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DO GROWTH RATES DEPEND ON THE INITIAL FIRM SIZE? EVIDENCE FOR THE GERMAN AGRIBUSINESS

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Abstract

The Agribusiness is in flux: a shrinking number of up- and downstream corporations questions traditional equilibrium concepts. How will the population of firms develop and which consequences will arise for competition? In 1931, Gibrat stated the firm size and a firm's growth rate to be independent. Testing the validity of Gibrat's Law for the German Agribusiness allows drawing conclusions on future developments of concentration. By investigating 454 manufacturing downstream enterprises, we reject Gibrat's Law and find small firms to grow stronger than bigger firms in relation to their initial size. Consequently, the sector could reach a steady state in concentration.

Keywords

Agribusiness; structural change; empirical growth

1 Introduction

In a recently published article, SEXTON (2013: 209ff.) describes the change of agricultural markets to markets with imperfect competition. He pleads for the combined consideration of ongoing concentration, vertical integration as well as the increasing relevance of product quality and differentiation in economic modeling. Farmer and consumer welfare as well as the general welfare are linked to the competitive structure in the up- and downstream areas of agriculture. Furthermore, market power reduces farmers' incentives for investments (SEXTON, 2013: 5) and may therefore weaken their future negotiation position in the supply chain.

Does the Agribusiness run the risk of a limited competitive intensity? Empirical research indicates a typical development pattern of industries. "In the long run, the growth of firms influences the evolution of industry structure" (GODDARD et al., 2006: 267). After slow growth processes in the beginning, the population rapidly reaches a peak and afterwards declines while still increasing its output (AGARWAL et al., 2002: 972). Concentration tendencies increase if smaller firms have a higher mortality than larger ones, if larger firms grow faster or in case of a positive serial correlation in growth rates (DUNNE AND HUGHES, 1994: 115).

Table 1: Concentration of supply for selected products of food manufacturing industries 2000 and 2008 in Germany

	Percentage of production accounted for by the top 6 firms (CR6)	
Industry	**2000**	**2008**
Milk and Milk Products	22,9	24,5
Wine	72,0	78,7
Meat Processing	12,6	19,6
Sugar	86,4	99,7

Source: Own research based on GERMAN FEDERAL STATISTICAL OFFICE, 2013a

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MELHIM et al. (2009a: 285 ff.) examine the growth rates of U.S. dairy farms. If the current rates proceeded, the authors assess a disappearance of the competitive nature of the industry and an emergence of concentration and market power as probable. A similar pattern could evolve in the German Agribusiness, as shown by the development of concentration ratios in the table above. All of the selected product categories show an increasing concentration ratio between 2000 and 2008.

The following examples are intended to illustrate and clarify the situation: According to the GERMAN FEDERAL STATISTICAL OFFICE (2013b) there were 191 milk treating and processing enterprises in 2009. In contrast, CENTRAL MARKETING AND PRICE REPORTING UNIT (1999) counted 551 processing dairy enterprises in 1988. A sector inquiry of the GERMAN FEDERAL CARTEL AUTHORITY (2012: 19ff.) published in 2012 identifies concentration tendencies in German dairy industry. This is supposed to be a result of domestic mergers as well as of acquisition of German dairy enterprises by foreign dairies. Especially farmers in the northeastern parts of Germany are confronted with a reduced choice of dairy enterprises. A similar picture emerged in the wine industry: According to the GERMAN FEDERAL STATISTICAL OFFICE (2013c), 14 wine manufacturing enterprises with more than 50 employees existed in 2011, as against 17 enterprises in 2007. However, the GERMAN FEDERAL MINISTRY OF CONSUMER PROTECTION, FOOD AND AGRICULTURE (1995) counted 632 manufacturing and processing wine enterprises in 1992. The concentration of supply seems to have increased in the last years: whereas the six largest suppliers had a share of 72 percent of supply in 2000, their shares enhanced to 78.7 percent in 2008 (GERMAN FEDERAL STATISTICAL OFFICE, 2013a). The prosecution of currently detectable developments could lead to a further strengthening of the firms' bargaining position opposite to farmers. The lack of sufficient sales opportunities causes a single-sided dependency of farmers.

