GJAE 65 (2016), Number 1

What Influences the Growth of Organic Farms? Evidence from a Panel of Organic Farms in Germany

Einflussfaktoren für das Wachstum von ökologisch wirtschaftenden Betrieben – Modellierung mit Hilfe von Paneldaten aus Süddeutschland

Thelma Brenes-Muñoz, Sebastian Lakner and Bernhard Brümmer
Georg-August-Universität Göttingen

Abstract

Organic farming is one of the fastest-growing branches of agriculture in Germany. The net increase in the number of hectares comes partly from the conversion of conventional farms, but also in part from the acreage expansion of existing organic farms. So far, empirical research has focused on analysing conversion to organic farming, and lately on reversion to conventional farming. However, changes in individual organic farm sizes have remained ignored by empirical researchers. Additionally, the occurrence and the extent of farm growth are largely dependent on the regional conditions of land market, farm structure and policy measures. Therefore, it remains unclear what other factors besides increasing demand for organic products might influence growth of organic farms. The main objective in this study is to determine whether organic farms are changing their scale of operation and, if so, which factors contribute to – or stagnate – farm growth and to what extent. To answer these questions we analyse growth in a unique panel dataset of 453 farms over the 1993-2005 period using the system generalised method of moments estimator (SGMM). The results reveal that all farms increase area by a maximum of 10 ha and large farms change farm size more frequently than smaller ones. Increases in organic area are influenced by subsidies for organic farming and intensity of livestock production. Farm growth measured in terms of output is affected by farm size, land, capital, soil quality, and intensity of livestock production.

Key Words

farm growth; organic farming; Gibrat’s Law; dynamic panel data

Zusammenfassung

Der ökologische Landbau ist eine der am schnellsten wachsenden Branchen in der Landwirtschaft in Deutschland. Der Zuwachs an Fläche kommt hauptsächlich von der Umstellung von konventionellen Betrieben, jedoch auch vom Flächenwachstum bereits etablierter Ökobetriebe. Die empirischen Analysen beschränken sich bisher auf die Umstellung auf Ökolandbau und ganz aktuell auf die Rückumstellung auf konventionelle Wirtschaftsweise. Allerdings ist das Wachstum von Ökobetrieben bisher nicht untersucht worden. Das betriebliche Wachstum sowie dessen Umfang sind stark abhängig von regionalen Gegebenheiten wie den lokalen Bodenmärkten, der gegebenen Agrarstruktur und den Politikmaßnahmen in einem Bundesland. Abgesehen vom Anstieg der Nachfrage bleibt auch unklar, welche Bestimmungsgründe das Größenwachstum von Ökobetrieben beeinflussen. Das Ziel dieser Studie ist eine Untersuchung der zwei unterschiedlichen Wachstumsdimensionen landwirtschaftliche Nutzfläche und landwirtschaftlicher Umsatz sowie die Bestimmung der Faktoren, die das Wachstum – oder die Stagnation – auf Ökobetrieben beeinflussen Wir analysieren einen Panel-Datensatz mit 453 Betrieben zwischen 1993 und 2005 mit Hilfe eines ‘System Generalised Methods of Moments (GMM)’-Schätzer. Die Ergebnisse zeigen, dass die Zuwächse bei ökologisch bewirtschafteter Fläche bei maximal 10 ha liegen. Die großen Betriebe ändern hierbei häufiger ihre Betriebsgröße als kleine Betriebe. Das Flächenwachstum von Ökobetrieben ist beeinflusst von Agrarumweltzahlungen und der Intensität der Tierhaltung. Auf das Umsatz-Wachstum der Ökobetriebe wirken die Betriebsgröße, Fläche, Kapital, Bodenqualität sowie die Intensität der Tierhaltung.

Schlüsselwörter

Wachstum der Betriebe; Ökolandbau; Gibrat-Regel; dynamische Panel-Modelle

1 Introduction

Organic farming has become one of the fastest-growing branches of agriculture over the last two decades. This growth has been driven partly by the increase in consumers concern for the environmental and animal welfare effects of food production (ZANDER and HAMM, 2010). The policy support for organic farming (NIEBERG and STROHM-LÖMPCKE, 2001; NIEBERG et al., 2011) and the associated price premium for organic products also influenced the development of the branch. In this context, the organic sector has experienced an impressive development in Germany. The country is the largest market for organically produced food in Europe (SAHOTA, 2014). Additionally, the total number of hectares (ha) farmed organically in Germany grew from 354 171 ha in 1996 to 1 060 669 ha in 2013, an increase of about 200% (BÖLW, 2014).

The increase in hectares comes from conversion of conventional farms to organic agriculture and in part, presumably, from the acreage and output expansion of existing organic farms. Recent empirical analyses reveal that some organic farms decide to leave the business and reconvert to conventional production (for a review see SAHM et al., 2012). Other studies find a trend towards larger farm sizes in organic agriculture (LANGER et al., 2005; BEST, 2008). These two findings together indicate that besides the plain processes of converting to organic or reconverting to conventional agriculture, there are also adjustments in the operation scale of organic farms which remain largely ignored. In this context, the present paper contributes to identifying the magnitude of these individual adjustments on organic farms, as well as their drivers and constraints.

From the late 1980s until today, organic farming grew particularly rapidly in the South German states of Bavaria and Baden-Württemberg. Roughly 53% of the organic farms and 31% of the total organic area in Germany are found in this region (DESTATIS BL, 2013). This development is partly the result of a comprehensive policy framework to provide financial support for conversion and for the expansion of organic farms (NIEBERG et al., 2011). These federal states, among others, had the largest public expenditures for area payments and investment assistance to organic agricultural businesses from 1999 to 2007 (NIEBERG et al., 2011). Nevertheless, it remains unclear what other factors have influenced the individual growth of organic farms in this region of Germany.

To the best of our knowledge, all previous studies on farm growth address only conventional. This research seeks to fill this gap by analysing two dimensions of growth in organic farms in Bavaria and Baden-Württemberg: Utilised Agricultural Area (UAA) in hectares and agricultural revenue. The results of this study will shed light on the dynamics of one of the most developed regions in Germany with respect to organic agriculture. However, we do not aim to provide a comparison between organic and conventional farms, since we do not have the information required for such an analysis. Instead, we address the following research questions: are organic farms changing their scale of operation? If so, which factors influence the individual changes in size? Do these changes in farm size mainly occur in small or large organic farms?

In this paper we review theory on firm and farm growth, and provide background information on the potential determinants of growth in the context of organic farming. Subsequently we present a brief description of the data, as well as a description of the estimation procedure that we employ. Lastly, we present the results and draw conclusions.

2 Literature Review

Farm growth is a multidimensional event, which can be analysed from several theoretical perspectives. The most relevant approaches are: the stochastic approach introduced by GIBRAT (1931) and known as the Law of Proportionate Effect (LPE); PENROSE's theory (1959) based on human resources management; the process of active learning proposed by JOVANOVIC (1982); the evolutionary theory of NELSON and WINTER (1982); the path-dependence model of BALMANN et al. (1996) about inefficient but persistent technologies; and the internal transaction costs approach which explain the development of family farms developed by POLLAK (1985). This study focuses on the internal growth of farms to determine the factors that influence changes in their size. Empirical studies that analyse such changes use the LPE as a foundation. GIBRAT (1931) finds that the size of firms in the French manufacturing sector follows a log-normal distribution, and that changes in a firm's size are the result of a large number of small, normally distributed shocks that are independent of previous firm size.

