit (2006) show a negative effect of descendant-CEOs on firm value.

In contrast, Anderson & Reeb (2003) find for the Standard & Poors 500 firms as of 1992 a positive performance effect when family members serve as CEOs relative to outside CEOs. A similar result is found by McConaughy et al. (1998) who argue that descendant-controlled firms are more efficient than founder-controlled firms. The former generate significantly higher sales growth rates, sales per employee and cash flow per employee than the latter ones, indicating that successors were able to enhance firm performance. Using panel data from the US cement industry, Tushman & Rosenkopf (1996) show that CEO succession is positively associated with subsequent organizational performance if environmental turbulences are held constant. Sraer & Thesmar (2007) analyze a sample of 750 French firms that are on the French stock market and do not find a significant difference in firm performance of founder- and descendant-controlled firms. However, both types of firms are related to better performance than firms that are run by unrelated CEOs. Using panel data on 1,101 Austrian firms, Diwisch et al. (2009) find a significant and positive effect of business takeovers on employment growth, which becomes stronger over time. The effect amounts to 15 percentage points over a six year period. Werner et al. (2010) observe for German small firms that the successors manage, with a simultaneous reduction of employment, to enter new opportunities for growth, which is reflected in higher revenue growth rates and optimistic revenue and profit expectations. Using panel data for 153 small- and medium sized Belgian firms, Molly et al. (2010) study the impact of a family business transfer on the financial structure and performance. Transfer from the first to the second generation negatively influences the debt rate of the firm, whereas in successions between later generations this effect is reversed. With respect to the growth of the firm, for first-generation firms the growth rate decreases after the business takeover, whereas in next generation firms no effect on the growth can be identified.

The present article differs from these studies in three ways. First, whereas most studies mentioned above focus mainly on large publicly traded firms, this article focuses on small- and medium sized firms because they constitute the majority of firms in Germany. It is likely that the process of transition is different for these firms. Second, the focus on small German firms also implies that stock values as performance measures cannot be used because these firms are not publicly traded firms. Instead, the present article analyzes the consequences of business takeovers on the growth of employment. Third, due to lack of data the present article does not differentiate between family and non-family business takeovers.

4.3 The relationship between adjustment costs and growth of employment

There is a debate about the randomness of firm growth rates (Coad 2012; Coad et al. 2013; 2015; Derbyshire & Garnsey 2014; 2015). This debate is based on earlier discussion about Gibrat's (1931) Law of proportionate effects. However, instead of the traditional size-growth relationship, the focus is now on the degree of serial correlation of growth rates (Coad & Hölzl 2009; Coad 2007; Fotopoulos & Giotopoulos 2010; Hölzl 2014). As noted by Stam (2010), this reappraisal of Gibrat's Law has resulted in two different strands. First, an approach that suggests that growth is characterized as a close-to-random process and, thus, one would expect a null correlation between past and current growth (Coad et al. 2013; Geroski 2005; Storey 2011). Second, the growth of firms is considered to depend on past events (Barney & Zajac 1994; Dierickx & Cool 1989), thus, serial correlation of growth rates exist. In the present article serial correlation and autocorrelation are used synonymously.

The literature on serial correlation of growth rates presents heterogeneous results. Positive autocorrelation has been shown for UK quoted firms (Chesher 1979; Geroski et al. 1997), for manufacturing firms in Germany (Wagner 1992) for Austrian farms (Weiss 1998) and for US manufacturing firms (Bottazzi & Secchi 2003). In contrast, negative serial correlation has been found in studies for German firms (Boeri & Cramer 1992), for quoted Japanese firms (Goddard et al. 2002) and for Italian and French manufacturing firms (Bottazzi et al. 2007; Bottazzi et al. 2009). There are also studies that fail to find any significant serial correlation in growth rates, for example for selected Italian manufacturing sectors (Bottazzi et al. 2002) and for the US automobile industry (Geroski & Mazzucato 2002).

In general, it seems that there is no clear pattern emerging regarding the serial correlation of the growth rates of firms (Habermann & Schulte 2017). However, this changed with the findings of Coad (2007) and Coad & Hölzl (2009), who find that serial correlation is strongly negative for small firms, whereas larger firms show positive serial correlation (Daunfeldt & Halvarsson 2015). Thus, the inconclusive results of the studies on autocorrelation of growth rates can be explained that previous studies have used datasets that include both small and large firms.

In evolutionary economics, established routines and organizational inertia are used to explain why after business takeover a positive serial correlation is expected since the change in ownership does not modify significantly the way the firm operates in the short run (Coad 2009). In contrast, other scholars (Cooper & Haltiwanger 2006; Hamermesh & Pfann 1996) argue that at the micro level adjustment costs influence the growth pathway of firms and, therefore, are related to serial correlation. After business takeover, the successor undertakes various changes to realign the firm. The structural changes in the business strategy are related to the firms' internal structures, which include the reorganization of work processes, changes in business operations, in innovation efforts and in the product range. The successors often change business partners and find access to international markets (Gottschalk et al. 2010). Table 9 provides an overview about these changes in the internal and external structure.

Table 9: Changes in the internal and external structure of a firm after business takeover

Changes in the internal structure of the firm			Changes in the external business relationship	
Work organization	Business operation	Products and processes	External business partners	Access to new markets
• Hierarchy • Work time models • Remuneration models • Hiring or dismissal of employees	• Purchasing • Production • Marketing and sales • Human resources • Finance, accounting and controlling	• New production processes • New products and services • Market innovation	• Acquisition of new customers • Acquisition of new suppliers • Cancellation of contracts with existing suppliers • Change of the regular bank • Acquisition of new investors • Hiring new consultants	• Local • National • European Union • Other countries

Source: Gottschalk et al. (2010)

These changes involve adjustment costs, which consist of the time and effort required to integrate operations when changing the activities of the firm. Especially external successors need to get to know the existing structures (Cater & Justis 2009), which takes time. The period immediately after takeover is critical for all successors because they still need to acquire firm-specific knowledge and may also need a general introduction to the management of a firm. Consequently, the successors may not be able to run the firm in the same manner as their predecessors. Against this background, it is interesting to analyze how certain corporate performance indicators, such as the growth of employment, develop over time (Moog et al. 2012).

Neoclassic theory assumes that firms have a target size that they tend towards. A positive autocorrelation of growth rates is related to convex adjustment costs because they prevent firms from immediately attaining their chosen size and lead to a gradual adjustment over time. In contrast, non-convex adjustment costs prohibit firms from instantly attaining their ideal size and are more related to the empirical evidence that employment change is non-smooth (Hamermesh & Pfann 1996). If non-convex adjustment costs play an important role a negative autocorrelation in growth rates is expected (Coad & Hölzl 2009). This means that after positive growth, immediate subsequent further positive growth is rather unlikely and after decrease positive growth can be expected to follow. For example, asymmetric adjustment cost models imply that the process of hiring and dismissing employees is non-linear.

