Do Growth Rates Depend on the Initial Firm Size? Evidence for the German Agribusiness

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Abstract

The agribusiness is in flux: how will the population of firms develop, and which consequences will arise for competition? In 1931, GIBRAT stated the firm size and growth rate to be independent. Testing the validity of Gibrat's Law for the agribusiness allows drawing conclusions on future developments of concentration. After the examination of 454 manufacturing downstream enterprises in Germany, we reject Gibrat's Law and find small firms to grow stronger than bigger firms in relation to their initial size. Our results emphasize the application of Gibrat's Law to subsectors and size classes as well as to the agribusiness as a whole.

Key Words

agribusiness; structural change; empirical growth

1 Introduction

In a recently published article, SEXTON (2013) describes the evolution 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 modelling. Farmer and consumer welfare as well as general welfare are linked to the competitive structure of the interrelated up- and downstream industries of agriculture. Furthermore, market power reduces farmers' incentives for investments (SEXTON, 2013) and may therefore weaken their future negotiation position in the supply chain.

According to the EUROPEAN COMPETITION NETWORK (ECN, 2012), 180 antitrust cases in the food sector were investigated from 2004 to 2011 all over Europe with an increasing number of opened cases per year. Recent antitrust proceedings and the detection of illegal agreements, like in the cases of the Greece poultry production and distribution (HELLENIC COMPETITION COMMISSION, 2014), the French, Dutch and German milling industry (GERMAN FEDERAL CARTEL OFFICE, 2013) as well as the Finnish fresh milk producer and wholesaler Valio (FINNISH COMPETITION AND CONSUMER AUTHORITY, 2014) raise questions as to how firms behave when faced with the above mentioned changes. Structural characteristics are a major determinant of their adequate strategy (KÜHL, 1992).

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 progresses through phases of maturity and decline while still increasing its output (AGARWAL et al., 2002). Concentration tendencies are enhanced when smaller firms have a higher mortality rate than larger ones, when larger firms grow faster, or in case of a positive serial correlation in growth rates (DUNNE and HUGHES, 1994). MELHIM et al. (2009a) examine the growth rates of U.S. dairy farms. They argue that if the current rates proceed, a disappearance of the competitive nature of the industry and an emergence of concentration and market power is quite likely. A similar pattern could evolve in the downstream sectors. The European Union faces a rise in concentration with an increasing influence of multinational food manufacturers (ECN, 2012). A sector inquiry into the food retail sector in Germany (GERMAN FEDERAL CARTEL OFFICE, 2014) revealed that four companies are accounting for approximately 85% of total purchasing volumes.

With his work "*Les inégalités économiques*" in 1931, GIBRAT was one of the first researchers to analyze firm size distributions. Gibrat's Legacy, also called the Law of Proportionate Effect, was developed by GIBRAT in order to explain skewed distributions of firm sizes. Since then it has been serving as a reference point for research on industrial organization (for an overview, see SEGARRA and TERUEL, 2012). GIBRAT (1931) claims the size of firms and their growth rates to be statistically independent and, accordingly, the growth rate in each period to be proportional to the current size of the firm, independent of its size in absolute terms. Main implications of the random growth rates proposed by the Law are a conver-

gence of size distributions to lognormal distributions as well as an increase in concentration over time. Lognormal distributions are characterized by a large amount of small firms and a small number of large firms. The food manufacturing industries in EU-28 also consist of a large number of small firms and a comparatively low number of large firms (EUROSTAT, 2014a). Small and medium-sized enterprises account for 99% of all European businesses (EUROSTAT, 2014b).