Most empirical studies of conventional agriculture which have tested the LPE find that previous farm size is negatively related to future farm growth; namely, smaller farms have higher growth rates than their larger counterparts (SHAPIRO et al., 1987; WEISS, 1999; RIZOV and MATHIJS, 2003; BAKUCS and FERTŐ, 2009; GARDEBROEK et al., 2010). Furthermore, the previous result holds across different indicators of farm size: acres and sales in Canada (SHAPIRO, 1987), livestock units in Austria (WEISS, 1999), hectares (RIZOV and MATHIJS, 2003) and sales (BAKUCS and FERTÖ, 2009) in Hungary, and sales and number of employees in various European countries (GARDEBROEK et al., 2010). This is explained by the long-run average cost curve (LRAC) when a farm expands its scale of operation. Previous studies in agriculture find evidence that the LRAC is L-shaped (HALL and LEVEEN, 1978; KUMBHAKAR, 1993); this means that the average costs decrease notably for small farms and become constant for large farm sizes when output increases. The former implies that economies of scales exist for small farms and that there is a wide range of farm sizes where average cost is approximately constant (CHAVAS, 2001).

2.1 Farm size

A prerequisite for a consistent analysis of farm growth is an appropriate definition of farm size. There is no universally accepted definition of farm size. Measurements of farm size are either output- or input-based (HALLAM, 1993; WEISS, 1998). Input-oriented measures are livestock units (LU) and acreage under cultivation. However, LU is a problematic measure when analyzing various farm types. Certainly, acreage is relevant since it provides a spatial perspective of farm size distribution, and without land, farm growth is only possible to a limited extent (HÜTTEL and MARGARIAN, 2009). Nevertheless, farm growth is not limited to acreage expansion, as it involves adjustments in other factor proportions and output quantities (WEISS, 1998). Output-based indicators, such as inflation-corrected sales capture those adjustments better than a single input measure (HALLAM, 1993). Furthermore, output-based measures allow for comparison of farms that produce different products (DEBERTIN, 2012). This is particularly important in organic agriculture because the farming system is more diverse than in conventional farming (OFFERMANN and NIEBERG, 2000). To provide a complete perspective of the growth process, we used land in UAA as an input-based measure for farm size and revenue from agricultural products as an output-based indicator.

The conditions of the regional market determine the land availability (for purchase or lease). Compared with the rest of the country, transactions for agricultural land in Bavaria and Baden-Württemberg are limited in terms of the area. In 2003, the average size of each sale of agricultural land was 1.4 ha in Bayern and 0.9 ha in Baden-Württemberg, and all sales represented only 0.14% and 0.23%, respectively, of the total agricultural land (SIEGMUND, 2004; DESTATIS, 2013). Therefore, farm growth mainly occurs via land lease. In 2005, farms that leased land annexed on average 17 ha to the owned land in Bayern (BStELF, 2012); in Baden-Württemberg it was 30 ha if the farmer was full-time farmer and 8 ha for part-time farmers (STALA, 2006). The prices for leased agricultural land were 259 €/ha in Bayern and 219 €/ha in Baden-Württemberg, the fourth and fifth-highest prices in Germany (DESTATIS, 2014)[1]. A study by KUHNERT et al. (2013) reveals that 21% of organic farmers in Germany feel constrained by the low availability of agricultural land and by failing to renew their land-lease contracts.

The limited availability and high opportunity cost of agricultural land in the region increases the competition among conventional and organic farms for available land. Acreage expansion is more expensive for organic farms than for conventional farms because farmers have to cope with investment costs to certify the additional land, to improve soil fertility, and to control for weeds and pests without using chemical pesticides or synthetic fertilizers. During the conversion period, farmers do not benefit from price premiums for organic produce, and yields are lower and more irregular. Additionally, certified organic inputs such as fodder, manure, and seed are becoming expensive and supply is often limited (SAHM et al., 2012; KUHNERT et al., 2013). These factors combined suggest that the average costs for organic farms do not decrease as markedly as when conventional farms increase their scale of operation, and that, therefore, the slope of the LRAC for organic farms is lower than for conventional farms. Thus, the threshold for land expansion is higher for organic than for conventional farms. However, even if the slope of the LRAC is lower for organic farms, small organic farms still have

---

[1] This tendency continues: in 2013 leasing prices for a hectare of agricultural reached 338 € in Bavaria and 246 € in Baden-Württemberg (DESTATIS, 2014).

Table 1. Factor endowment of organic and comparable conventional farms[*] in Germany, 1999/2000 and 2013/2014

Factor	Unit	Organic farms		Comparable conventional farms		Percentage difference	
		1999/00	2013/14	1999/00	2013/14	1999/00	2013/14
Land[*]	UAA	60.2	126.3	60.1	121.6	0.2%	3.9%
Labour	AWU/farm	1.9	2.6	1.6	2.0	16.8%	30.0%
Cost of hired labour	€/ha	100.1	222.9	41.7	137.6	140.1%	62.0%
Farm-owned capital	€/ha	7 315.7	4 562.4	9 480.2	5 075.0	- 22.8%	- 10.1%

[*] This term refers to a subgroup of conventional farms from the German Test Farm Network and consists of the same farm-types as the group of organic farms in the network. They also have similar structural features with respect to land in UAA, location, and land tenure among others. OFFERMANN and NIEBERG (2001) provide an exhaustive definition of this concept.

Source: Data for 1999/2000 cp. BMELF (2001): 61-63, and for 2013/14 cp. SANDERS (2015)

greater economic incentives to adjust towards a more efficient (larger) farm sizes. Thus, the probability to expand the scale of operation is expected to be higher for smaller organic farms, as it has been found in the conventional sector.

However, according to CHAVAS (2001) and HÜTTEL and MARGARIAN (2009) there are many other factors which can also influence the choice of farm size or the persistence of farms in a determined size, such as transaction and sunk costs, uncertain future revenues, and the presence of imperfect input markets. Some of these factors can play an important role in organic farming. For instance, if there is imperfect financial markets and small organic farms cannot cope with the initial costs of purchasing or leasing to convert land into organic agriculture. Then smaller farm would display lower growth rates than their larger peers. This result would contradict previous findings from conventional agriculture.

2.2 Other Factors Affecting Farm Growth

Although the LPE offers a starting point to analyse the effect of firm size on growth, its main limitation is that it disregards the effects of other factors. Results from previous empirical studies in the agricultural sector show that farm growth is also affected by the initial endowment of other factors, such as capital, labour, and human capital (UPTON and HARWORTH, 1987; SUMNER and LEIBY, 1987; GALE, 1994; WEISS, 1999; KIMHI, 2000; JUVANCIC, 2006; GARDEBROEK et al., 2010).

The production structure and factor endowment of organic farms differ from those in conventional agriculture. Table 1 shows the differences of organic farms in comparison with conventional farms from the German test farm network. Organic farms require about 17% more Agricultural Working Units (AWU), and spend 140% more on *hired labour*, than conventional farms (see Table 1). This is attributed to farming practices, such as weed control and preparation and application of soil amendments, e.g. compost. Besides this, organic farming requires additional documentation to comply with certification requirements and inspections. Farmers have to record, for instance, practices and equipment used for each field, log equipment cleanout, grazing schedules, logs for compost production and field inputs, among others. Indeed, 47% of the farmers, which reverted to conventional agriculture, remark that documentation workload was a very important aspect for their decision to revert (KUHNERT et al., 2013).

Hired labour is particularly expensive in southern Germany; in 2007 the average gross salary per hour in Baden-Württemberg was 18.60 € and 18.05 € in Bayern, the third and fifth highest in Germany[2] (DESTATIS, 2009). The higher demand for hired labour on organic farms combined with the opportunity cost that agricultural workers face in southern Germany may have a negative effect on farm growth in the region. Another factor, which presumably constrains farm expansion, is *part-time farming*. According to KIMHI (2000) and WEISS (1999), part-time farming can be considered the ‘first step’ outside of agriculture, however it can also prevent the cessation of farming operations by stabilizing a household’s income (SAUER and PARK, 2009). WEISS (1999) and JUVANCIC (2006) find that off-farm work promotes the restructuring of the farming sector by reducing both the probability of farm survival and the growth rates of farms. Consider-

---

[2] In 2013, the gross salary per hour was 21.98 € in Baden-Württemberg and 21.24 € in Bavaria.

ing the greater demand for labour among organic farms, we expect *part-time farming* to have fewer incentives to increase farm size in terms of land.