Due to adjustment costs, indivisibility and uncertainty the present article hypothesizes that employment growth is non-linear, where a positive growth is rather followed by negative or zero growth and a negative or zero growth is rather followed by positive growth. This means that expansion follows contraction and contraction follows expansion. Indivisibility of employment results from individual employment contracts. In Germany, these contracts need to be portioned or scaled in certain regulatory boundaries (Habermann & Schulte 2017). Furthermore, some responsibilities are subject to indivisibility. As German employees are protected by strict labor laws the simple termination of labor contracts is difficult and, therefore, small firms are carefully with the recruitment of new employees. Thus, small firms need to align additional capacity and increase demand step-by-step. Recruitment and termination of employees cause costs related to information and search, reorganization and contract design (Hamermesh & Pfann 1996; Cooper & Haltiwanger 2003; Hall 2004). Therefore, fluctuations in the growth of small firms can be expected. After positive growth, immediate subsequent further positive growth is rather unlikely. After decrease or stagnation positive growth can be expected to follow (Habermann & Schulte 2017).

As serial correlation of growth rates varies with firm size three hypotheses are proposed. The hypotheses take into account the arguments of adjustment costs, indivisibility and uncertainty explained above.

H1 After takeover a given firm is more likely to enter a period of negative growth in a subsequent period.

H2a After a period of negative growth a given firm that was taken over is more likely to enter a period of positive growth in a subsequent period.

H2b After a period of positive growth a firm that was taken over is more likely to enter a period of negative growth in a subsequent period.

4.4 Research Design

Data

The data used is from the Start-Up Panel of the German state of North Rhine-Westphalia (NRW), which collects primary data from a standardized questionnaire sent to business owners of small firms in the skilled crafts sector. This allows long-term monitoring of a large number of small firms, which are either newly created or taken over. The skilled crafts sector is typical of many entrepreneurial activities in Germany in terms of size, business model, or legal type (Lambertz & Schulte 2013).

Table 10: Response rates

Panel wave	Survey period	Number of questionnaires distributed	Number of responses	Response rate
5	Summer 2004	6,881	3,627	0.527
6	Summer 2005	8,153	3,978	0.488
7	Summer 2006	9,149	3,610	0.395
8	Summer 2007	9,751	4,014	0.412
9	Summer 2008	7,265	3,231	0.445
10	Summer 2009	7,322	3,316	0.453
11	Summer 2010	7,880	3,272	0.415
12	Summer 2011	8,443	3,447	0.408
13	Summer 2012	8,805	3,653	0.415

Source: Habermann (2016)

Response rates ranging from 39.5 to 52.7 percent (Table 10) allow valid and reliable results (Baruch 1999). The panel covers start-ups, successions as well as active participations. The dataset only contains full time entrepreneurs and is, therefore, not biased by part-time businesses (Lambertz & Schulte 2013). Single-person firms are only covered if they are run as a full-time business. Thus, part-time businesses, which are often created only for auxiliary income, are not included in the dataset.

This survey has no survivorship bias[5]: Hidden market exits are impossible within the first two years after business takeover because governmental authorities (Landes-Gewerbeförderungsstelle) monitor all the included small firms.[6] All exits can be verified by using a special crafts register, where all entries and exits are recorded. For a longer time period the mortality of firms in the skilled crafts sector is lower than in other sectors (Paulini 1999; Albach & Hunsdiek 1987).

The questionnaires of the annual panel wave cover recurring questions assessing corporate development (achievement of profit goals, corporate profits, expected corporate earnings, investment volume, number of employees, sales volume and utilization) as well as non-recurring questions (counseling, entrepreneurial marketing, motivation, etc.) (Lambertz & Schulte 2013).

The study begins with Wave 5 and is based on data that includes nine waves of the Start-Up Panel NRW. As the survey period changed from six months to one year, the first four waves are excluded. The survey is conducted once a year in summer and if the business takeover took place in spring of the same year, it still does not have one complete year in business. Thus, the time span between the time of business takeover and the first survey is defined as Year 0. This time span, therefore, is shorter than twelve months. This does not affect, however, the analysis on the growth of small firms. This study investigates up to eight years of a given firm after business takeover, it covers Year 0 and eight years, which are numbered 1 to 8 and are equal to an entire year of business activity following Year 0. It is important to mention that the present article distinguishes between periods and years. In general, absolute numbers of

[5] Survivorship bias refers to the problem that only the track record of those firms that have survived can be seen.

[6] The Landes-Gewerbeförderungsstelle (LGH) is a joint service institution set up both by the chambers and the confederations of skilled trades in NRW. The LGH advises and assists SMEs to strengthen their potential, competitiveness and success (LGH, 2016).

employment from one year are related to absolute numbers in the preceding year. The ratio between the total number of employees of Year 0 and Year 1 is defined as Period 0. Consequently, state changes can be defined, e.g. if the total number of employees decreases, does not change or increases in a given period (Habermann & Schulte, 2017). The concept of state changes will be explained in more detail below.

The focus of the present article is solely on business takeovers. The total dataset contains information on 7,082 firms, which were set-up or taken over between 2003 and 2012. Out of these 7,082 firms 1,872 (27 percent) firms were taken over by an individual. This data is in line with information from the Register of Craftsmen (Müller 2014) that states that in 2009 around 28 percent of all German firms in the skilled crafts sector were taken over. 75 percent out of the 1,872 firms are sole proprietorships, and 73 percent are owned by men. The dataset contains information about the sector for 1,725 firms. Out of these 1,725, 267 (15 percent) firms work in the building and interior finishing trades, 549 (32 percent) in the electrical and metalworking trades, 580 (34 percent) in the health and body care trades as well as the chemical and cleaning sector, 119 (7 percent) in the woodcrafts and plastic trades, and 149 (9 percent) in the food crafts and trades. There are 61 (3 percent) firms representing other trades. On average, the firms have 6.1 employees (including the entrepreneur) at the time of business takeover.

To analyze if the data set is representative for new ventures in the German craftsman sector the data set is compared to official data from the Register of Craftsmen (Müller 2014). This analysis shows that the numbers are comparable, for example in 2009, 72 percent of all new ventures were sole proprietorships and 79 percent were male. One limitation is that sector alignment is difficult because the sectors in the Register of Craftsmen are defined different than the sectors in the data set.