According to SUTTON (1997: 52f.), empirical evidence suggests that continuing entry and exit take place in an industry. The turbulence, expressed as the sum of gross entry and gross exit rates, is strongly influenced by changing demand patterns, the adoption of new technologies and the replacement of existing products by substitutes. ERICSON and PAKES (1995: 54) see "the stochastic outcome of a firm's investment, the success of other firms in the industry, and competitive pressure from outside the firm" as major determinants of the firms' success, verbal their profitability and value. If profitability worsens, a decision for exit could be the optimal solution for a firm. Besides, entry barriers are able to diminish entry to a very low level while an ongoing withdrawal of less fit firms occurs (AGARWAL et al., 2002: 976). HJALMARSSON (1974: 123) examined size distributions of firms by means of sales, assets, number of employees, value added and profit. He finds that the observed populations of firms always exhibit extremely skewed distributions. LOTTI ET AL. (2009: 32) provide evidence for the existence of lognormal size distributions in most economic sectors. These distributions are characterized by a large amount of small firms and a small number of large firms.

2 Aims and research question

The Agribusiness is in flux. Corporations in German Agribusiness feature a sharp decline in their population density while facing ongoing changes in competition, alteration of institutional arrangements and modified marketing conditions. While the decrease of the number of farms has been subject to research yet (see for example WEISS (1998) and the literature mentioned there) and a further decrease is considered as likely, the development of the Agribusiness' populations of up- and downstream corporations as well as their implications for the whole sector seem to be less predictable and also less investigated. Primarily the evolution of the organizational structures from regionally-based, single-plant firms to internationally-active, multi-plant firms with complex company structures questions the shape of future competitive environments.

The size distribution within the population of firms has implications for competition in the Agribusiness. Ericson and Pakes (1995: 54f.) suppose that the firms maximize their present discounted value on the basis of their expectations concerning the development of their competition and information about past states. The distribution of outcomes is thereby a result of the quantity of a firm's investment as well as parameters of the evolution of the market and competition. Especially large firms are important employers and might execute significant market power. Furthermore, little changes in the size distribution may have important microeconomic consequences (Segarra and Teruel, 2012: 314). Describing and explaining the development of size distributions could therefore provide clues to recent and future competitive situations in Agribusiness and references to shifts in the organizational structure of its firms. How did the structures evolve and how will they continue to evolve? These questions could be answered by means of identifying and modeling empirical size distributions of the Agribusiness' branches. Furthermore, the relationship between the growth of firms, their sizes as well as the implications for the competitive structure will be considered in our considerations.

Small or big firms: which ones will succeed in the future and what kind of competitive structure will arise? Standard economic theory does not allow clear statements on the distribution of firm sizes (Simon and Bonini, 1958: 607). Even though some models combine cost theory and adjustment processes of firms, *Gibrat's legacy* remains an important point of origin for the examination of these distributions (Shapiro et al., 1987: 477). The legacy, also called the Law of Proportionate Effect, was developed by Gibrat in 1931 in order to explain skewed distributions of firm sizes. Since then, it has been serving as a reference point in research on industrial organization (Segarra and Teruel, 2012: 315). Gibrat (1931) claims the size of firms and their growth rates to be statistically independent and accordingly the growth rate in each period as proportional to the current size of the firm, independent of its size in absolute terms. A main implication of the random growth rates proposed by the Law is a convergence of size distributions to lognormal distributions. As it is part of many mathematical models and intended to explicate the size distribution of firms (Mansfield, 1962: 1031), assessments of its validity allow drawing conclusions with regard to the concentration in the Agribusiness. If growth is not related to firm size, the central limit theorem implies that logarithmic firm sizes represent a random walk. The asymptotic size distribution approximates a lognormal distribution and the variance of firm sizes shows an increasing tendency. Hence, industry concentration shows a rising trend on the long run (Goddard et al., 2006: 267)

The following considerations and analyses aim at deriving conclusions for the comprehensive competitive situation in the Agribusiness and its areas by investigating competitive developments for a selected number of firms based on *Gibrat's Law.* Does the population of firms in the German Agribusiness behave according to *Gibrat's Law*? The remainder is structured as follows. A survey on empirical and theoretical research on size distributions begins with an overview on the research on growth so far. Furthermore, important phenomena in the research on industry dynamics are described. A literature review on the validity of *Gibrat's Law* as well as on the problems arising when estimating models of industry dynamics will serve as a base for our model. The model will be estimated with firm level data in the subsequent section. Besides, this following section focusses on the different branches of the Agribusiness and their particular developments to examine the validity of *Gibrat's Law*. The article ends with a conclusion and a discussion of possible perspectives with regard to the changing competitive nature in the Agribusiness.