We are interested in the dynamics of intra-industry change. The change in the industrial land-scape, its consequences for the competitive structure and the future size distribution of firms present three interesting aspects of this study. Do growth rates depend on the initial firm size? In order to answer this question, we examine the evolution of structures in the agribusiness in terms of Gibrat's Law by the example of German food manufacturing firms. Despite the sector's strategic position between producers and customers, structural changes in the food manufacturing do not seem to be fully investigated yet. To our knowledge, our contribution is the first one to link results from the estimation of Gibrat's Law explicitly to extensive industrial economics considerations, based on a comprehensive overview of different subsectors as well as on recent developments in practice. Our aim is to draw conclusions about future developments regarding the sectors' structure and competition as well as to stimulate further research. The concentration on changes in size and size distribution as one of many indicators of structural change is promising, as they are major and measurable determinants of an industry's dynamics.

The remainder is structured as follows. Section 2 contains a survey on empirical and theoretical research on size distributions. The following sections cover methodology and data. The model will be estimated in the section 5. Besides, this section focuses on the different branches of the agribusiness and their particular developments. The article ends with a conclusion and a discussion of possible perspectives with regard to the changing competitive nature in the agri-business.

2 Literature Background

Certain firms mature and then disappear, sometimes growing to dominate the market for a time and sometimes without any influence on competition (see for example HIRSCH and GSCHWANDNTER, 2013).

Changes in size and efficiency occur both, for individual units as well as for groups of firms. Furthermore, firms disband and are reconstituted as a result of mergers and structural changes. 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). These developments are strongly influenced by changing demand patterns, the adoption of new technologies, and the replacement of existing products by substitutes (SUTTON, 1997). The empirical firm size distribution is the cumulative result of these dynamics. One way of describing competitive structures is to view them as a state of affairs. The intensity of competition is assessed by taking a snapshot at a point of time. The sole observation of changes in market concentration does not provide information about the size distribution and the growth of differently sized firms (CONNOR et al., 1985) as well as about movements within the size distribution as a whole. However, this information is necessary to evaluate the strength of the different competitors and to provide a holistic assessment of the structural changes.

GIBRAT (1931) considered the effect of luck and unpredictability on concentration. 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, provided a stable number of firms, the variance of firm sizes shows an increasing tendency (WEISS, 1963). Hence, industry concentration shows a rising trend in the long run (GODDARD et al., 2006). If the law is invalid and small firms grow faster than larger firms, the variance of the firm sizes is bounded and concentration will not increase (GEROSKI, 2005). As his law is part of many mathematical models and is intended to explicate the size distribution of firms (MANSFIELD, 1962), assessments of its validity allow drawing conclusions with regard to the concentration in the agribusiness as well as comparisons with previous studies.

"Firm dynamics have a rich statistical structure" (SEGARRA and TERUEL, 2012: 319). Although GI-BRAT (1931) provided some striking results by applying his law, the research on regularities of size distributions in industries started 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, for example scale economies, the role of advertising, and the importance of R&D on the market structure. Alongside game theoretical approaches, maxim-

izing 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. According to SUTTON (1997), 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. These developments may be related to the emergent access to broad datasets in the mid-to-late 80s (SEGARRA and TERUEL, 2012). Besides, life cycle models of the industry and the evolution of market structures became an important issue (SUTTON, 1997). Though still being stochastic models, newer approaches stress the different attributes of firms as the source of 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. Nevertheless, a large part of the studies finds mixed distributions, including elements of both forms (SEGARRA and TERUEL, 2012). Despite the amount and variety of studies concerning size distributions, a generally accepted theoretical framework is still missing.

LOTTI et al. (2009) point out that especially earlier studies tended to confirm Gibrat's Law meanwhile more recent research usually rejects it. SUTTON (1997) 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 growth rates as well as a specific size distribution of firms. GEROSKI (2005) finds growth rates and size to be only weakly correlated. He shows that the expectation of nearly random growth rates is consistent with a variety of theories. According to him, the magnitude, the effects, and the timing of events affecting the size of firms contribute to the unpredictability of their future sizes. LOTTI et al. (2009) 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 in 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. BENTZEN et al. (2012) focus on Danish firms of various sectors between 1990 and 2004 and come to the conclusion that 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 to be responsible for these observations. However, it is questionable if this causality between structural development and growth rate as well as its direction are plausible. Moreover, the authors only include surviving firms in their dataset and exclude small firms with low probabilities for survival. Nevertheless, their finding indicates an increasing pressure for small und medium-sized firms with regard to productivity, growth, and survival.