Besides land, farms require additional *capital* for expansion – particularly for the acquisition of new assets such as storage facilities and feed systems. Capital investments improve productivity and increase the probability that a firm will remain active and prosper in the market (HESHMATI, 2001; GARDEBROEK et al., 2010). Although organic agriculture is less capital-intensive than conventional agriculture (Table 1), capital is required whenever a farm expands the resource base. Thus, organic farms with large capital endowment are expected to generate returns on their investments.

Previous studies emphasise that farmer's education, experience and managerial ability partly determine changes in firm size. SUMNER and LEIBY (1987) stress that human capital, represented as age and experience, is associated to more effective production management, lower interest rates for borrowed capital and thus faster growth. This might differ in organic farming as organic farming practices are unknown prior conversion from conventional agriculture (SIPILÄINEN and OUDE LANSINK, 2005). Therefore, farmer's age may not adequately capture his or her experience on growth of organic farms. Nevertheless, aging might depicts the life-cycle pattern of the farmer, proposed by GALE (1994). WEISS (1999) and JUVANCIC (2006) find that the effect of a *farmer's age* on growth and survival is non-linear; it is positive for young farmers, who often invest and expand farm operations, and becomes negative for older farm operators. We expect farmer's age to follow the life-cycle pattern proposed by GALE (1994).

Livestock production represents an important component of agricultural production in South Germany; 78% of the farms in Bavaria and 63% in Baden-Württemberg keep livestock in their holdings (DESTATIS, 2011). Organic farms, which use their grassland areas intensively, are able to exploit better their agricultural land. Furthermore, *intensification of livestock production* increases technical efficiency of organic farms (TIEDEMANN and LATACZ-LOHMANN, 2011; LAKNER et al., 2012). This has presumably a positive effect on the competitiveness of the farms and the probability to grow in terms of revenue. Nonetheless, it might have a negative effect on acreage expansion.

A farm's growth is also influenced by its *operating environment* (e.g. marketing conditions and political factors). OFFERMANN and NIEBERG (2000) find that organic farmers who sold their products directly to consumers received double the price obtained through wholesale, and thus were more profitable than farms selling through other marketing channels. We, therefore, expect that direct marketing has a positive effect on farm growth via profitability.

Organic farms in Germany, and especially dairy and arable farms in southern Germany, are highly dependent on policy support (OFFERMANN et al., 2009). The most important policy support for organic farming in Germany is provided via agri-environmental measures (STOLZE and LAMPKIN, 2009). To receive payments for organic farming, farmers sign contracts for a minimum period of 5 years that provide for payments per area to compensate the additional costs and income foregone during the conversion period (EU COMMISSION, 2010). These payments are supposed to stabilise the farmer's income and increases the probability of growth.

Furthermore, soil conditions increase output and technical efficiency in organic farming (TIEDEMANN and LATACZ-LOHMANN, 2013; LAKNER et al., 2012). Therefore, higher soil quality has presumably a positive effect on the farm growth in terms of revenue, via profitability and reduction in average cost. This factor might have a negative effect when farm growth is measured in terms of agricultural land, because as land productivity increases, less area is demanded for the same output.

We analyse two dimensions of growth in organic farming and measure the effect of the factors identified above, i.e. farm size, labour, capital, on these dimensions. For this, we construct a dynamic model, using the LPE as starting point. The next section describes the data set and the empirical specification.

3 Empirical Model and Data

3.1 Empirical Model

Based on the above literature review, we derive a growth model from a firm size equation and its relation to the size in the previous period:

$$\ln S_{it} = \alpha_1 \ln S_{it-1} + X_{it-1}\beta + \gamma_t + a_i + u_{it}, \qquad (1)$$

where $\ln S_{it-1}$ is the logarithm of farm size, and α_1 is the relationship between firm size in two consecutive periods. X_{it-1} represents a group of additional covariates, and γ_t captures time effects common to all farms. a_i captures unobserved and time-constant farm-specific effects, such as location (proximity to market) or differences in the initial levels of efficiency. u_{it} is a random disturbance term. To analyse different dimensions of farm growth, we estimate the model using two different dependent variables - namely, farm size in hectares of UAA, and revenue from agricultural production. A description of the dependent variable and the covariates in X is presented in Table 2.

The growth model is obtained by redefining the dependent variable as the first difference of the logarithm of farm size, on the left side of Equation (1):

$$\begin{aligned} G_{it} \equiv \ln S_{it} - \ln S_{it-1} = \\ \alpha_1 \ln S_{it-1} + X_{it-1}\beta + \gamma_t + a_i + u_{it}, \end{aligned} \qquad (2)$$

Therefore, farm growth is defined as the annual change in farm size. Analysis of the effect of farm size on growth consists of testing the null hypothesis $H_0\colon \alpha_1 = 0$, which implies that changes in size are independent of the size in previous period. If $\alpha_1 < 0$, smaller farms grow faster than larger farms. Based on previous literature from agriculture, we expect that previous farm size has a negative effect on future growth. Hypotheses for assessing the effects of the additional explanatory variables on farm growth are tested individually.

The lagged dependent variable on the right-hand side of Equation (2) is correlated with the error term a_i, which violates the assumption of exogeneity. ANDERSON and HSIAO (1981) propose a difference generalised method of moments (DGMM) approach to obtain unbiased estimates. This procedure takes the first differences from Equation (2) and uses all available lags of the dependent variable as instruments (BOND et al., 2001). However, the DGMM method performs poorly when the parameter α_1 approaches unity (i.e. size follows a random walk), because in this case past levels of farm size provide little information on present changes (ROODMAN, 2009a). In the first stage of the analysis, we obtained coefficients for the lagged dependent variable of 0.99.

To increase efficiency in the context of near-random walk or persistent series, ARELLANO and BOVER (1995) and BLUNDELL and BOND (1998) each propose an augmented version of the DGMM - namely, the system generalised method of moments (SGMM), which uses a system of level and first-difference Equations:

$$\begin{bmatrix} \Delta G_{it} \\ G_{it} \end{bmatrix} = \alpha \begin{bmatrix} \Delta \ln S_{it-1} \\ \ln S_{it-1} \end{bmatrix} + \beta \begin{bmatrix} \Delta X_{it-1} \\ X_{it-1} \end{bmatrix} + u_{it}. \qquad (3)$$

SGMM is based on the assumption that the first difference of the endogenous variable is uncorrelated with the unobserved (individual) effect. This makes it possible to use additional instruments, namely lags of the first difference of lnS_{it} in the equation in levels.

To test the various assumptions of the SGMM model and to determine the most appropriate model specification, we perform several tests. ARELLANO and BOND (1991) propose a test to determine serial correlation on the residuals in first differences. Here, a negative serial correlation among the first differences was expected, since Δu_{it} relates to Δu_{it-1} through the common term u_{it-1}. Thus, the AR(2) test will detect first-order serial correlation in levels between u_{it-1} in Δu_{it} and u_{it-2} in Δu_{it-2} (ROODMAN, 2009a). Additionally, we test the validity of the overidentifying restrictions with the Hansen test; the null hypothesis is that the moment conditions used are satisfied and the instruments are valid (BOND et al., 2001). This test is robust to heteroscedasticity, but is weakened by the use of many instruments (lags), resulting in implausibly perfect *p*-values of 1.00. There are no clear guidelines on how many instruments one can use, but in any case, they should not exceed the number of observations (ROODMAN, 2009b).

The Hansen test evaluates the entire set of instruments. Nevertheless, to test the validity of specific subsets of instruments, we use the difference-in-Hansen test. This is done by estimating the change in the Hansen test, when the subset of suspect instruments is added to the estimation set-up. The null hypothesis is that the examined instruments are exogenous (ROODMAN, 2009b). For the land growth model, revenue and payments for agri-environmental measures correlates with the error term. For revenue growth the covariates capital, agricultural area and subsidies correlate with the error term. Thus, we treated these covariates in the same way as the lagged dependent variables and instrument them with further lags in levels and first differences. We estimate the two-step SGMM with the Windmeijer correction for finite samples; without this correction, the standard errors of the SGMM are severely biased downward (ROODMAN, 2009a).