3 Gibrat's legacy in literature

"Firm dynamics have a rich statistical structure" (Segarra and Teruel, 2012: 319). With his work "Les inégalités économiques" in 1931, Gibrat was one of the first researchers who analyzed firm size distributions. Although he provided some striking results by applying his law, the research on regularities of size distributions in industries started principal becoming popular in the mid of the 19th century. A second, cross-sectional strand had evolved at the same time. Economists tried to describe the influence of industry-specific properties, e.g. scale economies, the role of advertising and the importance of R&D on the market structure. Alongside game theoretical approaches, maximizing models became very popular. Last-mentioned accounted for the nature of the technology, information available to firms as well as the description of the product market. Econometric issues as well as the integration of stochastic elements into maximizing approaches and the estimation of a firm's survivability subject to its age, size and other characteristics were the main themes in the 1980s (SUTTON, 1997: 41ff.). These developments may be related to the emergent access to broad datasets in the mid-to-late 80s (SEGARRA and TERUEL, 2012: 315). Besides, life cycle models of the industry and the evolution of market structures became an important issue (SUTTON, 1997: 45ff.). Though being still stochastic models, newer approaches stress the different attributes of firms as the source for differing profit maximizing choices and thereby growth processes. Recent research on firm size distribution concerns the choice of appropriate functional forms, especially between power-law functions and lognormal functions. Though a large part of the studies finds mixed distributions, including elements of both forms (SEGARRA and TERUEL, 2012: 314f.). Despite the amount and variety of studies concerning growth rates, a generally accepted theoretical framework is still missing.

3.1 Statistical regularities

SUTTON (1997) describes four statistical regularities which strongly influenced literature in the decade before his article was published: Life Cycle, Shakeout, Turbulence as well as Size and Growth. Summarizing various studies, he concludes that larger firms have lower growth rates in proportion to their size, but are more likely to survive than smaller ones. This is expressed in the net growth rate of firms in a given size class, which results from the output of all firms at the beginning and the total output of the surviving firms at the end of the sample period. BENTZEN et al. (2012: 941ff.) focus on Danish firms of various sectors between 1990 and 2004 and come to a different conclusion. Large firms show significantly higher growth rates in comparison to small firms. The authors suspect the increasing importance of scale effects, structural development and the evolution of information technology as responsible for these observations. Though, it is questionable if this causality between structural development and growth rate as well as its direction are plausible. Besides, the authors only include surviving firms and exclude small firms with low probabilities for survival of their dataset. Nevertheless, their finding indicates an increasing pressure for small und medium-sized firms with regard to productivity, growth and survival.

One important contribution to the aforementioned life cycle research was made by AGARWAL et al. (2002). The authors examine the conditioning effect of time on firm survival. They distinguish the life cycle of an industry in two major phases: the growth and the mature phase. Structural change is the trigger for different resource conditions and unequal competitive advantages within the phases, leading to resource constraints (e.g. knowledge, efficiency and network sources) which increase competitive pressure. The authors show that the mortality rates of firms significantly differ conditional on the phase the industry is in. They believe this to be the result of the transformation of the competitive scenery which influences mortality rates as well as the relationship between a number of organizational and industrial characteristics along with environmental processes and failure rates.

As another important phenomenon, SUTTON (1997) diagnoses a shakeout-effect. The number of producers moves to a peak and afterwards sinks to a lower level. Possible reasons could be the emergence of new technologies which provide scale economies or a decline of production costs of larger firms based on their higher dedication of fixed costs to process innovations.

Turbulence is another statistical regularity found in many empirical works and deals with the observation of entry and exit patterns in industries. SUTTON (1997: 57) considers a connection of these four economic mechanisms with purely statistical effects as a promising step towards a complete theory. Especially issues of industry-specific determinants of firm turnover, the volatility of market shares and the exit patterns in declining industries look promising to him. Though, it might be complicated to model the complex evolution of market structure in a single approach. The following therefore focusses on growth processes as an important determinant of industry structure.