While the size distribution of farms has been subject to research already (see for example WEISS (1998) and the literature mentioned there) and further structural changes are considered 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 effects of structural change in the food supply chain are mainly characterized by consolidation and alteration of vertical and horizontal boundaries of firms: the sizes and scopes of firms as well as their position and functions in the supply chain are subject to shifts. The size distribution within the population of firms has implications for the dynamics of industrial competition in the agribusiness and thus for every stage of the supply chain. Especially large firms are important employers and might execute significant market power. Furthermore, small changes in the size distribution may have important microeconomic consequences (SEGARRA and TERUEL, 2012).

In the agribusiness, only a few numbers of studies have been conducted, often for indivual subsectors: MELHIM et al. (2009a) test the validity of Gibrat's Law on the basis of the U.S. dairy farming industry. They reject the hypothesis after a regression analysis of milk producing firms in three regions between 1992 and 2002. Instead they evidence that big farms had significantly higher growth rates than midsize farms in the same time period. They conclude that the size distribution has not reached a stationary equilibrium yet. Further concentration tendencies appear to be likely. MORRISON PAUL et al. (2004) determine a competitive advantage of larger operations with production contracts over smaller, independently operating farms in selected U.S. states. DUNNE and

HUGHES (1994) investigated UK Companies in "Food and Drink" between 1975-1987 and found that Gibrat's Law applied to their sample. In a recent study, SCHMIT and HALL (2013) 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 the 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 were 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: larger firms did not grow as rapidly as smaller firms.

Amongst others, STAM (2010), EVANS (1987) and MANSFIELD (1962) highlight the different possibilities of interpreting Gibrat's Legacy. Apart from examining only firms that survived, it is also feasible to include firms that already exited the market. DUNNE and HUGHES (1994) test for a selection bias by reestimating their model with a probit analysis of survival by size and age and conclude that their results are not subject to a selection bias. Similarly, WEISS (1998) 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, but may complicate the derivation of statements for longer time horizons. SCHMIT and HALL (2013) hazard the consequences of a selection bias by excluding firms that exited the market. They state the existence of a negative revenue growth in their data base as an argument for a negligible bias. 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 that entry and exit have a much lower importance for concentration processes as the systematic firm-level growth. SUTTON (1997) suggests the consideration of the growth rates that would have been achieved by the firms which have already left as another possibility of interpretation. In this connection, it remains unclear how to include these firms in an econometric model.

BAUM and POWELL (1995) stress the importance of including information on decline, historical processes, and structural changes when conducting research on the evolution of industries. Hence, aspects of path dependence and learning effects are emphasized. GEROSKI (2005) shows possibilities for incorporating learning in models of random growth. Furthermore, he concludes that the influence of R&D as well as diversifying activities on growth rates and thus firm size distributions is also highly unpredictable.

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. WEINZIMMER et al. (1998) highlight the conceptual differences between the measures. For example, growth in terms of sales volume and the number of employees may indicate unequal results due to increases in process efficiency and changes in productivity. Therefore, they recommend the use of multiple concepts. RODRÍGUEZ et al. (2003) use multiple indicators for size and growth as well as a multi-criteria factor representative for economic size. They find the results of their estimations to be very similar.