Sample selection bias could occur if a particular group of farms has a higher probability of remaining in the data set than others. Correction for sample selection in the context of dynamic panel data is still incipient. Nevertheless, to test whether dropouts differ from remaining observations, we conduct a test outlined by VERBREEK and NIJMAN (1992). The test consists of creating a dummy variable for selection, which equals zero at *t* if the farm remains in the database in *t+1*, and it changes to 1 if the farm exits in the subsequent period. We created similar dummy variables for farms with less than 5 years of observations. The results are discussed in following section.

Finally, to identify the magnitude of the changes in size, we calculate a transition probability matrix. For this, we classify farm size in ha in *j* groups and the change in hectares in *k* categories. The matrix estimates, $p_{jk} = Pr(\Delta ha_t = k|S_{t-1} = j)$, the probability of a farm being in category *k* in period *t*, given that it was in group *j* in period *t-1*. The conditional probability uses the following formula:

$$p_{jk} = n_{jk}/\sum_{j=1}^{n} n_{jk}. \qquad (4)$$

where n_{jk} denotes the number of farms who were in category *j* in period *t-1* and are in group *k* in period *t*.

3.2 Data

The analysis is based on a unique 13-year panel data set provided by the firm Land Data GmbH, a service firm for agricultural accountancy. It consists of 2 759 observations from i = 453 organic farms, from 1993 until 2005 located in the federal states of Bavaria and Baden-Württemberg. The information is drawn from an unbalanced panel dataset comprising incumbent farms (with observations over the entire 13 years), dropouts (farms that exited the dataset before 2005), and newcomers (farms that entered after 1993). The data set does not provide information on whether the dropouts ceased to operate, reverted to conventional agriculture, or changed their bookkeeping company. However, all farms in the sample received agri-environmental payments for organic farming. To obtain these payments, farmers sign a contract for a minimum of 5 years during which they commit to farm organically. This restricts farmers from reverting to conventional agriculture after less than 5 years. In addition, the average age of farmers who dropped out of the data set was relatively young at 42 years old. Therefore, it is more likely that the dropouts in the data set stopped hiring the accountancy service, rather than reverting to conventional agriculture or giving up their holdings. The effects of ignoring attrition are discussed below. Despite this limitation, the dataset provides accurate information on the changes in the size of individual organic farms. 90% of the farms either increased or decreased their acreage during the sample period.

Table 2 presents descriptive statistics for all of the variables that we employ. On average, organic farms make use of 50 ha of UAA, 1.6 AWUs, and earn 86 770 € per year from sales of agricultural products. Most organic farmers are full-time; their average age is 43 years; and they receive an average of 11 000 € per year in agri-environmental payments for organic farming. The average livestock intensity is 1 LU/ha. Considering the panel structure of the data set, we divide the overall standard deviation into between and within variation. The between standard deviation shows the spread in the mean values between firms, while the within standard deviation indicates the deviation from each individual's averages. Table 2 shows that the growth rates of revenue have a larger variation within each farm than between them; contrary to land growth which has a larger dispersion between farms. For the econometric estimation, we used the natural logarithms of all variables. All monetary variables are expressed in constant 2 000 Euro. We used the standard agricultural price indices from official statistics available from BMELV (2006).

4 Results and Discussion

We find that the individual increases of organic farms totalled 2 540 ha, and the decreases totalled 511 ha for the sample period. The decreases in acreage were mostly small; 78% of the farms that reduced their size lost 5 ha or less. The increases were more evenly distributed, with 47% of the farms that grew gaining up to 5 ha, 20% growing between 5 and 10 ha, and 33% gaining more than 10 ha.

Table 3 presents the results for the two econometric models, growth of agricultural *revenue* and growth of *land*. The outcomes of the Arellano-Bond test for AR(1) in the first differences in columns (a) and (b) show that the residuals are negatively autocorrelated, corresponding to the first-differencing process inherent in the SGMM method. The AR(2) tests did not reject the null hypotheses of autocorrelation in the second differences, which is a required assumption for consistent results.

The estimated coefficients in Table 3 indicate that the returns to farm size are negative and less than equi-proportionate when farm size is measured in terms of output. Therefore, the hypothesis that changes in farm size are independent of the size in the previous period is rejected for this estimation. According to the results in Table 3, the elasticity of farm growth with respect to farm size in the previous period is

Table 2. Definition of variables and descriptive statistics of the analysed farms for the entire observation period 1993-2005

Variable	Unit	Definition	Mean	Standard deviation		
				Overall	Within	Between
Dependent variables						
Revenue G_{it}	%	Change of agricultural revenue	0.10	0.29	0.26	0.20
Land G_{it}	%	Change of Utilised Agricultural Area	0.02	0.11	0.09	0.10
Variables regarding farm size						
Revenue$_{it-1}$	1 000 €	Revenue from agricultural revenue	86.77	76.13	21.61	69.96
Land$_{it-1}$	Hectare	Utilised Agricultural Area, owned and rented	49.77	31.90	6.57	32.75
Explanatory variables						
Capital$_{it-1}$	1 000 €	Annual depreciation	17.98	13.05	3.53	13.00
Labour$_{it-1}$	AWU	Annual Work Units (AWU)	1.63	0.75	0.26	0.82
Part-Time$_{it-1}$	0/1	Dummy = 1 if the farmer has a part-time job, 0 otherwise	0.12	0.32	0.10	0.31
Age$_{it-1}$	Years	Farm operator age, in years	43.44	8.50	2.75	8.42
Livestock Intensity$_{it-1}$	LU/ha[a]	Livestock Units (LU) per hectare	1.08	0.72	0.22	0.69
Subsidies$_{it-1}$	1 000 €	Agri-environmental payments for organic farming	11.44	6.82	6.14	6.88
Direct Marketing$_{it-1}$	0/1	Dummy = 1 if the farms has its own farm shop, 0 otherwise	0.09	0.30	0.18	0.21
Soil Quality$_{it-1}$	EMZ[b]	Soil quality index	3 511.91	1 236.81	444.27	1 236.78
Farm type	0/1	Dummy for each farm type Share of grazing livestock farms Share of mixed farms Share of arable farms Share of pig and poultry farms Share of horticultural farms	 63.15 18.19 13.32 4.56 0.78			
Years	Years	Vector of years dummies	-	-	-	-

[a] from Großvieheinheiten (GVE) which is a measure of animal units defined by the German legislation.

[b] Ertragsmesszahl (EMZ) is a soil-quality index whose value ranges from 25 to 10 000 based on various farm characteristics that influence yield potential (e.g. soil texture, local temperature, and soil's water-holding capacity)

Source: based on data from Land Data GmbH 1993-2005; own calculation

-0.42, i.e. a farm that is 1% smaller will on average have a rate of growth that is 0.42% higher. These results are consistent with previous findings in the agricultural sector. SHAPIRO et al. (1987) and GARDEBROEK et al. (2010) also found that large farms grow slower than small farms when farm size is measured in economic terms of output (e.g. gross sales). Figure 1 illustrates the estimated growth values with respect to farm size and shows that smaller organic farms achieve higher growth rates than their peers. The result in Figure 1 implies that small farms are increasing revenue to a larger extent than large farms; as predicted by economic theory.