3.2 Validity of Gibrat's legacy

One possible test of *Gibrat's Law* is the division of firms into size classes and a subsequent examination for significant differences in mean and variance of growth rates (MCCLOUGHAN, 1995: 406). A huge part of literature on empirical growth is based on regression analysis, cross-sectional or as a dynamic approach, using random walk model specifications (BENTZEN et al., 2012: 939). One way of testing the validity of *Gibrat's Law* is by estimating the least squares model below (following MELHIM et al., 2009: 288):

$$y_{it} = \beta_{0t} + \beta_{1t} r_i + \varepsilon_i, \qquad \text{i=1,...,N} \tag{1}$$

Where y_{it} is the growth rate of incumbents, r_i is the size of firm i and ε_i is an independently and identically distributed error term. Depending on the dataset, the use of logarithm may be useful for the estimation. This is taken into account in the following specification, where S denotes the size of the firm i (following DUNNE and HUGHES, 1994: 125):

$$logS_{it} = \alpha + \beta logS_{it-1} + \varepsilon_{it}, \tag{2}$$

Contrary to (1), which tests the relationship between the size level and the growth rate of firms, (2) estimates the relation between two size levels. If β (β_{1t} in (1)) does not differ significantly from one (zero), *Gibrat's Law* is valid. If it is below one (negative), the mean reversion hypothesis is confirmed and small firms grow faster than larger firms. This implies that firms converge to a steady-state equilibrium in size. Therefore, industry concentration also tends to a stable long-run equilibrium (GODDARD et al., 2006: 267). β greater than one (β_{1t} greater than zero) indicates that larger firms grow faster than smaller firms and a steady-state equilibrium has not been reached yet.

LOTTI et al. (2009: 31ff.) point out that especially earlier studies tended to confirm *Gibrat's Law* meanwhile more recent research usually rejects it. SUTTON (1997: 41ff.) provides an overview of previous studies concerning the Law which arrive at very different conclusions with regard to its validity. He notes that there is no obvious argumentation for postulating any correlation between firm size and expected growth rates as well as a specific size distribution of firms. GEROSKI (2005: 129) finds growth rates and size only weakly correlated. Furthermore he shows that the expectation of nearly random growth rates is consistent with a variety of theories. According to GEROSKI, the magnitude, the effects and the timing of events affecting the size of firms contribute to the unpredictability of their future sizes. Besides, size distributions exhibit wide differences between individual industries.

In the Agribusiness, only a few number of studies has been conducted: MELHIM et al. (2009a: 284ff.) test the validity of *Gibrat's Law* on the basis of the U.S. dairy industry. They reject the hypothesis after a regression analysis of milk producing firms in three regions between 1992 and 2002. Instead, the authors evidence that big farms had significantly higher growth rates than mid-size farms in the same time period. They conclude that the size distribution has not reached a stationary equilibrium yet. Further concentration tendencies may appear to be likely. Their results seem to be supported by MORRISON PAUL ET AL. (2004: 1309ff.), who determine a competitive advantage of larger and contracted operations over smaller, independently operating farms in selected U.S. states. DUNNE and HUGHES (1994: 126) found a β for UK Companies in "Food and Drink" between 1975-1987 which did not differ significantly from one. In a recent study, SCHMIT and HALL (2013: 319) estimate higher growth rates for larger food manufacturing firms in New York and attribute this finding to benefits of economies of scale. On the contrary, in a follow-up study of MELHIM et al. (2009b), *Gibrat's Law* cannot be rejected for the US-American wheat and apple industry, whereas mean-reversion is considered as likely for corn and beef industry between 1992 and 2002. At the farm level, WEISS (1998) examined 40,000 farms in the Upper Austrian farm sector between 1979 and 1990. Smaller farms are found to grow faster than bigger farms. Creating size classes, he finds that the size distribution is characterized by a disappearing middle and the emergence of a bimodal structure. SHAPIRO et al. (1987) test *Gibrat's Law* for farms in Canada between 1966 and 1981. They reject *Gibrat's Law* and obtain estimates of β which are always significantly less than unity. Despite some empirical approaches in agriculture and in the Agribusiness of several countries, an examination of the various up- and downstream firms in the areas of the German Agribusiness with regard to *Gibrat's Law* is missing.