3 Methodology

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). 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). Cross-sectional tests are the most commonly used methodology (GODDARD et al., 2002). Three different specifications are common. One way of testing the validity of Gibrat's Law is by estimating the least squares model below (following MELHIM et al., 2009a):

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

y_{it} is the growth rate of incumbents, r_i is the size of firm i in the initial period and ε_i is an independently and identically distributed error term. t describes the examined period. If β_{1t} does not differ significantly

from zero, Gibrat's Law is valid. If it is negative, smaller firms grow faster than larger firms. If it is positive, larger firms grow faster than smaller ones. 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):

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

Opposite to (1), which tests the relationship between the size level and the growth rate of firms for different periods t, (2) estimates the relation between two size levels at different points in time on a cross-sectional basis. If β does not differ significantly from one, Gibrat's Law is valid. If it is below one, the mean reversion hypothesis (see also BALDWIN, 1995) 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). β greater than one implies explosive growth paths. It indicates that larger firms grow faster than smaller firms or, in other words, that firms tend to grow faster as they get larger. A steady-state equilibrium has not been reached yet. Another, slightly different, way of testing Gibrat's Law is by regressing the logarithms of the firm sizes in different periods without an axis intercept (following BENTZEN et al., 2012). This model ist often estimated on cross-sectional data:

$$\Delta z_{t,i} = \gamma z_{t-1,i} + \varepsilon_{i,t} \qquad (3)$$

$z_{t,i}$ denotes the logarithm of the size of the firm. $z_{t,i-1}$ is subtracted on both sides. Gibrat's Law is valid if $\gamma=0$. In comparison to (1) and (2), the assumption of no intercept would exclude a firm of the size one ($log(z_{t,i})=0$) from growing and a firm of the size zero from the model. Furthermore, estimators of a model without an intercept might be biased.

Serial correlation is an econometric issue which biases the estimation of β upwards, "even though estimation proceeds using cross-sectional data" (CHESHER, 1979: 404). DUNNE and HUGHES (1994) 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) proposes incorporating past growth into the estimation:

$$logS_{it} = \alpha + \beta logS_{it-1} + \gamma logS_{it-2} + \varepsilon_{it}, \quad (4)$$

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). Besides this, the chosen method could influence the outcome of the estimation. Since the cross-sectional analysis is a widespread method for estimating Gibrat's Law and its use thus enables comparisons with previous studies, this issue will not be discussed in detail.[1]

The Durbin-Watson statistic is not indicative of serial correlation. Another test for serial correlation, proposed by SHAPIRO et al. (1987), confirms that our growth rates in sales are unrelated over time. An incorporation of past growth as shown in (4) thus appears unnecessary. As (3) may result in biased estimations and the results of (1) are easier to interpret than the results of (2), we chose the following specification[2]:

$$y_{it} = \beta_{0t} + \beta_{1t}S_i + \varepsilon_{it}, \qquad i=1,...,N \qquad (5)$$

y represents the growth of firm i in period t and S its size in the initial period. We chose this specification due to its superior interpretability in comparison to (2) and the lack of an axis intercept which was criticized in (3). The logarithmic transformation of our data yields normally distributed data, which we use as basis for our estimations.

We tested our model for the various industries of the agribusiness and for different time horizons.

4 Data

The sample for the present study contains firms of the 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 industry as a whole do not seem to be fully investigated yet. Furthermore, manufacturing can be considered as a key stage in food marketing, since the associated firms own a strategic position, located between producers and customers (CONNOR et al., 1985). In addition, the processing stage was subject to 28% of the antitrust investigations related to the food sector in Europe between 2004 and 2012 (ECN, 2012).

We chose total sales and the number of employees to proxy size and growth in the model. We thereby consider the results of the literature review. Conceptu-

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[1]   For a detailed discussion, see GODDARD et al. (2002).

[2]   r from (1) has been replaced by S in order to allow a more intuitive understanding of the equation.

al differences between the indicators (WEINZIMMER et al., 1998) allow differentiated statements, as sales can be considered as an output whereas the number of employees can be seen as an input variable. Additional variables, like total assets, profits or market value, were not included for the following reasons. Our approach is a first-time and thereby explorative application of Gibrat's Law to various subsectors of the food manufacturing industry. The amount of widely available data for the sector as a whole is limited and the studies cited above indicate that the results of the estimations will be very similar (RODRÍGUEZ et al., 2003). Due to the mentioned results of earlier studies concerning the effects of selection bias, we focus on the surviving firms in the period of investigation.