We do not find the same tendency when we measure farm size in terms of land. The results from the regression in column (b) of Table 3 indicate that previous farm size (measured in terms of agricultural area) does not have a significant effect on farm growth. Since the coefficient for farm size in terms of area is close to zero, we also test whether the coefficient of previous farm size is significantly smaller than zero $\alpha_1 < 0$. The t-test fails to find any evidence that the farm size coefficient for land is smaller than zero, F(1, 309) = 1.21, p-value = 0.1364. This result contradicts previous studies in conventional agriculture which find that small farms grow at higher rates than larger ones, when farm size is measured in hectares (SHAPIRO et al., 1987; RIZOV and MATHIJS, 2003). To provide a detailed analysis about the absolute changes in agricultural land by predefined farm

Table 3. Regression results for growth of agricultural revenue and land, 1993-2005

Explanatory variables[†]	Dependent variables			
	Revenue G_{it}		Land G_{it}	
ln $Revenue_{it-1}$	**- 0.414 *****	(0.053)	0.026	(0.025)
ln $Land_{it-1}$	**0.175 ****	(0.074)	0.093	(0.073)
ln $Capital_{it-1}$	**0.096 ****	(0.043)	- 0.042	(0.028)
ln $Labour_{it-1}$	**0.218 *****	(0.048)	- 0.034	(0.029)
$Part\text{-}Time_{it-1}$	- 0.078	(0.059)	0.025	(0.019)
Age_{it-1}	0.004	(0.010)	0.009	(0.006)
Age^2_{it-1}	- 5.690^{-05}	(1.107^{-04})	- 1.004^{-04}	(6.820^{-05})
ln $Livestock\ Intensity_{it-1}$	**0.109 *****	(0.032)	**- 0.037 ****	(0.017)
ln $Subsidies_{it-1}$	0.012	(0.011)	**0.021 ***	(0.011)
$Direct\ Marketing_{it-1}$	0.028	(0.032)	0.015	(0.017)
ln $Soil\ Quality_{it-1}$	**0.077 ****	(0.030)	- 0.008	(0.012)
$Mixed\ Farm_{it}$	0.004	(0.033)	- 0.001	(0.013)
$Arable\ Farm_{it}$	0.093	(0.098)	**0.037 ***	(0.023)
$Pig\ and\ poultry\ farms\ Farm_{it}$	**0.318 *****	(0.069)	0.014	(0.025)
Observations	1579		1579	
No. Instruments	136		31	
F-Test	5.85	[0.00]	1.61	[0.03]
Arellano-Bond test AR(1)	- 5.14	[0.00]	- 6.45	[0.00]
Arellano-Bond test AR(2)	0.77	[0.44]	- 1.53	[0.13]
Hansen test of over-identification restrictions	114.69	[0.46]	4.72	[0.58]
Diff.-in-Hansen tests of exogeneity of GMM instrument for the level equation	73.44	[0.46]	3.61	[0.31]

Corrected standard errors in parentheses; *p*-values in square brackets; significance levels: ***/**/* denote significance at the 1, 5, and 10% levels, respectively.

Results were generated using xtabond2 from ROODMAN (2003).

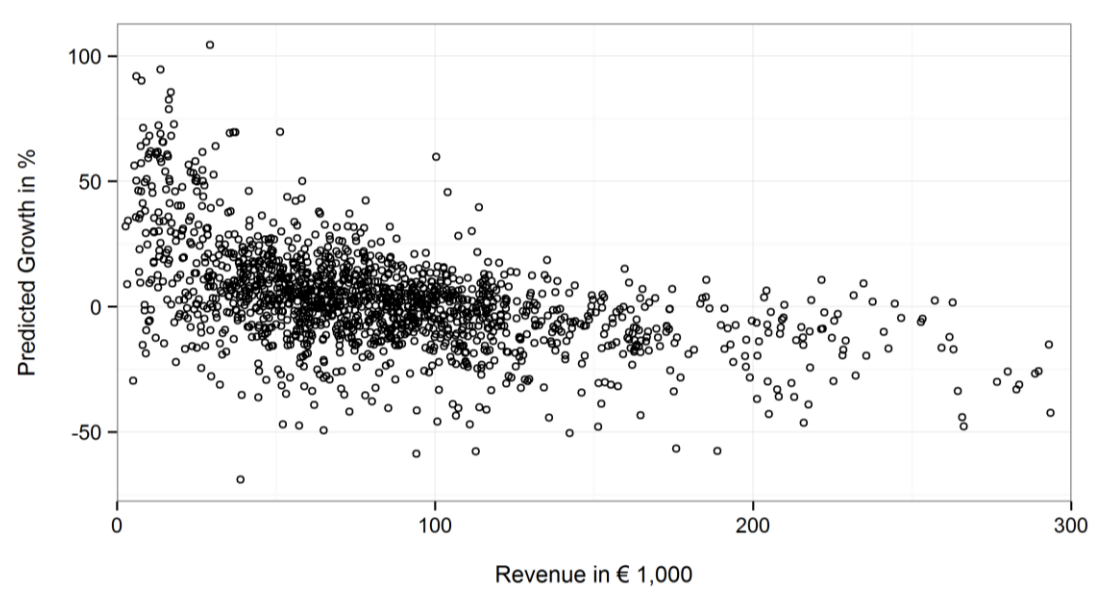
[†] We estimated the model including farmer's education; however, the results did not provide additional information to the model.

Source: based on data from Land Data GmbH 1993-2005; own calculation

size categories, we present the results of the transition probability matrix. Table 4 shows the transition probabilities of changing the number of hectares in *t* depending on the size of the farm in *t-1*. As an example, the first row in Table 4 indicates that the smallest farms (< 10 ha) have a 9.5% probability of reducing their agricultural land area between 10 ha and 0.5 ha in the next year, 67% probability of not changing their size and 20% probability to increase their acreage between 0.5 to 10 ha for the following period. Note that each row in Table 4 sums up to 1.0.

The results in Table 4 column (4) show that small farms (<10 ha) have a 67% chance of not changing farm size within the next year. This percentage drops to 21% if the farm has more than 50 ha. The group differences in column (4) are statistically significant from each other, except for two pairwise comparisons (see Appendix 1). This result provides evidence that the probability to change the scale of operation is lower for categories with smaller farm sizes. Additionally, the results in Table 4 column (5) show that the increases in land mostly occur by a maximum of 10 ha. The probability of increasing acreage by 10 ha is statistically different between most size categories (see Appendix 2); it increases with increasing farm size. These results combined reinforce the findings form SGGM regression that small organic farms are not adjusting their scale of operation in terms of land as expected by economic theory. The persistence of farms in a determined size category is a frequent event observed in empirical literature in agriculture. As described by HÜTTEL and MARGARIAN (2009) and

Figure 1. Predicted growth rates and farm size (in revenue) for organic farming[*]



[*] The predicted growth rates are the estimates values from Equation (2) with respect to revenue.
Source: based on data from Land Data GmbH 1993-2005, own calculations

CHAVAS (2001), this is related to the reluctance of farms to exit the sector or to grow and is explained by sunk and transaction costs, uncertain future revenues, and the presence of imperfect input markets.

In organic farming, reluctance to exit or grow can arise as a result of part-time or "hobby farming". Certainly for these farms are less likely to be affected by market pressures to move towards more efficient sizes or exiting the sector. Thus, it is tempting to speculate that the reluctance to grow from small farms in the data set comes from this type of farming. However, this is not the case for work presented here: small farms (<10 ha) are managed in 81% of the cases by full-time farmers. The former supports the assumption that farms in the data set correspond to commercial organic farms and that the persistence of farms in a small size category is caused by other reasons.

In organic farming, sunk costs arise from the conversion costs from learning the technology, restoring and converting the soil into organic, and any other investment to improve buildings and equipment to comply with the standards for organic farming. In case of exiting the organic sector and reverting to conventional agriculture, the conversion costs are partly reduced by selling redundant machinery and equipment (MUßHOFF and HIRSCHAUER, 2008). Therefore, sunk costs do not appear to be the main reason for persistence of size in organic farming.