Amongst others, STAM (2010: 130 ff) and MANSFIELD (1962: 1031) highlight the different possibilities of interpreting *Gibrat's legacy.* Apart from only examining firms that survived, it is also feasible to include firms that already exited the market. SCHMIT and HALL (2013: 310) hazard the consequences of a selection bias by excluding firms that exited the market. They state the existence of negative revenue growth in their data base as an argument for a negligible bias. DUNNE and HUGHES (1994) test for a selection bias by reestimating their model with a probit analysis of survival by size and age. They conclude that their results are not subject to a selection bias. Similarly, WEISS (1998: 308) does not find evidence for a selection bias in his data. In addition, the selection of a shorter period of estimation could counteract the selection bias. Though, it may complicate the derivation of statements on longer time horizons. MCCLOUGHAN (1995: 407) states that *Gibrat's Law* "ignores births and deaths of firms". Though, through the simulation of an alternative stochastic model of concentration by means of growth, entry and exit processes of 280 hypothetical firms, he shows entry and exit have a much lower importance for concentration processes as the systematic firm-level growth. Setting the size of the exited firms to zero, MANSFIELD (1962: 1031) disproves *Gibrat's Law* in seven of ten cases. A third version only incorporates firms which were able to overcome the minimum efficient scale of production. MANSFIELD (1962: 1034) comes to the conclusion that *Gibrat's Law* fails to hold in more than a half of the examined cases, regardless which version is tested. SUTTON (1997: 44) suggests the consideration of the growth rates that would have been achieved by the firms that already left as another possibility of interpretation. In this connection, it remains unclear how to include these firms in an econometric model. Another thinkable interpretation of *Gibrat's Law* emanates from growth as a random process, which is not determined by structural or environmental properties of the firm.

STAM (2010: 130ff.) emphasizes that "firm size and firm age can be indicators for multiple mechanisms (e.g., economies of scale, learning effects, reputation effects)". He points to the possibility of wrongly confirming *Gibrat's legacy* due to omitted variables and to the influence many other variables might have on firm growth. Studies differ widely in their measurement of size and growth, e.g. via employees, sales, net assets, profit, equity, as well as in the methodological proceeding. Besides, growth can be measured for different contexts, firm types and periods, for different regions, industries and sizes, and may be influenced by randomness as well as by strategy (STAM, 2010: 132). Apart from growth rates, there is a variety of factors influencing the size distributions as well as the empirical results (HJALMARSSON, 1974: 134). SEGARRA and TERUEL (2012) test the sample size dependence of empirical results by examining the firm size distribution of Spanish firms regarding sales and the number of employees. They conclude that different results in literature may be a result of different sample sizes. LOTTI et al. (2009: 38) measure size by means of employment performance. Their results indicate invalidity of *Gibrat's Law* ex ante while suggesting that a convergence toward *Gibrat*-like characteristics on the long run can be detected ex post. They attribute their observation to the effects of learning and market selection, leading to a core of surviving firms which behave according to *Gibrat*.

Serial correlation is an econometric issue which biases the estimation of β upwards. Though, DUNNE and HUGHES (1994: 129) suppose this problem to be insignificant due to the evidence of weak persistence in growth in their sample. In order to avoid serial correlation, KUMAR (1985: 332) proposes incorporating past growth into the estimation:

$$logS_{it} = \alpha + \beta logS_{it-1} + \gamma logS_{it-2} + \varepsilon_{it}, \quad (3)$$

Another statistical problem emerges with heteroskedasticity. Larger firms often show less variance in their growth rates than samples of small firms (DUNNE and HUGHES, 1994: 130ff.).