Our data is based on NACE Rev. 2 codes and was taken from a Bureau van Dijk database which is providing financial information on companies. The sample includes all German companies which were registered with sales as well as with the number of employees for the years 2007 to 2013. We focus on Germany as the largest national food manufacturing sector within EU-28 is located in Germany, contributing 17.4% of the EU-28's (estimated) value added in food manufacturing in 2012 (EUROSTAT, 2014a). In addition, it was the country with the highest cumulative share of value added for the five largest contributors in "food and beverages" among EU Member states in 2007 (EUROSTAT, 2010). On the basis of their annual turnover (BMELV, 2014; EUROSTAT, 2014a) and due to their direct links to the upstream farms, we focused on firms within the following sectors: processing and preserving of meat and production of meat products, processing and preserving of fruit and vegetables, manufacturers of dairy products, manufacturers of grain mill products, starches and starch products, manufacturers of other food products (e.g., sugar, cocoa, tea, coffee) as well as manufacturers of wine from grapes.

The sample contains 454 firms. An initial descriptive analysis (see Table 1, exemplary for the year 2013) 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 comparison of our size distribution with official data reveals similarities. For 2011, enterprises with less than 50 employees account for 54.1% of our sample (see Table 2); the statistical yearbook (BMELV, 2012) shows a share of 55.5% for enterprises of this

Table 1. **Descriptive statistics for the sample – sales and number of employees 2013**

	Sales in Millions of Euro	Number of Employees
Mean	44.58	111
Standard Deviation	149.05	245
Median	10.75	46
Minimum	0.12	1
Maximum	2,100.00	3,644

Source: own representation

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

Number of employees	Statistical Yearbook in %	Investigated Sample in %
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
1,000 and more	0.4	1.8

Source: own research based on BMELV (2012)

size class in the whole population of food and feed manufacturing enterprises in September 2011. Enterprises in the category 50 to 99 employees account for 16.0% of our sample (20.5% in the official statistics). Likewise, the subsequent size classes exhibit similarities between our sample and the population as a whole. However, the largest size class seems to be overrepresented, which might be due to publicity obligations. We shall return to this issue in the final conclusion.

The annual average relative 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.

5   Estimation Results

Our analysis by means of ordinary least squares focused on the relationship between size and growth of

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Table 3. **Coefficient estimates of equation (5) for sales and number of employees between 2007 and 2013**

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

Note: standard errors are in parentheses. *p=0.1; **p=0.05
Source: own representation

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. We present our results for the estimation relating to sales and the number of employees for the period 2007 to 2013. In this case, *t* in (5) describes a six-year period.

The estimations for sales in the sectors "all" and "meat" show slight tendencies towards 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 results presented in Table 3 were obtained.

The estimated parameters for *β* (*β₁* in (5)) are mainly negative and statistically significant. In other words, 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 correlated. More precisely, a one percent increase in the initial firm size leads to a decrease of the estimated growth in the observation period amounting to 0.141% in sales and 0.160% in the number of employees. The negative relation 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 correlated to the initial size. The comparison of β coefficients between the sectors by means of a t-test revealed no significant differences between the meat sector and "others". Dairy and grain milling show no significant difference in terms of their β coefficients for sales, whereas the coefficients for fruit and vegetables and dairy do not differ significantly in terms of the number of employees.

We tested some more specifications with different time horizons[3] (*t=1, t=3*) in order to overcome the shortcomings of first-and-last-year approaches (WEINZIMMER et al., 1998). For short periods of one year, a significantly negative *β* was estimated for the whole sample and for the grain milling and starch sector. The longer the chosen time horizon, the more significant 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

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[3] Not reported.

differences between the classes: micro-entities with up to 10 employees show a significantly negative β when it comes to sales, the same holds true for large firms with more than 250 employees. Small companies with up to 50 workers and medium-sized companies with up to 250 workers show a β not significantly different from zero.