Table 11: Descriptives

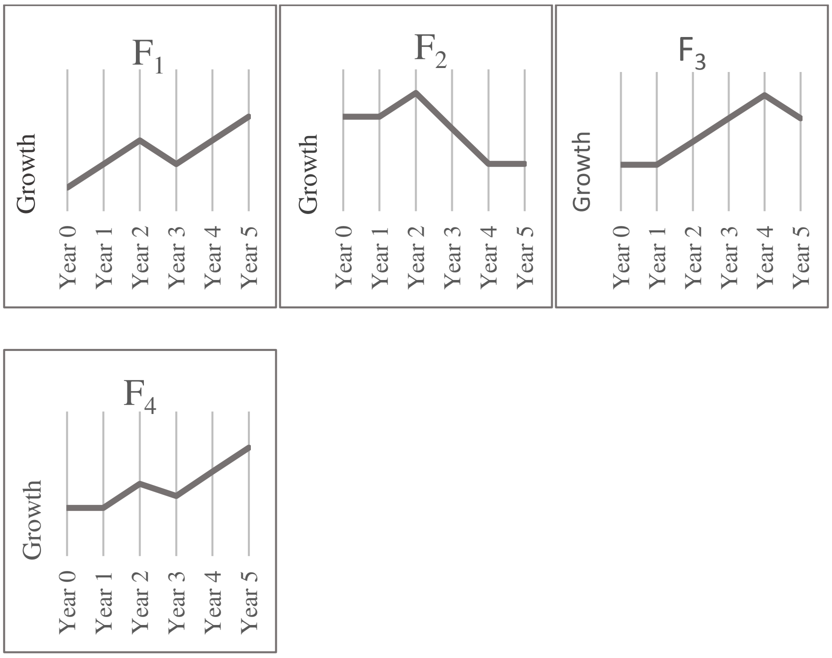
Variable	Mean	Standard deviation
Number of employees (including entrepreneur, at takeover)	6.12	6.687
Gender: male	0.73	0.444
Profit situation	2.00	0.573
Form of organization		
Unlimited private company	0.11	0.174
Sole proprietorship	0.75	0.432
Limited liability company	0.14	0.350
Age (in years)		
Age of firm (in 2012)	5.37	2.517
Age of business owner (in 2012)	41.46	7.657
Sector		
Building and interior finishes trades	0.15	0.362
Electrical and metalworking trades	0.32	0.466
Woodcrafts and plastic trades	0.07	0.254
Clothing, textiles and leather crafts and trades	0.02	0.131
Food crafts and trades	0.09	0.281
Health & body care trades and chemical & cleaning	0.34	0.473
Others	0.01	0.133

Date-related tendencies

Employment and sales are the most commonly used indicators to measure average business growth (Delmar 2006; Gilbert et al. 2006). The present article focuses on the growth of employment because employment data offers standardized, comparable data on the rate and direction in which small firms expand (Garnsey et al. 2006). In contrast, sales are influenced by price effects, productivity effects, exchange rate effects and taxes (Brenner & Schimke 2014). Coad (2009) provides an extensive discussion about the advantages and disadvantages of each indicator.

The approach of date-related tendencies is developed by Habermann & Schulte (2017) who divide long-term developments of firms into state changes between time points. These state changes are called date-related tendencies and allow identifying the pathway of a given firm's development. In general, a state change is the analysis if the change in input or outcome from year t to the subsequent year t+1 is negative, constant or positive. This approach is exemplified for employment in Figure 10 and shows the approach of state changes by four different firms ($F_{1 \text{ to } 4}$). The change in the total number of employees from Year 1 to Year 2 is for all four firms non-negative. During the transition from Year 4 to Year 5, F_1 and F_4 experience an increase, whereas F_2 and F_3 show a constant respectively negative development. This approach allows to consider individual temporal interdependencies of absolute change and to distinguish different patterns of growth. Thus, the growth of a firm is defined as the comparison of date-related tendencies of employment between two consecutive periods (Habermann & Schulte 2017).

Figure 10: Individual growth pathways of four firms (F1 to F4)



Source: Habermann & Schulte (2017)

Residual analysis and mosaic plots

To test the hypotheses a residual analysis is applied, which allows identifying categories relevant for a significant Chi-square statistic. The standardized residual for each cell of the contingency table of date-related tendencies is calculated (Haberman 1973):

$$e = \frac{\mathrm{O} - \mathrm{E}}{\sqrt{\mathrm{E}}}$$

Where e represents a standardized residual, O is the observed count in the cell and E is the expected count in the cell (Tredoux & Durrheim 2002: 375) and defined as:

$$E = \frac{(\text{sum of data in that row}) \times (\text{sum of data in that column})}{\text{total data}}$$

A two-tailed test of significance is used to analyze the probability of the standardized residual. A significant standardized residual indicates that the cell made a significant contribution to the Chi-square statistic (Agresti 2013).

Multivariate analysis

To allow comparability with other studies on growth of small firms (Bottazzi et al. 2009; Federico & Capelleras 2015; Habermann & Schulte 2017), the measure of growth rates is calculated by taking the differences of the logarithms of size (The transformation allows to interprete changes in the explanatory variables in terms of percentage changes in the dependent variable):

$GROWTH_{it}=\log(SIZE_{i,t})-\log(SIZE_{i,t-1})$

Where $SIZE_{it}$ is measured by employment for firm i at time t.

In line with Habermann & Schulte (2017) who analyze the autocorrelation between growths of new ventures, the following equation is estimated for pooled data:

$(\log(empl_{i,t})-\log(empl_{i,t-1})) = \alpha_0+\alpha_1 1(\log(empl_{i,t-1})-\log(empl_{i,t-2})) + \alpha_2(\log(empl_{i,t-2})-\log(empl_{i,t-3})) + \alpha_3 Legalform_{i,t} + \alpha_4 Age_{i,t} + \alpha_5 Sex_{i,t} + \alpha_6 Totalemployment_{i,t} + \alpha_7 Performance_{i,t} + \alpha_{8-9} IndustryDummy_{i,t} + \varepsilon_{i,t}$

The equation represents a growth model, where current growth of employment, which is used as dependent variable, is estimated using a set of lagged values of growth to analyze the serial correlation of these growth indicators.

As control variables firm age, the legal form of small firms, sex and industry dummies are added. This selection of control variables is in line with other studies analyzing variables that influence the growth of new ventures (Gilbert et al. 2006; Gupta et al. 2013). In addition, the total number of employees and business outlook are also used as control variables. Firm age has a negative effect on growth, which has been shown for US manufacturing (Evans 1987a; b) and service firms (Variyam & Kraybill 1992), for Taiwanese electronics plants (Liu et al. 1999), for large European firms (Geroski & Gugler 2004) and for Japanese manufacturing firms (Yasuda 2005). The present article refers to the age of the small firm at the time of the business takeover.