Concluding his considerations on *Gibrat's Law*, MANSFIELD (1962: 1035) describes last-mentioned as a "rather unreliable base" for research on the size distributions of firms. KLEPPER and THOMPSON (2009: 861) criticize models of stochastic growth for not having much economic content and ignoring fundamental drivers of firm growth. Hence, GODDARD ET AL. (2006: 268) remind that *Gibrat's Law* does not preclude these drivers, but expects their distribution *ex ante* to be random across firms. GEROSKI (2005: 133 f) concludes that the influence of R&D as well as diversifying activities on growth rates is also highly unpredictable. SHAPIRO et al. (1987: 477) emphasize the concept of growth as a purely stochastic process. According to them, growth is the outcome of the "cumulative effect of the random operation of a multitude of forces acting independently of each other". WEISS (1998: 310) highlights, that the results "should be interpreted as pointing to an empirical trend rather than fully describing an economic adjustment process". Other authors suppose the effect of the various number of different factors to be dwindling small (see KUMAR, 1985: 328).

4 Empirical model

The sample for the present study contains firms in the German Agribusiness. In this case, Agribusiness is perceived as the entity of farms as well as the associated up- and downstream firms. Special attention will be paid to the manufacturing downstream enterprises as the structural changes for this area as a whole do not seem to be fully investigated yet. As illustrated below, there exists a multitude of interpretations and variables with regard to *Gibrat's Law.* RODRÍGUEZ et al. (2003: 293ff.) use multiple indicators for size and growth as well as a multi-criteria factor representative for economic size. They find the different results of their estimations to be very similar. SCHMITTING and WÖHRMANN (2013) examine empirical research based on archival data. They show that the choice of a database can influence the validity of hypotheses. The choice of conservative significance levels can counteract this influence. Furthermore, they propose to check the definition of variables, the review of definitions for a manageable number of cases and, if possible, the control of robustness by using another database. These findings and the limited amount of widely available data for the sector as a whole result in total sales and the number of employees as the indicators for growth in the model. Due to the mentioned results of earlier studies concerning the effects of selection bias and due to data limitations, we focus on the surviving firms in the period of investigation.

Our data is based on NACE Rev. 2 codes. We included all German companies which were registered with sales for the years 2007 to 2013 as well as with the number of employees between 2007 and 2013. Thereby, we focused on firms within the sectors: processing and preserving of meat and production of meat products, processing and preserving fruit and vegetables, manufacture of dairy products, manufacture of grain mill products, starches and starch products, manufacture of other food products (e.g., sugar, cocoa, tea, coffee) as well as manufacture of wine from grapes.

The sample contains 454 firms. An initial descriptive analysis of the variables “sales” and “number of employees” reveals highly skewed distributions with a few large and many small-sized firms. The same applies to the calculated variable “sales per employee”. The positive skew of the distribution suggests the validity of *Gibrat’s Law*, which is our null hypothesis. The logarithmic transformation of our data yields normally distributed data, which we use as basis for our estimations. The comparison of our size distribution with official data reveals similarities. For 2011, enterprises with less than 50 employees account for 54.1 percent of our sample (see table 2); the statistical yearbook (German Federal Statistical Office, 2012) shows a share of 55.5 percent for enterprises of this size class in the whole population of food and feed manufacturing enterprises. Enterprises in the category 50 to 99 employees account for 16.0 percent of our sample (20.5 percent in the official statistics). Likewise, the subsequent size classes exhibit similarities between our sample and the population as a whole.

Table 2: Food and feed manufacturing enterprises by size classes in terms of the number of employees, 2011, for Germany and the investigated sample

Number of employees	Statistical yearbook	Investigated sample
less than 50	55.5%	54.1%
50 - 99	20.5%	16.0%
100 - 249	16.7%	19.6%
250 - 499	5.0%	6.5%
500 - 999	1.9%	1.8%
more than 1000	0.4%	1.8%

Source: Own research based on GERMAN FEDERAL STATISTICAL OFFICE (2012)

The annual average growth rates in sales (not adjusted for inflation) between 2007 and 2013 are the highest for meat (19.53% per year), grain milling and starch (13.47%) and the firms in “others” (9.48%). Lower annual growth rates were achieved by fruit and vegetables (6.55%), dairy (1.98%) and wine (0.02%). Furthermore, annual growth rates in sales are negatively correlated with the belonging to a size cohort of 10 equally distributed size classes.