Our results indicate differences between the sectors. A press report (STRUCK, 2014) tends to confirm 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 invest more strongly in value creation instead of new capacities. In addition, the second largest company, Vion, intends to close ten of their production sites over the next years as part of the company's restructuring process (ESCRITT, 2014). At the same time, the smallest size group (up to 10 employees) exhibited the strongest growth. The comparison of the β coefficients indicates similarities in growth within the sector "others". We will discuss possible reasons for these observations later.

The concentration process in the fruit and vegetables group intensified during the investigated period (DESTATIS, 2014). The production of fruit and vegetables is a highly heterogeneous sector with a variety of seasonal and perishable products. Transport costs and the perishability support a location of production facilities close to the supply of inputs (CONNOR and SCHIEK, 1997). The processing of fruit and vegetables is characterized by both, economies of scale and branding. It is facing increasing international competition and thus shifts towards products with added value, for example organic or high quality products (BIJMAN, 2012).

We found Gibrat's Law to be valid for the dairy industry in terms of sales, which is also supported by an increasing concentration ratio in the official data. The dairy sector exhibits consolidation tendencies as well, which are likely to be a reason for the increasing concentration. Furthermore, the industry experiences growing competition with companies from other European countries. In 2000, the dairy sector was one of the food manufacturing industries with the lowest concentration ratio (DESTATIS, 2014). In our sample, growth in the number of employees was negatively linked to the initial size. One explanation is an increasing importance of regional craftsmanship which is related to labor-intensive products. For realizing the same growth rates as large firms, small firms had to employ a comparatively higher number of employees.

This may also be the case for the sector fruit and vegetables, which did not differ significantly from the dairy industry in terms of its β coefficient.

Official data (DESTATIS, 2014) shows a decreasing concentration for the top 6 firms in grain milling and starch between 2000 and 2010, which is in line with our results. This sector is characterized by overcapacities and a nearly saturated domestic demand (BMELV, 2013). VK Mühlen AG (nowadays GoodMills Deutschland GmbH), Germany's largest milling company, also closed a flour mill as a consequence of overcapacities (HOGAN, 2012). The β coefficient did not differ significantly from the β coefficient of the dairy industry. Both sectors are characterized by a self-sufficiency rate above 100 (BMELV, 2014) and surplus goods must be sold: either on the domestic market or through exports.

The wine sector is characterized by increasing concentration, too. Some of the farms produce their own wine, others deliver their grapes to processors or producer organizations, which in turn vinify or resell the grapes to a processor. The trend towards concentration is reflected in a rising amount of mergers. Producer organizations, which were traditionally located in one wine region, are increasingly involved in cooperations across their traditional borders (KNOLL, 2012; HÖHLER and KÜHL, 2014). This development is an indication for scale economies.

Our results imply that the sector as a whole approximates a steady-state equilibrium in industry concentration, especially processors of fruit and vegetables as well as of wine will experience further concentration. The increase in concentration in sectors with a comparatively low level of concentration (dairy) and the decrease in sectors with a comparatively high level (meat, grain milling) is in line with the findings of BALDWIN (1995). However, the concentration ratio has to be interpreted with caution as it only gives static information on the n biggest firms while ignoring the dynamic distribution of firm sizes as a whole. The official data on concentration rates used for comparison was based on data from the period 2000 to 2010. Additional data exactly matching the examination period can help us to weaken or confirm our results. Our data is based on publicly available balance sheets and cannot be seen as a stratified random sample since very large firms seem to be overrepresented. However, we assume the bias to be negligible as our β-values are likely to become even more negative when the large firms are well represented. Furthermore, mergers, acquisitions, and joint ventures were

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not taken into account in our model. In addition, we supposed the selection bias and the influence of firms which did not survive to be negligible.