Uncertain future revenues can play an important role in inhibiting dynamics, particularly for small organic farms that mainly depend on agricultural revenue. Purchasing (or renting) additional land to restore and convert it into organic is a long-term investment decision, whereas these are factors beyond farmers' control which can create uncertainty. The first one is policy support through area based payments for the introduction and maintenance of organic farming. The amount and the subsidies themselves are subject to political objectives and economic decisions taken at different levels, i.e. European, Federal and State levels. Potential changes in policy support, as it occurred in Baden-Württemberg in 2001 and 2007 and in Bayern the in 1998, 2001 and 2007 (NIEBERG et al., 2011: 23/24) gives rise to uncertainty for organic farmers with respect to whether the subsidies will remain stable, decrease, or cease to exist. This uncertainty can discourage some farms to invest in new areas, especially during times of political change. Another source for uncertainty in future revenues is the market; specifically, the issues regarding whether the demand for organic products will keep growing, stagnate or decrease, and whether the prices will remain higher than for conventional products. The potential changes of these two factors are crucial when a small farm considers whether to keep its current farm size or expand its scale of operation.

Finally, area-based payments for conversion and maintenance of organic farms (combined with the direct payments of the common agricultural policy's (CAP) 'first pillar') can also contribute to create per-

Table 4. Transition probability matrix for acreage changes in organic farming, 1993-2005*

Farm Size$_{t-1}$ (ha)	Δ hectares $_t$						
	> - 20 (1)	- 20 to - 10 (2)	- 10 to - 0.5 (3)	0 (4)	0.5 to 10 (5)	10 to 20 (6)	> 20 (7)
< 10	0.0	0.0	9.5	66.7	19.1	4.8	0.0
10 to 20	0.0	0.0	16.5	56.7	26.8	0.0	0.0
20 to 30	0.3	0.0	22.5	41.3	34.1	0.6	1.2
30 to 40	0.0	0.5	21.0	40.7	36.7	1.2	0.0
40 to 50	0.3	0.3	26.3	31.9	38.2	2.0	1.0
> 50	0.4	1.7	26.5	20.7	40.7	7.0	3.0

* Pairwise comparisons by the modified Wald test revealed significant differences between farm size categories. The results of pairwise tests are presented in Appendix 1 for column (4) and Appendix 2 for column (5).

Source: own calculations

sistence for small farms: small organic farms might not leave the organic sector or in general cease farming because they receive subsidies and the price premium, but they neither increase farm size due to the effect of the uncertainty or the capital-market imperfections. Determining whether this happens is beyond the data available; nevertheless it remains a subject for future work.

Table 4 indicates that farms that make use of larger areas of agricultural land have higher probabilities of increasing their revenue for the next period, as the elasticity value for land is 0.18. This result confirms the relevance of land to organic agriculture, considering that the use of larger areas allows organic farms to produce more output and more in-farm organic inputs, such as manure and fodder that otherwise they would have to buy at expensive prices.

Capital positively influences revenue growth, an increment of 1% in capital increases changes in revenue by 0.10%. This outcome can be explained by the positive effect of *capital* on the technical efficiency of German organic farms (TIEDEMANN and LATACZ-LOHMANN, 2011; LAKNER et al., 2012), which allows them to reduce operational costs and thus increase agricultural revenue. *Capital* does not have significant impact on acreage growth. The effect of *labour* on revenue growth rates is positive; 1% increase in labour leads to 0.22% growth in revenue. This outcome is surprising since it was expected that the high costs for labour in the region have a negative impact on revenue growth. However, the growth in revenue is probably large enough to offset the additional labour costs. *Labour, part-time farming* and *farmer's age* have no significant effect on acreage expansion. Interestingly, the signs of the coefficients for age and age squared are consistent with the life cycle pattern found by GALE (1994), WEISS (1999), and JUVANCIC (2006).

As expected, *intensity of livestock production* has a positive effect on revenue growth rates. The elasticity value of livestock intensity on growth of revenue is 0.09; thus this factor increases the revenue of organic farms via gains in productivity and reduction in the average costs of production. The result of the land growth model shows that an increase of 1% in the LU/ha would decrease acreage growth by 0.03%, implying that intensification of livestock production reduces the demand for additional agricultural area. Nonetheless, this finding should be interpreted cautiously, since the variable also captures the reduction of LU/ha when mixed farms increase acreage.

Subsidies for organic farming have a significant and positive effect on growth of agricultural land. This indicates that support payments contribute to offset the lower and irregular yields and additional costs during the conversion period of new farmland. Nevertheless, the magnitude of the elasticity is low (0.02) to create a large impact on acreage growth at regional level. Additionally, the support payments did not have a significant effect on changes of revenue, which indicates that the support provided is well targeted and do not provide additional economic benefits to farmers.

Soil quality (EMZ) has a positive effect on the change in revenue, and no impact on the change in land. The coefficient shows that a 1.0% increase in soil quality is accompanied by a 0.08% higher growth rates in revenue. This could be explained by the positive effect of soil quality on output and technical efficiency in organic farming (TIEDEMANN and LATACZ-LOHMANN, 2013; LAKNER et al., 2012); which reduces the average cost of production, and thus increases revenue growth. Furthermore, farms in favourable soil conditions can more readily adjust their production programme to fit market demands. *Direct marketing* has no significant impact on farm growth, neither measured in revenue nor measured in agricultural land.

Results from previous studies indicate that farm size and survival have a negative relationship. If small-slow-growing farms are less likely to remain in the data set than large farms, over time we observe in the data only those small farms performing well. Thus, an analysis based on incumbent farms alone will be biased, finding that small surviving farms are growing at higher rates than large farms. Nevertheless, this is not the case in the present study; the results of the land growth model show that all organic farms increase acreage in the same amount of land and that large farms change size more frequently than small ones. Moreover, the analysis includes yearly newcomers and dropouts. Furthermore, the VERBREEK and NIJMAN-test failed to find significant differences between dropouts and incumbent farms for the revenue growth model z = 0.46, p-value= 0.64 and the land growth model, z = 1.41, p-value = 0.16. The dummy variable for dropouts with less than 5 years of observations was not significant, z = 0.44, p-value = 0.66 (revenue growth) and z = 1.41, p-value = 0.16 (land growth). Additionally, farmers in the sample are young (43 years old) and all receive support payments, commiting them to maintain organic farming for a minimum of 5 years. Thus, these results do not show evidence for the existence of attrition bias and reinforce the assumption that most dropouts did not cease operations or revert to conventional, but more likely stopped hiring the bookkeeping services. Finally, if bias still exists, it should tend to produce conservative estimates for the revenue growth and even more unfavourable results for land growth of small organic farms.

Finally, it should be borne in mind that the data set is not representative of organic farming in Germany. These results are situation specific and cannot be extrapolated to other regions or countries with different conditions. There are differences across the regions in Germany with respect to farm structure, regional land market, policy support as well as in the demand for organic products. The results of a similar study in other regions of Germany might differ compared to those presented here, depending on the context. For instance, we would expect small differences to e.g. Rheinland-Pfalz or Hessen, differences could be larger in comparison to studies in e.g. Niedersachsen, Schleswig-Holstein and especially to East Germany, where agricultural structures differ widely.

5 Conclusions

We find that most organic farms in southern Germany have changed their farm size during the period of study. The increase in area farmed organically in this region does not only come from conversion of conventional farms, but also from the net growth of the existing organic farms. The evidence clearly shows that acreage expansion occurred in adjustments of less than 10 ha, regardless of farm size. Acreage growth is partly driven by subsidies for organic farming indicating that the political support for organic agriculture has not only fostered the conversion of conventional farms, but also the individual growth of the organic farms in this region. Additionally, the results indicate that organic farms with higher intensity of livestock production have lower demand for additional agricultural area and thus lower growth rates.

It appears that the regional market for agricultural land restricts the increases in area to less than 10 ha for all farm sizes. However, the results indicate that large organic farms cope better with this constraint because they increase farm size more frequently than small ones. This also implies that large organic farms adapt their production scale faster than small ones and have the additional capital to finance the costs for converting new farmland into organic. This study shows that previous findings on land growth from conventional agriculture differ from the case of organic farms in South Germany.