Our analysis focused on the relationship between size and growth of firms. A series of tests was conducted in order to test the validity of *Gibrat’s Law* for our sample. The null hypothesis states the Law of Proportionate Effect. For our model, we tested the following specification according to (1) and (2):

$$\Delta S_{i,t} = \beta_0 + \beta_1 S_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

With $\Delta S_{t,i}$ as the growth of a firm and S as the logarithmized size. The subtraction of $logS_{i,t-1}$ from both sides of (2) leads to this equation, which allows interpreting β by testing for significant differences from zero. We tested the models with an absolute and a relative specification for growth as well as for the various areas of the Agribusiness and for different time horizons. As the differences between the estimation of growth in relative and absolute terms proved to be insignificant, we present selected results for the estimation of (3) relating to sales and the number of employees.

Furthermore, we checked our models for serial correlation and heteroskedasticity. The Durbin-Watson statistic is not indicative of serial correlation. Another test for serial correlation, which was proposed by SHAPIRO et al. (1987), confirms that our growth rates in sales are unrelated over time. Though, the estimations for sales in the sectors “all” and “meat” show slight tendencies to heteroskedasticity. Subsequently, standard errors for this estimators may be biased meanwhile the estimate is still unbiased. We reestimated our model with heteroskedasticity-consistent standard error estimators as proposed by HAYES and CAI (2007).

For the estimation with sales values and the number of employees in the period between 2013 and 2007, the following results were obtained:

Table 3: Coefficient estimates of equation (3) for sales and number of employees between 2007 and 2013

	Number of employees				Sales in thousand EURO			
Sector	Intercept	Beta	n	R²	Intercept	Beta	n	R²
All	0.349** (0.054)	-0.160** (0.030)	454	0.160	0.650** (0.149)	-0,141** (0.038)	454	0.106
Meat	0.405** (0.115)	-0.196** (0.063)	185	0.172	0.700** (0.343)	-0.162* (0.088)	185	0.091
Fruit and Vegetables	0.238 (0.199)	-0.095 (0.119)	53	0.033	-0.021 (0.111)	0.038 (0.028)	53	0.016
Dairy	0.329** (0.077)	-0.114** (0.037)	44	0.269	1.222* (0.642)	-0.250 (0.150)	44	0.195
Grain Milling and Starch	0.311* (0.156)	-0.158** (0.088)	44	0.199	1.099** (0.571)	-0.236* (0.136)	44	0.277
Wine	0.066 (0.110)	-0.017 (0.057)	24	0.003	-0.336 (0.383)	0.075 (0.103)	24	0.025
Others	0.408** (0.089)	-0.190** (0.052)	104	0.265	0.693** (0.158)	-0.147** (0.039)	104	0.238

Standard errors are in parentheses. Estimated parameters that are significant at the 0.10 level are marked with an asterisk and those significant at the 0.05 level are marked with two asterisks.

The estimated parameters for beta are mainly negative and statistically significant different from zero. Larger firms do not appear to grow as rapidly as smaller firms. The sample as a whole provides evidence for the hypothesis that growth rate and initial size are negatively related. This is also applicable to the meat sector, the grain milling and starch sector as well as the cohort named “others”. Interestingly, these are also the sectors with the highest average annual growth rates. In the case of fruit and vegetables, *Gibrat’s Law* cannot be rejected for both specifications. Growth in the number of employees is inversely related to the initial size though not significantly. Growth in sales shows a positive coefficient which does not differ significantly from zero, too. The same holds true for wine. Though, the sample of wineries appears to be quite small. For the dairy industry, *Gibrat’s Law* cannot be rejected in the case of sales in thousand Euros meanwhile growth in the number of employees is negatively related to the initial size. We tested some more specifications with different time horizons (not reported). For short periods of one year, a significantly negative beta was estimated for the whole sample and for the grain milling and starch sector. The longer the chosen time horizon, the more significant is the negative relation between growth and initial size. Dummy variables for the sectors did not prove to have a significant influence. Size classes of employees according to the European Union reveal differences between the classes: micro-entities with up to 10 employees show a significant negative beta when it comes to sales, the same holds true for large firms with more than 250 employees. The small companies with up to 50 workers and medium-sized companies with up to 250 workers show a beta which is not significantly different from zero.