West German limited liability firms have significantly higher growth rates in comparison to firms with other legal forms. However, these firms also have a significantly higher risk of exit (Harhoff et al. 1998). The limited liability legal form provides incentives for managers to pursue projects, which are described by both a relatively high risk of failure and a relatively high expected return (Stiglitz & Weiss 1981).

Industry dummies are added to the equation because it is supposed that firms in mature industries are likely to have lower average growth rates than firms in new sectors. Whereas in mature industries a lower level of growth opportunities exists, firms in new sectors may have high growth rates due to the rapid pace of technological progress and the emergence of new products (Coad 2009).

Current total number of employment and performance of a small firm are supposed to be a major influence for growth. A good performing firm is much more able to grow than an underachieving one because profit enables the firm to fund additional employees. For this reason, “business situation” is also added as an independent variable for performance into the regression, proxied by business outlook assessed by the business owner (Habermann & Schulte 2017). The business outlook for the next six months is distinguished between i) is expected to become worse (defined as 1), ii) stays the same (defined as 2) and iii) the situation will be better than at the moment (defined as 3). Table 11 explains the descriptives of the merged data of the 1,872 firms between 2003 and 2012.

4.5 Results

Mosaic plots

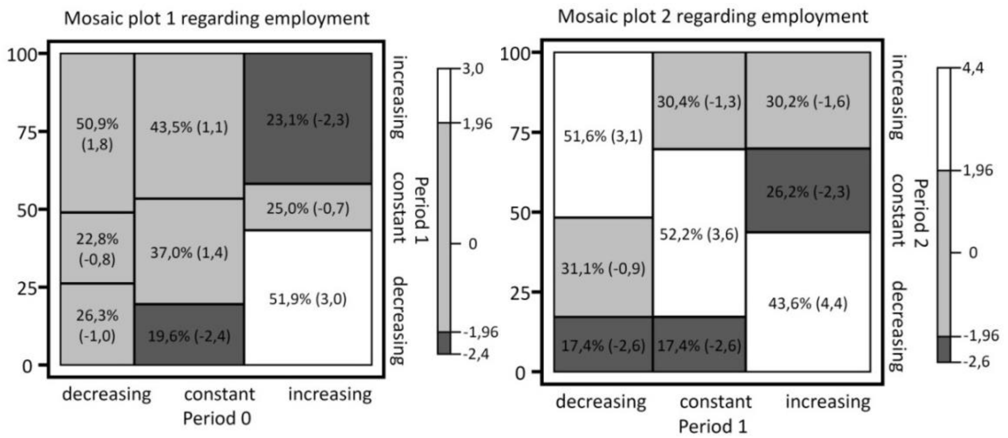
Date-related tendencies regarding employment are used to explain how these firms grow within the first seven periods after business takeover. All results of the Chi-square test are significant throughout the bivariate analysis. In Period 7, more than twenty percent of the expected counts are less than five and, thus, the Chi-square test may be invalid (Wildemuth 2009). Therefore, the present article focuses on date-related tendencies for periods 0 to 6.

The present article uses mosaic plots to illustrate the results of the residual analysis. Mosaic plots show percentages of cross-classified categorical variables (Friendly 2002; Hofmann 2000). On how to read mosaic plots the present article refers to Habermann & Schulte (2017). Mosaic plot 1 in Figure 11 shows the relationship between Period 0 and Period 1, mosaic plot 2 explains the relationship between Period 1 and 2 and so forth. Mosaic plot 1 supports Hypothesis 1. The number of firms that enter a period of negative growth after business takeover is overrepresented. In addition, the number of firms that increased their employment further after business takeover is underrepresented.

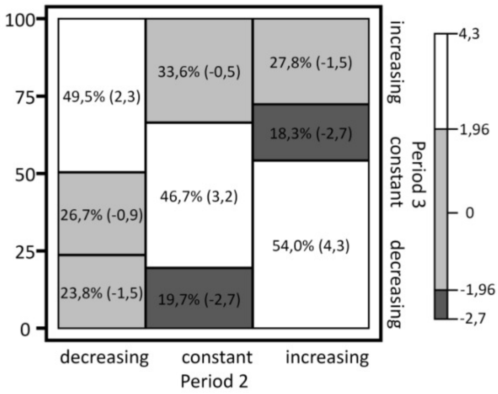
As presented in Figure 11, mosaic plots show partly evidence for Hypothesis 2a. The value of standardized residuals shows that observations for decline of employment in period t and increase in period t+1 are, as shown in the upper left corner of the mosaic plots in Figure 11, overrepresented for mosaic plots 2, 3 and 6. For mosaic plots 1, 4 and 5 no evidence is found that the number of cases in that cell is significantly larger than would be expected.

As illustrated in Figure 11, mosaic plots show evidence for Hypothesis 2b. The value of standardized residuals shows that observations for growth of employment in period t and decline in period t+1 are, as shown in the bottom right corner of the mosaic plots in Figure 11, overrepresented within the entire period under observation. In addition, all periods, which see an increase in period t and zero growth in period t+1 are underrepresented in mosaic plots 2 to 5.

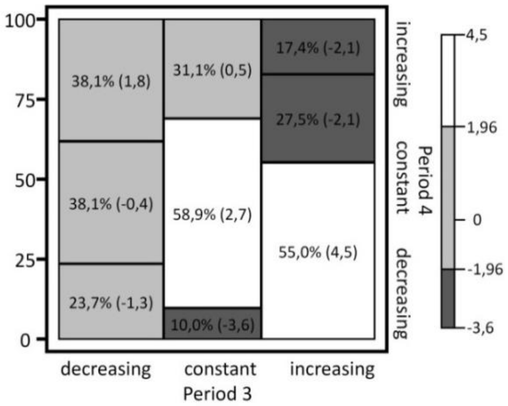
Figure 11: Mosaic plots regarding growth of employment for firms that were taken over