6 Conclusion and Discussion

One of our goals was the description and explanation of size distributions in the 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. We found differences in the growth rates which will influence the future structure and competition in the agribusiness. Small firms are facing increasing growth whereas larger firms stagnate in terms of growth. Growth processes within small firms are accompanied by consolidation tendencies in size classes containing large firms. Structural changes in industries consist of shifts in demand as well as of changes in supply (CONNOR and SCHIEK, 1997). As small firms grew faster than bigger firms in relation to their size, the small firms may exploit economies of scale where the larger firms cannot and are facing diseconomies of size instead (CONNOR et al., 1985). This is also supported by ALDRICH and PFEFFER (1976), who consider scale economies as small and below the scale of operations which prevails in many industries. The negative relationship between growth and size for the smallest size class is an indication for small firms' occupation of niche markets. Once having filled a niche, further growth would mean increasing competition with larger firms. Therefore, small firms are considered to reach steady-states in size and concentration.

One reason for the low growth rates of large firms compared to smaller ones is the market entry of large foreign companies. The above mentioned behavior of large firms in the sectors of grain milling and meat can be considered as a consequence of these developments. In particular the grain milling sector is characterized by overcapacities. Large firms are closing production sites whereas small firms grow particularly strong. Furthermore, collusive tendencies were revealed by antitrust authorities. Beside this supply side explanation, there are demand side and political reasoning. Political and economic decisions have been and will be beneficial for smaller firms, for example the trend towards support and consumption of regionally produced food. WIJNANDS et al. (2008) mention large cultural differences in Europe as disincentives for large-scale production. In addition, the saturated domestic demand in many food categories can explain the occurrence of diseconomies of scale. Thus, for example, increasing marginal costs arise from shipping to distant markets.

According to PORTER (1979), the variances of firms in multiple dimensions reflect their different decisions regarding their competitive strategy. The resulting strategic groups, differing for example in their degree of vertical integration and marketing strategies, may explain the observed differences in growth as well. The relation between growth rates and initial size differs between size classes. Consequently, the emergence of a new size distribution is possible. Our findings indicate the development of a bimodal structure, as the middle size class is tending towards the largest size class. This development is contrary to the size distribution proposed by GIBRAT and found in most of the publications regarding this issue. Furthermore, the concentration tendencies in the middle size classes could be reflected in a "missing middle", a state which is mainly known from development economics. As a consequence, the largest size class is likely to face increasing competition from middle-sized firms. Simultaneously, it will become more difficult for smaller firms to overcome the gap between large and small firms and structures may harden. With regard to consumer welfare, these tendencies should be observed by the antitrust authorities in order to prevent welfare losses from market power. Our results emphasize the application of Gibrat's Law to different size classes and sectors jointly with the consideration of the agribusiness as a whole.

As an ex-ante model, Gibrat's Law allows the derivation of predictions concerning the future evolution of concentration in various sectors. In our case, the processing stage of the value chain will be characterized by a mean reversion of sizes and tends to a steady-state equilibrium in concentration. Hence, our results provide no indications for the initially mentioned further strengthening of the (downstream) firms' bargaining position in contrast to farmers as well as for an increasing pressure for small und medium-sized processing firms with regard to productivity, growth, and survival. On the contrary, a decreasing concentration may prevent that farmers become increasingly dependent on a single buyer. The occupation of niche markets and the decreasing concentration can strengthen the position of small and medium enterprises in the supply chain.

GODDARD et al. (2006: 275) point out that large parts of the literature consider mean reversion to be 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. Further studies could elaborate this issue in order to derive reliable statements on the welfare effects of the observed growth patterns and the resulting development of the competitive structure. Thereby, Gibrat's Law can serve as an early warning indicator. According to ASCH and SENECA (1975), high industry concentration and high entry barriers could facilitate collusion. Gibrat's Law may facilitate and support political decisions on structural as well as on economic policies. DEMSETZ (1973), for example, argues that favorable results of an antitrust policy are more likely if small firms in concentrated industries are equally or more efficient than larger ones. In this case, existing collusion can be reduced. From the viewpoint of labor and structure policy, the negative beta in terms of the number of employees indicates that small firms are generating proportionally more jobs than large firms. In the light of the weak competitiveness of the European food industry in comparison to the U.S. and Canada (WIJNANDS et al., 2008), measures to enhance competitiveness should bear our results in mind. Furthermore, the results provide a base for strategic decisions and negotiations of the different interest groups involved in the supply chains.