The results of the revenue growth estimation reveal that small organic farms have higher growth rates of revenue than their counterparts. This result is consistent with previous studies from conventional agriculture, which state that average costs of production decrease more rapidly for small farms than for large farms when output increases. Moreover, any improvement in output and reduction in costs has a larger impact in proportional terms in small farms than in large ones. We also found evidence that capital, labour, intensity of livestock production and, soil quality have a significant positive impact on revenue growth in organic farming. This is particularly important for organic farms with restricted possibilities to expand acreage, since they can increase revenue through efficient allocation of the previous factors and improvements in current technology.

Data limitation prevented the consideration of variables such as organic farming practices, certification and conversion costs for additional land and, the comparison with conventional farms. Indeed, agricultural surveys are as yet tailored for prevalent agricultural systems without any regard for organic farming. Data limitation on the specificities of organic farming poses a problem because it restricts research studies which aim to include these aspects on their analysis and consequently it limits our understanding of the farming system. Once this information is documented and made available for researchers, future research should consider the effect of certification and conversion cost of additional land, as well as the differences in growth patterns between conventional and organic farms.

The SGMM estimation provides an appropriate framework to analyse the determinants of growth, but certainly cannot capture all aspects of this process. The SGMM estimation ignores those farms which do not change their size in a given year, because the dependent variable equals zero. This information is crucial to determine why farms persist in a specific farm size category and decide not to grow. Future research should consider this issue for further analysis. Extending this research topic to other regions under different conditions of land market, farm structure, and policy support can shed light on regional differences in the development of organic farming in Germany. Additionally, further research is also needed to understand the effect of uncertainty on investment decisions in the context of organic farming.

References

ALVAREZ A. and C. ARIAS (2003): Diseconomies of Size with Fixed Managerial Ability. In: American Journal of Agricultural Economics 85 (1): 134-42.

ANDERSON, T.W. and C. HSIAO (1981): Estimation of dynamic models with error components. In: Journal of the American Statistical Association 76 (375): 598-606.

ARELLANO, M. and S. BOND (1991): Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. In: Review of Economic Studies 58 (2): 277-297.

ARELLANO, M. and O. BOVER (1995): Another look at the instrumental-variable estimation of error-components models. In: Journal of Econometrics 68 (1): 29-52.

BAKUCS, L.Z. and I. FERTŐ (2009): The growth of family farms in Hungary. In: Agricultural Economics. 40(S): 789-795.

BALMANN, A., M. ODENING, H. WEIKARD and W. BRANDES (1996): Path dependence without increasing returns to scale and network externalities. In: Journal of Economic Behavior and Organization 29 (1): 159-172.

BEST, H. (2008): Organic agriculture and the conventionalization hypothesis: A case study from West Germany. In: Agriculture and Human Values 25 (1): 95-106.

BStELF (Bayerisches Staatsministerium für Ernährung, Landwirtschaft und Forsten) (2012): Bavarian Agricultural Report 2012 (in German). Retrieved May 25, 2015. Bavarian State Ministry for Food, Agriculture and Forestry (BStELF) 2014: http://www.agrarbericht-2012.bayern.de/landwirtschaft-laendliche-entwicklung/pachtverhaeltnisse.html.

BLUNDELL, R. and S. BOND (1998): Initial conditions and moment restrictions in dynamic panel data models. In: Journal of Econometrics 87 (1): 115-143.

BMELF (Bundesministerium für Ernährung, Landwirtschaft und Forsten) (2001): Bookkeeping Results of the Test Farms 1999/2000, addendum to the Agricultural Report of the Federal Government 2001. Berlin.

BMELV (Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz) (2006): Statistical Yearbook on Food. Agriculture and Forestry (in German). Federal Ministry for Food, Agriculture and Consumer Protection (BMELV). NW-Verlag, Bremerhaven.

BÖLW (Bund Ökologische Lebensmittelwirtschaft) (2013): Zahlen - Daten - Fakten: Die Bio-Branche 2013. Berlin..

BOND, S., A. HOEFFLER and J. TEMPLE (2001): GMM estimation of empirical growth models. Discussion Paper No. 2048. Centre for Economic Policy Research (CEPR), London.

CHAVAS, J.P. (2001): Structural change in agricultural production: Economics, technology and policy. In: Handbook of agricultural economics 1 (2001): 263-285.

DEBERTIN, D. (2012): Agricultural Production Economics. Second Edition. Macmillan Publishing Company, New York.

DESTATIS (2009): Income and Labour Costs (in German). Wiesbaden

– (2011): Animal Production on Farms (in German), Agricultural Census 2010, Series 3, Issue 2.1.3. Wiesbaden.

– (2013): Prices for purchasing agricultural land (in German). Wiesbaden.

– (2014): Rental prices for arable land 1999-2013 (in German), database of the Federal Statistical Office Germany. Wiesbaden. URL: https://www.genesis.destatis.de (last accessed 3 November 2014).

DESTATIS BL (2013): Regional Database, Statistical Offices of the German Federal States (DESTATIS BL). Düsseldorf. URL: https://www.regionalstatistik.de/genesis/online/logon (last accessed 8 July 2013).

EU COMMISSION (2010): Agriculture and Rural Development. Agri-environment measures. Retrieved February 1, 2014. URL: http://ec.europa.eu/agriculture/envir/measures/index_en.htm.

GALE, F. (1994): Longitudinal analysis of farm size over the farmer's life cycle. In: Review of Agricultural Economics 16 (1): 113-123.

GARDEBROEK, C., K.N. TURI and J. WIJNANDS (2010): Growth dynamics of dairy processing firms in the European Union. In: Journal of Agricultural Economics 41 (3-4): 285-291.

GIBRAT, R. (1931): Les Inégalités Économiques. Librairie du Recueil Sirey, Paris.

HALL, B.F. and E.P. LEVEEN (1978): Farm size and economic efficiency: The case of California. In: American Journal of Agricultural Economics 60 (4): 589-600.

HALLAM, A. (ed.) (1993): Size, Structure, and the Changing Face of American Agriculture. Westview Press Inc, Boulder, CO.

HESHMATI, A. (2001): On the growth of micro and small firms: Evidence from Sweden. In: Small Business Economics 17 (3) 213-228.

HÜTTEL, S. and A. MARGARIAN (2009): Structural change in the west German agricultural sector. In: Agricultural Economics 40 (Supplement): 759-772.

JOVANOVIC, B. (1982): Selection and the evolution of industry. In: Econometrica 50 (3): 649-670.

JUVANCIC, L. (2006): Determinants of farm survival and growth in Slovenia (1991-2000). Paper presented at the 96th EAAE Seminar Causes and Impacts of Agricultural Structures, Tänikon (Switzerland), January 10-11, 2006.

KIMHI, A. (2000): Is part-time farming really a step in the way out of agriculture? In: American Journal of Agricultural Economics 82 (1): 38-48.

KUHNERT, H., G. BEHRENS, U. HAMM, H. MÜLLER, H. NIEBERG, J. SANDERS and R. STROHM (2013): Ausstiege aus dem ökologischen Landbau: Umfang - Gründe - Handlungsoptionen. Johann Heinrich von Thünen-Institut. Available at http://www.ti.bund.de/fileadmin/dam_uploads/Institute/BW/bw_de/bw_de_downloads/Ausstieg_2013.pdf, (last accessed 3 March 2013).

KUMBHAKAR, S.C. (1993): Short-run returns to scale, farm-size, and economic efficiency. In: The Review of Economics and Statistics75 (2) 336-341.

LAKNER, S. (2010): Effizienzanalyse im ökologischen Landbau - Bestandsaufnahme, empirische Analyse und agrarpolitische Schlussfolgerungen, Ph.D. Thesis. University of Göttingen.

LAKNER, S., S. VON CRAMON-TAUBADEL and B. BRÜMMER (2012): Technical efficiency of organic pasture farming in Germany: The role of location economics and of specific knowledge. In: Renewable Agriculture and Food Systems 27 (3): 228-241.

LANGER, V., P. FREDERIKSEN and J.D. JENSEN (2005): The development of farm size on Danish organic farms-a comment to the conventionalisation debate. International Scientific Conference on Organic Agriculture: Researching Sustainable Systems, Adelaide, Australia.