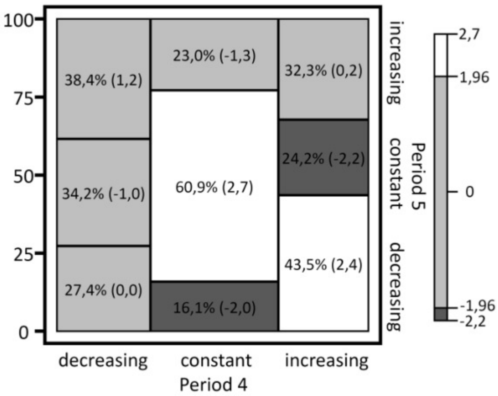
Mosaic plot 3 regarding employment



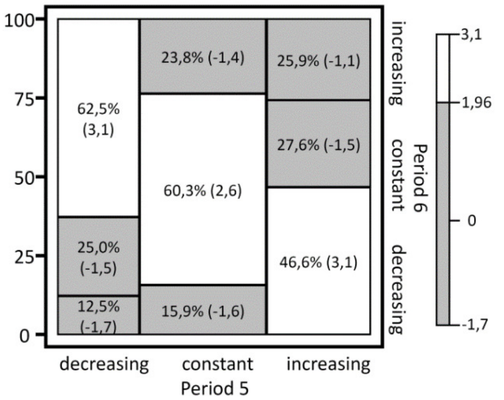
Mosaic plot 4 regarding employment



Mosaic plot 5 regarding employment



Mosaic plot 6 regarding employment



Multivariate analysis

As the mosaic plots show mixed result, a pooled OLS regression is run. Utilizing pooled data, potential biasing effects of different economic business cycles, cohorts and outliers are reduced. The numbers in Table 12 refer to the number of lags and the table shows that the autocorrelation of the growth of small firms is low but significant for t-1 and t-2. Adding further lags might also reduce critically the number of observations and may not imply an improvement in the explanatory power of the model. Although the approach of lagged variables is different to the analysis of the mosaic plots, the different views on the results do not affect the main objective to analyze how small firms grow after business takeover. Mosaic plots analyze future growth rates, whereas the pooled OLS regression includes past events (Habermann & Schulte 2017).

Table 12: Serial correlation between growths of employment (p-values in parentheses)[7]

	0lag	1lag	2lag	3lag	4lag	5lag	6lag	7lag
0lag	1							
1lag	-0.3668 (0.0000)	1						
2lag	-0.1618 (0.0000)	-0.3499 (0.0000)	1					
3lag	0.0389 (0.2782)	-0.1587 (0.000)	-0.3587 (0.0000)	1				
4lag	-0.00179 (0.6907)	0.0383 (0.2922)	-0.1670 (0.000)	-0.3544 (0.0000)	1			
5lag	-0.0382 (0.5063)	-0.0224 (0.6237)	-0.0051 (0.8953)	-0.2013 (0.0000)	-0.3494 (0.0000)	1		
6lag	-0.0064 (0.9330)	-0.0407 (0.4914)	0.0457 (0.3625)	0.0158 (0.7083)	-0.02604 (0.0000)	-0.3664 (0.0000)	1	
7lag	-0.1229 (0.3109)	0.0129 (0.8752)	-0.0750 (0.2818)	0.0398 (0.4948)	0.0180 (0.7194)	-0.3110 (0.0000)	-0.4139 (0.0000)	1

In Table 13, the results of three different pooled OLS regressions are summarized. Model 1 estimates the impact of the first lag of employment growth on employment growth. In model 2, the second lag is included and in model 3, the control variables are included. All three models show a significant autocorrelation for the first lag. The result is also economically significant, as one standard deviation increase in the first lag of the employment growth variable yields a decrease in employment growth of 16 percent. Also for the second lag a significant negative serial correlation between growth in t in in t-2 exist, however, the coefficient is smaller. The result is also economically significant, as one standard deviation increase in the second lag of employment growth variable decreases employment growth by 10 percent.

[7]For example 1Lag refers to ($\log(empl_{i,t-1})-\log(empl_{i,t-2})$) and 2lag refers to ($\log(empl_{i,t-2})-\log(empl_{i,t-3})$)

Table 13: Pooled OLS regression results for growth of employment (standard errors in parentheses)

	Model 1	Model 2	Model 3
Dependent variable: $growth_{it}$			
$Growth_{it-1}$	-0.3540*** (0.0200)	-0.3858*** (0.0272)	-0.3918*** (0.0279)
$Growth_{it-2}$		-0.244*** (0.0274)	-0.2321*** (0.0289)
Legal form			0.0325 (0.0258)
Firm age			0.0113* (0.0060)
Manufacturing			0.0191 (0.0142)
Services			-0.0071 (0.0137)
Sex			-0.0045 (0.0276)
Total employment			0.0093*** (0.0014)
Business outlook			0.0073 (0.020)
Constant	0.0171	0.0162	-22.6383
R-squared	0.13	0.17	0.20
Obs.	2004	1175	1055

*p ≤0.1, **p ≤0.05, ***p ≤0.01

The results of the multivariate analysis highlight two important features. First, firm growth rates are not random and non-linear, which supports the results of the mosaic plots. Second, the analysis shows that after business takeover small firms are subject to negative serial correlation of growth rates. This means that negative autocorrelation does not only exist for organic growth (Coad & Hölzl 2009; Coad 2007, Fotopoulos & Giotopoulos 2010; Hölzl 2014) but also for growth after business takeovers. For small firms showing a large increase of employees at time t, the negative coefficient implies that in the previous period t-1 these firms probably dismissed employees. Similarly, for those slowest-growing firms at time t, the negative coefficient indicates that these firms probably performed relatively strongly in the previous period t-1. The negative autocorrelation could be explained with the fact that firms hire more than the required number of employees with the expectation of keeping only top performers. This may lead to a mechanical effect of negative autocorrelation. However, the present article focuses on small firms, which normally do not have the necessary resources to apply such a strategy (Habermann & Schulte 2017).

The significance and the positive sign of the year of business takeover mean that the younger the firm the higher the growth rate of employment. This negative dependency of the growth rate on age appears to be a robust feature of industrial dynamics in the dataset. In addition, total number of employment has a positive sign and is significant.

Further analyses to check the robustness of the main findings are conducted and are shown in Table 14. The regression, which includes the control variables are reran comparing the results of the pooled OLS regression (Model 1) with the results of the regression using Cluster-robust Huber/White standard errors (Model 2 | Rogers 1993; Williams 2000) and of a robust regression (Model 3| Li 1985). A robust regression eliminates gross outliers before calculating starting values. Cluster-robust Huber/White standard errors allow controlling for intraclass correlation between the small firms in the dataset. The additional analyses allow double-checking the results from the OLS regression to make sure that the conclusions are not compromised by heteroscedasticity. Since there was no heteroscedasticity problem in the model, the findings of the OLS regression remain robust after double-checking with other estimators.