KLEPPER and THOMPSON (2006) criticize models of stochastic growth for not having much economic content and ignoring fundamental drivers of firm growth. Hence, GODDARD et al. (2006) remind that Gibrat's Law does not preclude these drivers, but expects their distribution ex ante to be random across firms. 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 numbers of different factors to be dwindling small (see KUMAR, 1985). SHEPHERD and WIKLUND (2009) warn of rejecting growth theories in one or a few operationalizations. In consideration of these multiple scientific viewpoints, we apply Gibrat's Law as a first attempt

to answer our research questions. Yet we recognize the need of further analyses and additional explanatory approaches in order to overcome the described weaknesses.

The short period is a limitation of our work. An extension of the time span can provide further insights into the long-term development of the industry and may improve the explanatory power of our model. Additional data, which is not available from official statistics, has to be collected in order to deepen the methodological basis and achieve further results. The heterogeneity of the sector "manufacture of other food products" hampers the analysis of its development. Further differentiation in future research could provide additional results. As an extension of our work, it would be interesting to include further European countries as well as other sectors, particularly the retail sector. This was not possible due to our database. Gibrat's Law states an ex-ante stochastic distribution of the factors influencing a firm's growth. Research on factors influencing growth ex-post would be a desirable extension of the above mentioned results. A possible reference point is provided by the comparative regression analyses of 193 firms reported by WEINZIMMER et al. (1998). Furthermore, a panel analysis could generate stronger evidence, as pointed out by GODDARD et al. (2002). The issue which criteria and competencies are crucial for the existence and survival of agribusiness firms in the future has to be further explored. SEXTON'S (2013) plea for the revision of traditional models can be used as a starting point: Additional considerations should include the ongoing internationalization of the agribusiness, the impact of product differentiation, product quality and entry barriers as well as the parallel occurrence of local market power due to perishable products and transport costs. Moreover, specialization in farming to meet the processor's needs could lead to a low supply elasticity and thus be considered another source of market power. In addition, the expansion of multinational retailers (KADITI, 2013) will affect the distribution of market power within the chain.

Our findings, the stagnating number of employees, domestic demand and sales in the larger part of sectors as well as the introductory remarks on tendencies towards collusion raise the question of strategies in view of the recent market development. How do firms behave in an environment with a stable concentration? AGARWAL et al. (2002) distinguish between a growth phase 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 a mature industry or can it even be considered a declining industry? The shrinking mass of firms, the stable number of employees, and the achievement of (domestic) market saturation for important agricultural products in the EU at least indicate stagnation. Other size measures, like the expected global demand for food (OECD-FAO, 2014), do not suggest stagnation. An interesting indicator for the industry's growth is the amount of capital invested in plants and equipment, as proposed by CONNOR and SCHIEK (1997). However, if the scenario of stagnation holds true for the future as well, the results of GHEMAWAT and NALEBUFF (1990) demonstrate a possible scenario. According to the authors, bigger firms in a homogeneous goods industry have stronger incentives to reduce their size because of their small-sized marginal revenue in comparison to smaller firms. Although this model was confirmed in several studies, there is no universally valid argument at a theoretical level which would suggest either a convergence or a divergence of firm sizes in industries (SUTTON, 1997). The decline of agribusiness will also force some of the firms to exit the market.

However, the previous developments of the 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. As HELMBERGER (1966) already noted in 1966 for the U.S., substitutes for farm products and inputs are increasingly originating from nonfarm sectors. The development and use of technologies across industry boundaries, called industry convergence, could be another shaper of the competitive structures in agribusiness. Industry convergence results from product and process innovations that alter the boundaries of markets. Its extent and rapidity influence the industry dynamics as well as competitive structures and thus may require the adaption of strategies (VOIGT and KÜHL, 2007). These are trends which can be anticipated by firms and help them to secure their survival in the industry.

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