MUSSHOFF, O. and N. HIRSCHAUER (2008): Adoption of organic farming in Germany and Austria: an integrative dynamic investment perspective. In: Agricultural Economics 39 (1): 135-145.

NELSON, R. and S. WINTER (1982): An Evolutionary Theory of Economic Change. Harvard University Press, Cambridge, MA.

NIEBERG, H., H. KUHNERT and J. SANDERS (2011): Förderung des ökologischen Landbaus in Deutschland - Stand, Entwicklung und internationale Perspektive. 2., überarbeitete und aktualisierte Auflage. Special Issue No. 347. Johann Heinrich von Thünen-Institut, Braunschweig.

NIEBERG, H. and R. STROHM-LÖMPCKE (2001): Promotion of Organic Farming in Germany: Development and Perspectives for the Future. In: German Journal for Agricultural Economics 50 (7): 410-421

OFFERMANN, F. and H. NIEBERG (2000): Economic Performance of Organic Farms in Europe. Organic Farming in Europe: Economics and Policy. University of Hohenheim, Department of Farm Economics, Stuttgart-Hohenheim.

– (2001): Economic Performance of Organic Farms in Selected European Countries: Situation, Development and Determinants (in German). In: German Journal of Agricultural Economics (Agrarwirtschaft) 50 (7): 421-427.

OFFERMANN, F., H. NIEBERG and K. ZANDER (2009): Dependency of organic farms on direct payments in selected EU member states: Today and tomorrow. In: Food Policy 34 (3): 273-279.

PENROSE, E. (1959): The Theory of the Growth of the Firm. Oxford University Press, New York.

POLLAK, R. (1985): A Transaction Cost Approach to Families and Households. In: Journal of Economic Literature 23 (2): 581-608.

RIZOV, M. and E. MATHIJS (2003): Farm survival and growth in transition economies: Theory and empirical evidence from Hungary. In: Post Communist Economies 15 (2): 227-242.

ROODMAN, D. (2003): XTABOND2: Stata Module to Extend xtabond Dynamic Panel Data Estimator. Statistical Software Components. Boston College Department of Economics, Boston.

– (2009a): How to do xtabond2: An introduction to difference and system GMM in Stata. In: Stata Journal 9 (1): 86-136.

– (2009b): A note on the theme of too many instruments. In: Oxford Bulletin of Economics and Statistics 71 (1): 135-158.

SAHM, H., J. SANDERS, H. NIEBERG, G. BEHRENS, H. KUHNERT, R. STROM and U. HAMM (2012): Reversion of organic to conventional agriculture: a review. In: Renewable Agriculture and Food Systems 28 (3): 263-275.

SAHOTA, A. (2014): The global market for organic food and drink. In: Willer, H. and J. Lernoud (eds.): The World of Organic Agriculture. Statistics and Emerging Trends 2014. Ifoam, Bonn: 125-131.

SANDERS, J. (2015): Analyse der wirtschaftlichen Lage ökologisch wirtschaftender Betriebe im Wirtschaftsjahr 2013/14, Report of Thünen-Institute, February 27, 2015, Braunschweig, Germany. Available at: http://www.ti.bund.de/media/institute/bw/Downloads/Bericht_Oeko_WJ1314.pdf (last accessed: 16.06.2015).

SAUER, J. and T. PARK (2009): Organic farming in Scandinavia: Productivity and market exit. In: Ecological Economics 68 (8-9): 2243-2254.

SHAPIRO, D., R.D. BOLLMAN and P. EHRENSAFT (1987): Farm size and growth in Canada. In: American Journal of Agricultural Economics 69 (2): 477-483.

SIEGMUND, K. (2004): Deutscher Bodenmarkt weiter zweigeteilt: Enorme Dynamik in den neuen Länder. In: Sonderheft Bodenmarkt: 4-9. Available at: http://www.bodenmarkt.info/g/BM-Ex/daten/1-3/1-3-1/BM1_Siegmund.pdf (last accessed 5 April 2012).

SIPILÄINEN, T. and A. OUDE LANSINK (2005): Learning in organic farming: An application on Finnish dairy farms.

Paper presented at the 2005 International Congress, Copenhagen (Denmark), European Association of Agricultural Economists, August 23-27, 2005.

STALA (Statistisches Landesamt Baden-Württemberg) (2006): Der Grundstücksmarkt in Baden-Württemberg. In Statistisches Monatsheft Baden-Württemberg 11/2006: 32-36. Available at: http://www.statistik.baden-wuerttemberg.de/veroeffentl/Monatshefte/PDF/Beitrag 06_11_07.pdf.

STOLZE, M. and N. LAMPKIN (2009): Policy for organic farming: Rationale and concepts. In: Food Policy 34 (3): 237-244.

SUMNER, D.A. and J.D. LEIBY (1987): An econometric analysis of the effects of human capital on size and growth among dairy farms. In: American Journal of Agricultural Economics 69 (2): 465-470.

TIEDEMANN, T. and U. LATACZ-LOHMANN (2011): Development of productivity in organic and conventional Agriculture: An empirical analysis. In: German Journal of Agricultural Economics 60 (2): 101-118.

– (2013): Production risk and technical efficiency in organic and conventional agriculture - The case of arable farms in Germany. In: Journal of Agricultural Economics 64 (1):73-96.

UPTON, M. and S. HARWORTH (1987): The growth of farms. In: European Review of Agricultural Economics 14 (4): 351-366.

VERBEEK M. and T.E. NIJMAN (1992): Testing for selectivity bias in panel data models. In: International Economic Review 33 (3): 681-703.

WEISS, C. (1998). Size, growth, and survival in the Upper Austrian farm sector. In: Small Business Economics 10 (4): 305-312.

– (1999): Farm growth and survival: Econometric evidence for individual farms in Upper Austria. In: American Journal of Agricultural Economics 81 (1): 103-116.

ZANDER, K. and U. HAMM (2010): Consumer Attitudes towards Ethical Attributes of Organic Food (in German): In: German Journal for Agricultural Economics 59 (4): 246-257

Contact Author:
DR. THELMA BRENES-MUÑOZ
Georg-August-Universität Göttingen
Department für Agrarökonomie und Rurale Entwicklung
37073 Göttingen, Platz der Göttinger Sieben 5
e-mail: thelma.brenes@agr.uni-goettingen.de

Appendix 1. Modified Wald Tests for pairwise comparisons for holding farm size constant, Table 4, column (4)

Farm size in ha	<10	10 to 20	20 to 30	30 to 40	40 to 50
10 to 20	0.82 (*0.37*)				
20 to 30	5.68 (*0.02*)	10.65 (*0.00*)			
30 to 40	6.03 (*0.01*)	12.34 (*0.00*)	0.03 (*0.87*)		
40 to 50	10.69 (*0.00*)	27.79 (*0.00*)	6.14 (*0.01*)	6.01 (*0.01*)	
>50	19.53 (*0.00*)	74.97 (*0.00*)	44.37 (*0.00*)	49.66 (*0.00*)	13.26 (*0.00*)

p-values in parenthesis
Source: own calculations

Appendix 2. Modified Wald Tests for pairwise comparisons for increasing acreage in 10 ha, Table 4, column (5)

Farm size in ha	<10	10 to 20	20 to 30	30 to 40	40 to 50
10 to 20	0.71 (*0.40*)				
20 to 30	2.84 (*0.09*)	2.85 (*0.09*)			
30 to 40	3.93 (*0.05*)	5.53 (*0.02*)	0.52 (*0.47*)		
40 to 50	4.50 (*0.03*)	6.50 (*0.01*)	1.12 (*0.29*)	0.17 (*0.68*)	
>50	6.10 (*0.01*)	12.52 (*0.00*)	4.26 (*0.04*)	1.82 (*0.18*)	0.58 (*0.45*)

p-values in parenthesis
Source: own calculations