Table 14: Robust Pooled OLS regression results for growth of employment, taking 2 lags (standard errors in parentheses)

	Model 1	Model 2	Model 3
Dependent variable: $growth_{it}$			
$Growth_{it-1}$	-0.3918*** (0.0279)	-0.3918*** (0.0453)	-0.2225*** (0.0191)
$Growth_{it-2}$	-0.2321*** (0.0289)	-0.2321*** (0.0453)	-0.069*** (0.0197)
Legal form	0.0325 (0.0258)	0.0325 (0.031)	0.0159 (0.0176)
Firm age	0.0113* (0.0060)	0.0113* (0.0055)	0.0041 (0.0041)
Manufacturing	0.0191 (0.0142)	0.0191 (0.0123)	0.086 (0.0097)
Services	-0.0071 (0.0137)	-0.0071 (0.0120)	-0.019 (0.0094)
Sex	-0.0045 (0.0276)	-0.0045 (0.0246)	0.0005 (0.0190)
Total employment	0.0093*** (0.0014)	0.0093*** (0.0046)	0.0041*** (0.0010)
Business outlook	0.0073 (0.020)	0.0073 (0.0224)	0.0090 (0.0137)
Constant	-22.6383	-22.6383	-8.3617
R-squared	0.20	0.20	0.13
Obs.	1055	1055	1055

*p ≤0.1, **p ≤0.05, ***p ≤0.01

4.6 Discussion and conclusion

Although scholars have already analyzed the impact of business takeovers on firm performance, these studies usually are mainly restricted to the analysis of large public firms or based on cross-sectional analysis. The present article seeks to overcome these limitations by analyzing business takeovers in small German firms using a longitudinal research design. The results show that recent positive growth is more likely to lead to negative growth, and conversely, that recent negative growth increases the probability of subsequent positive growth.

The present article makes five contributions to the literature: First, it complements the literature on the autocorrelation of growth rates by focusing on the dynamics of small firms after business takeover. So far, the focus of autocorrelation has been on organic growth. The present article shows that autocorrelation and the related adjustment costs play an important role when it comes to growth after business takeover. It is likely that adjustment costs and indivisibility prevent firms from growth at certain stages of development (Habermann & Schulte 2017). Consecutive periods of constant or negative growth can be explained by the need of firms for consolidation. Growth in period t can be a good predictor for growth in period t+1. This result also suggests that variables for growth need to be included as lagged variables in models analyzing growth. Second, the present article contributes to the literature on the non-linearity of growth and shows that growth is non-linear, prone to interruptions, amplifying forces and setbacks (Garnsey et al. 2006). Third, average growth rates fail to describe important dimensions of the course of growth of firms (Habermann & Schulte 2017) because different growth pathways can lead to the same average pathway (Wright & Stigliani 2013). Therefore, date-related tendencies of growth are introduced to describe the growth after business takeover in a more nuanced manner. Fourth, as growth after business takeover cannot be guaranteed and as resources of the successor are used to certain internal and external changes, small firms need to calculate the risks and opportunities of the takeover. Consultants and chambers of commerce and crafts can offer guidance on the smooth transition of the firm. Fifth, the present article shows that adjustment costs may influence the growth pathway of the firm that was taken over. This means that in addition to the cost of purchasing the firm, adjustment costs need to be calculated and considered by business owners. If the latter costs are not included, the process of integration could be hampered because unpredictable costs could mean that not enough resources are available to finance this process.

Due to the aging of the population the importance of business takeovers will increase in the future (Block et al. 2013). Takeovers are means to secure employment and prevent the loss of firm-related know-how. Policy documents have already stressed the importance of business takeovers as a form of entrepreneurship. Although the European Commission requests its member countries to afford successions the same importance as new ventures and raise awareness for takeover opportunities, many politicians focus on policies related to start-ups. The reduction of taxes or the development of measures to encourage timely preparation of those who want to sell their firms (European Commission 2003; 2006) could support the improvement of the environment of business takeovers. It would be also important to improve the match between potential buyers and sellers in marketplaces for business takeovers (European Commission 2012).

Because it uses the same dataset as the study by Habermann & Schulte (2017), the present article is also characterized by the same limitations. The dataset consists mainly of firms from the skilled crafts sector. Although these firms represent different occupations and belong to different sectors, a precise classification into certain sectors (for example as defined by NACE code) is not possible. A more panel-specific limitation results from decreasing case numbers with longer periods. As the number of firms participating in the survey decreases with the age of the firm, the period of observation is limited to the first six periods after business takeover. Due to this panel mortality more successful firms are more likely to report their development than less successful ones. This implies that later period estimations might be overestimated because underperforming firms tend not respond to the questionnaire anymore. However, this successor bias seems to be negligible, as respondents do not report growth but current size. As only firms still in business can be surveyed, survivorship bias could be another problem. However, the dataset allows controlling for exits for the first two years after business takeover because all exits can be verified using a special crafts register, in which all entries and exits are recorded. For a longer time period, the literature shows that exit rate of full-time businesses is much lower in the skilled crafts sector than in other sectors (Paulini 1999; Albach & Hunsdiek 1987). The present article has a broad understanding of successions and a differentiation between different modes of succession is not possible. In particular, it would be interesting to analyze the consequences of successions on firm growth separately for family and non-family successions.

More research on adjustment costs related to the growth of small firms in general and to business takeovers in particular is required to understand the growth process of these types of firms because due to the ageing population and the increasing numbers of retirement of business owners more and more successors will be needed. The present article shows that it is likely that adjustment costs have an impact on the growth after business takeover. However, no information about the size of the adjustment costs is available, and, therefore, empirical evidence cannot be provided to analyze when and if convex or non-convex adjustment costs play an important role. Nevertheless, the results show that it is likely that after period of growth successors enter a phase of consolidation because they may not want to grow further or even decide to reverse their decisions. This could indicate that non-convex adjustment costs are predominant. It is not clear how these costs can be calculated and the differences between sectors in terms of adjustment costs are unknown. The development of a tool that would allow business owners to calculate these costs would be desirable because it could support them when they have to make a decision concerning a business takeover. Scholars could support this development by collecting and analyzing available data on business takeovers and by identifying and evaluating factors that affect adjustment costs.

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Erklärungen und Versicherung

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Hiermit erkläre ich, dass ich mich noch keiner Doktorprüfung unterzogen oder mich um Zulassung zu einer solchen beworben habe.

Ich versichere, dass die Dissertation mit dem Titel „Essays on the growth and investment of small German firms“ noch keiner Fachvertreterin bzw. keinem Fachvertreter vorgelegen hat, ich die Dissertation nur in diesem und keinem anderen Promotionsverfahren eingereicht habe und, dass diesem Promotionsverfahren keine endgültig gescheiterten Promotionsverfahren vorausgegangen sind.