What do our results imply for concentration in the Agribusiness? Meanwhile the sector as a whole seems to approximate a steady-state equilibrium in industry concentration, especially processors of fruit and vegetables as well as of wine are likely to experience further concentration. The distinction in size classes reveals a random growth pattern in the middle classes and mean reversion in the upper and lower class. The middle classes are thus expected to face increasing concentration meanwhile the concentration in the upper and lower class seems to approach a steady-state equilibrium. This is in line with the development of the classes' shares in total sales. Meanwhile the smallest and the biggest size class lost share between 2007 and 2012, the other size classes increased their shares.

5 Conclusion and Discussion

One of our goals was the description and explanation of size distributions in the German Agribusiness. As a reference point, we used *Gibrat's Law*. Our results contradict the validity of *Gibrat's Law* in the dataset as a whole. As small firms seemed to grow faster than bigger firms in relation to their size, scale economies may have become less important in the last years. Besides, political decisions might have been beneficial for smaller firms. What do our results imply for concentration in the Agribusiness? If the observed growth patterns continued, a change in the Agribusiness' structures would be likely to occur. Meanwhile the sector as a whole seems to approximate a steady-state equilibrium and decreasing concentration, especially processors of fruit and vegetables as well as of wine are likely to experience further concentration. Our results indicate differences between the sectors as well as between size classes. An actual press report (AGRARZEITUNG, 2014) confirms the developments observed above for the meat sector. The market share of the four biggest companies in the sector remained stable from 2013 to 2014. Furthermore, these companies seem to invest more strongly in value creation instead of new capacities. In addition, the second largest company, Vion, intends to close five to ten German production sites in the next years. GODDARD et al. (2006: 275) point out that large parts of the literature consider mean reversion a slow process. They suggest a "natural tendency for aggregate and industry concentration to increase over time". SHAPIRO et al. (1987) distinguish a random and a systematic growth component. If the random component is larger than the systematic one, an increase in concentration is possible, even if small firms grow faster than larger ones.

The opposite observation in concentration rates obtained in our introduction was based on data from the period 2000 to 2008. Recent data on concentration rates in the German Agribusiness could help us to weaken or confirm our results. Besides, our methodological approach could explain the divergence of the introduced development of concentration rates and our estimations. Our data is based on public available balance sheets and cannot be seen as a stratified random sample as very small firms are likely to be underrepresented. Furthermore, mergers, acquisitions and joint ventures were not taken into account. In addition, we supposed the selection bias and the influence of firms which did not survive as negligible.

The relation between growth rates and initial size differs between size classes. Consequently, the emergence of a different size distribution is possible. As an extension, it would be interesting to include market shares in economic modeling, which was not possible due to our database. KLEPPER and THOMPSON (2006: 875 f.) stress the importance of not only relying on statistical patterns when coping with determinants of market structure. They propose examining empirical irregularities across industries and over time. *Gibrat's Law* states an ex-ante stochastic distribution of the factors influencing a firm's growth. Research on factors that influence growth ex-post would be a desirable extension of the above mentioned results. The issue of which criteria and competencies could be crucial for the existence and survival of Agribusiness firms in the future has to be further explored.

AGARWAL et al. (2002: 979) distinguish between a growth and a mature phase of an industry. The mature phase exhibits a higher mortality of firms and a dual competitive structure, characterized by large, concentrated firms as well as small, specialized firms. Is the Agribusiness likely to be a mature industry or could it even be considered as a declining industry? The decreasing number of employees, the shrinking mass of farms and the achievement of market saturation for important agricultural products in the EU could at least indicate stagnation. If this holds true for the future as well, the results of GHEMAWAT and NALEBUFF (1990: 167) demonstrate a possible scenario. According to the authors, bigger firms in a homogeneous goods industry have stronger incentives to reduce their size due to their small-sized marginal revenue in comparison to smaller firms. The decline will also force some of the firms to exit the market. Previous developments of food and Agribusiness sector are also characterized by innovations, for example in machinery, chemistry, seed and information management. As a matter of global warming, food and energy scarcity as well as other critical concerns in society, further innovations seem to be likely. The development and use of technologies across industry boundaries, called industry convergence, could be another shaper of the competitive structures in Agribusiness. These are trends which can be anticipated by firms and help them to secure their survival in the industry (BOEHLJE et al., 2011: 60ff.).

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