Ich versichere, dass ich die eingereichte Dissertation „Essays on the growth and investment of small German firms“ selbstständig und ohne unerlaubte Hilfsmittel verfasst habe. Anderer als der von mir angegebenen Hilfsmittel und Schriften habe ich mich nicht bedient. Alle wörtlich oder sinngemäß anderen Schriften entnommenen Stellen habe ich kenntlich gemacht.

Stuttgart, den 08.08.2017 Harald Habermann

Annex 1

Sampling

The generalizability of the data set in general is discussed in chapter D 2.2 of Schulte (2002, pp 201-2012). To varify the results of Schulte (2002), an updated version (from 2015) of the turnover tax statistics from the Federal Statistical Office and the Register of Craftsmen is used to compare variables of the Start-Up Panel NRW with the German economic sector in general (turnover tax statistics) and with the handicraft sector (Register of Craftsmen) in particular.

Table 1: Comparison of distribution of legal form between the Start-Up Panel NRW and the turnover tax statistics

Distribution of legal form	Turnover tax statistics 2015		Start-Up Panel NRW	
	Total	%	Total	%
Sole proprietorship (Einzelfirma)	2.181,285	67.0%	5,219	74.3%
Unlimited private company (GbR and OHG)	274,730	8.4%	538	7.7%
KG incl. GmbH&CoKG	158,090	4.9%	207	2.9%
AG incl. KGaA	8,063	0.2%		
GmbH	555,792	17.1%	927	13.2%
Cooperatives	5,567	0.2%		
Gewerbl. öff. Unternehmen	6,342	0.2%		
Others	65,668	2.0%	134	1.9%
Total	3,255,537	100.0%	7,025	100.0%

Source: Umsatzsteuerstatistik (2015)

Table 2: Comparison of distribution of gender between the Start-Up Panel NRW and the Register of Craftsmen

Distribution of gender	Register of Craftsmen 2015	Start-Up Panel NRW	
	%	Total	%
Male	78.9%	5,462	77.7%
Female	21.1%	1,566	22.3%
Total	100.0%	7,028	100.0%

Source: Müller (2014 p. 32)

Table 3: New ventures in comparison to business takeovers in the Start-Up Panel NRW and the Register of Craftsmen

Distribution of type of foundation	Register of Craftsmen 2015	Start-Up Panel NRW	
	%	Total	%
New venture	72.2%	4,880	69.4%
Business takeover (including active participation	27.8%	2,148	30.6%
Total	100.0%	7,028	100.0%

Source: Müller (2014 p. 32)

The comparison in Table 1 shows that the legal forms are similar distributed between the two datasets. Sole proprietorship is for around 70 percent of all ventures the choice regarding the legal form. Also the distribution between gender (Table 2) and type of foundation (Table 3) is similar. Almost 80 percent of business owners are men and around 70% of foundations are new ventures. Further comparison regarding sales can be found at Schulte (2002, p. 210).

The above mentioned comparisons show that the data of the Start-Up Panel has a similar distribution than the poulation of German companies in general or companies in the handicraft sector. However, as in any other research on entrepreneurship the question of the generalizability of the sample results can not be conclusively answered.

On the next pages you find the questionnaires for the waves used in the present thesis.

Annex 2

Distribution of the firms regarding the year of foundation

1) Total dataset

	Total num.	%
2003	825	11,7
2004	1359	19,3
2005	1179	16,8
2006	660	9,4
2007	734	10,4
2008	580	8,3
2009	576	8,2
2010	600	8,5
2011	474	6,7
2012	41	,6
Total	7028	100,0

2) New ventures

	Total num.	%
2003	608	12,5
2004	981	20,1
2005	877	18,0
2006	442	9,1
2007	473	9,7
2008	401	8,2
2009	377	7,7
2010	398	8,2
2011	302	6,2
2012	21	,4
Total	4880	100,0

3) Business takeovers

	Total num.	%
2003	178	9,5
2004	318	17,0
2005	260	13,9
2006	207	11,1
2007	233	12,4
2008	165	8,8
2009	179	9,6
2010	172	9,2
2011	142	7,6
2012	18	1,0
Total	1872	100,0

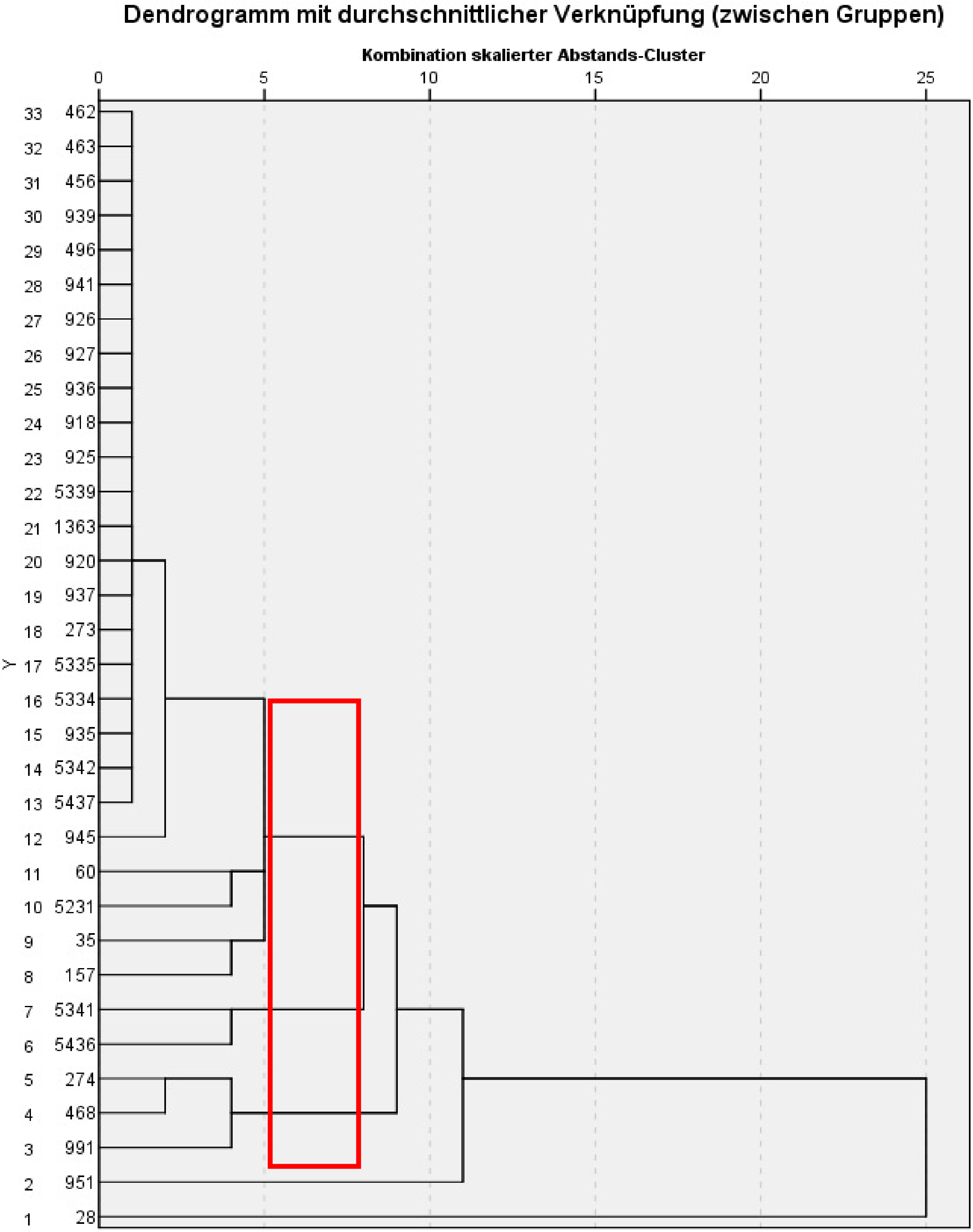
Annex 3

To define the number of clusters in a first step a proximity matrix, which is shown below, is analysed. This proximity matrix includes the squared Euclidean distance and shows that the biggest "jump" is between step 27 and 28 and between 28 and 29. This means a five- or four-Cluster solution is preferred. To validate these results and to find a final answer regarding the number of clusters a dendrogramm is analysed. The number of clusters is usually determined by considering the greatest increase in the heterogeneity in the dendrogramm. In the dataset the greatest increase in heterogeneity is between a six-cluster and a five-cluster solution (highlighted in red). Thus, the 5 cluster solution is preferred.

Table 1: Appoximation matrix of the dataset

	Zusammengeführte Cluster			Erstes Vorkommen des Clusters		
Schritt	Cluster 1	Cluster 2	Koeffizienten	Cluster 1	Cluster 2	Nächster Schritt
1	462	463	,000	0	0	18
2	273	5335	47,000	0	0	5
3	920	937	91,000	0	0	9
4	496	941	97,000	0	0	7
5	273	5334	155,500	2	0	9
6	925	5339	165,000	0	0	11
7	496	926	199,500	4	0	10
8	456	939	227,000	0	0	16
9	273	920	246,500	5	3	13
10	496	927	294,667	7	0	12
11	925	1363	388,500	6	0	14
12	496	936	426,500	10	0	16
13	273	935	451,400	9	0	14
14	273	925	594,167	13	11	19
15	5342	5437	602,000	0	0	20
16	456	496	605,500	8	12	17
17	456	918	859,286	16	0	18
18	456	462	932,875	17	1	19
19	273	456	1169,456	14	18	20
20	273	5342	1465,368	19	15	21
21	273	945	2241,667	20	0	27
22	274	468	2367,000	0	0	26
23	35	157	6137,000	0	0	28
24	5341	5436	6500,000	0	0	29
25	60	5231	7268,000	0	0	27
26	274	991	7598,500	22	0	30
27	60	273	7897,727	25	21	28
28	35	60	9559,417	23	27	29
29	35	5341	15261,654	28	24	30
30	35	274	16370,333	29	26	31
31	35	951	19777,194	30	0	32
32	28	35	47948,219	0	31	0

Table 2: Dendrogramm for the dataset



Annex 4

Dynamic panel data analysis using OLS and System GMM

Overview OLS and its shortcomings

OLS is a method for estimating the unknown parameters in a linear regression model, with the goal of minimizing the sum of the squares of the differences between the observed responses and those predicted by a linear function of a set of explanatory variables. In dynamic panel data models using OLS the lagged values of the dependent variable are correlated with the individual-specific fixed effects included in the error term, which is also called 'Nickell bias' (Nickell 1981). OLS methods yield biased and inconsistent estimators.

Overview System GMM and its shortcomings.

Blundell and Bond (1998) combined Difference and Level GMM to construct a system of equations known as System GMM. Difference GMM deals with potentially endogenous regressors in dynamic panel data models. Level GMM regressions are expressed in levels and endogenous instruments in terms of their lagged differences.

Although certain shortcomings of the OLS regression can be overcome the System GMM method has the following shortcomings (Binder et al. 2005; Bun and Windmeijer 2010; Roodman (2009). First, it requires additional moment conditions to be satisfied. Second, it also requires orthogonality between the differences of the errors and the lagged levels of the variables used as instruments, and at the same time, orthogonality between firm-specific effects and the lagged differences of the variables used as instruments. Consequently, it is necessary to report specification tests on over identifying restrictions to check the validity of the additional instruments. Third, System GMM requires that no second-order serial correlation in the error terms is present. Finally, this type of GMM estimation could be harmed by employing too many instruments. This shows that many requirements must be in place to assure the desirable asymptotic properties of System GMM in finite samples (Federico and Capelleros, 2015).

Explanation why OLS is chosen despite the shortcomings

The OLS regression was chosen because also the System GMM has its drawbacks and OLS is widely used in the entrepreneurship literature focusing on the analysis of variables influencing growth of new ventures. The idea of the PhD thesis is to be in line with this research (both methodologically and context specific) to compare the results and the metholodology. Bottazzi et al. (2009) apply an OLS regression with two time lags although they highlight that OLS estimation of the coefficient „may imply an estimation bias, if autocorrelation is present in the error term“ (Bottazzi et al. 2009, p. 107). Similarily, Wagner et al. (1992) use an OLS regression to test the validity of Gibrat´s Law estimating the deviation of the logarithm of the size of company at time t, t-1 and t-2 from the mean of the logarithms of the sizes of companies at time t, t-1 and t-2. Evans (1987, a) also apply an OLS regression to estimate the realtionship between firm growth, firm age and firm size. Variyam & Kraybill (1992) adjust the estimation of (Evans, 1987a) to define determinantes of firm growth and conclude that their results „are valid for a wide range of specifications that account for heteroskedasticity, nonlinearities in functional form, and outlier influence (Variyam & Kraybill, 1992, p. 36). Liu et al. (1999) estimate an OLS regression for the period 1990–1994 to investigate the relationship between plant growth, size and age for the Taiwanese electronics industry. These articles show that despite the drawbacks of OLS regressions these approach is widely established in the entrepreneurship literature.