Determinants of economic growth in organic farming: the case of Bavaria and Baden-Wuerttemberg

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Abstract
The organic sector in Germany has experienced a substantial growth since the beginning of the 1990s until today. During this process of expansion, most organic farms have grown in terms of factor endowment, while others have disappeared or reconverted to conventional agriculture. This paper investigates the potential determinants of farms growth in the organic sector. This paper models potential factors that might have an impact on the economic growth of 332 organic farms in Bavaria and Baden-Wuerttemberg. The econometric model was developed based on 'Gibrat's Law', using a fixed effect method (FE). The results suggest that direct marketing and livestock intensity significantly influence farm growth. In addition, less efficient farms grew faster than more efficient ones. This outcome can be explained by the economic pressure on inefficient firms for adaptation during the growth and survival process.

Keywords: farm-growth, Gibrat's law, technical efficiency, direct marketing

1 Introduction

Organic farming in Germany has experienced a substantially increase since the beginning of the 1990s until today. According to BÖLW (2010), Germany registered 951,557 hectares and 21,009 farms managed organically in 2009. More than half of organic farms are located in the Federal States of Bavaria and Baden-Wuerttemberg.

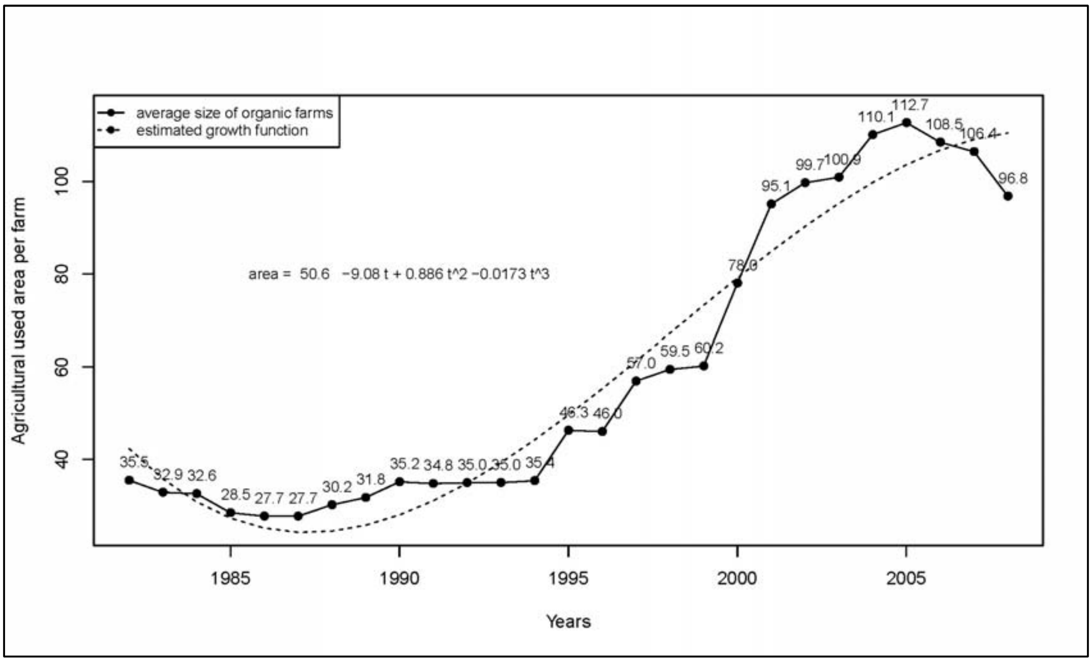

Figure 1 Farm-growth of organic and conventional farms in Germany between 1982 and 2009
Source: Own Calculation, data from the Federal Ministry of Agriculture, diff. Years

During this process of expansion, most of organic farms have also grown in similar patterns than conventional farms. A part of that structural change is also due to conventional farms with a large factor endowment, who converted to the organic farming system.[1] During the last years a share of organic farms have disappeared or reconverted to conventional agriculture; leading to the question why some farms are growing while other are rather disappearing. In this sense, the theory proposed by ROBERT GIBRAT, Gibrat's Law is a good starting point to analyze farm growth within a sector.

The economic growth of firms is determined by external and internal factors (Villatoro and Langemeier, 2006). However, firms can mostly influence on internal aspects, such as farm size, managerial ability and very little on externals, e.g. farm policies. Understanding which factors affect the economic growth of farms, is then a relevant issue for farm managers and policy makers. Our aim here is to give first insights in the potential determinants of farm growth in organic agriculture rather than describing the dynamics of the sector.

The present study examines the determinants of economic growth for 332 organic farms in Bavaria and Baden-Wuerttemberg. The analysis is based on Gibrat's Law

[1] Even if we assume constant factor endowment on the 'original organic farms', the large factor endowment of the newly converting farms lead to an increase in the average farm size in the group of organic farms.

and a fixed-effects estimation model with instrumental variables was carried out in order to obtain our results.

2 Theory of firm growth

Empirical studies on firm growth take a basis the 'Law of Proportionate Effect' or 'Gibrat's Law'. According to the original hypothesis of Gibrat, growth rates of firms follow a stochastic process, where small and large farms have the same probability to grow in any period (Shapiro et al., 1987). Gibrat's Law on its original form can be expressed as:

$$\frac{S_{i,t}}{S_{i,t-1}} = \alpha\, S_{i,t-1}^{\beta-1} u_{i,t} \qquad (1)$$

Where $S_{i,t}$ is size of the firm *i* at time *t*; α is the growth rate, which is common to all firms; $S_{i,t-1}^{\beta-1}$ is the systematic tendency of a firm to be related to its initial size and past history. Thus, β determines the effect of initial size on growth and $u_{i,t}$ is the random effect. The law requires that $\beta = 1$, which implies that growth is independent of size because the systematic component $(S_{i,t-1}^{\beta-1})$ is one for small and large firms. For $\beta > 1$, large firms grow faster than small ones and for $\beta < 1$ vice versa.

Rearranging equation (1) allows estimating the influence of farm size on growth

$$ln\, S_{i,t} - ln\, \mathrm{S}_{\mathrm{i,t-1}} = \alpha + \beta \ln S_{i,t-1} + u_{i,t} \qquad (2),$$

where $S_{i,t}$ is a farm size of *i* at time *t*; α and β are the parameters to be estimated; $u_{\mathrm{i,t}}$ is the random error. Here, Gibrat's Law requires that $\beta = 0$. If β is negative and significantly different from zero, growth is negatively related to size and it is assumed that small farms grow at higher rates.

Evans (1987) proved that the relation between firm size and growth is non-linear. Moreover, he observed the *heteroskedasticity* problem, associated with a greater variation of growth rates among small firms and lower among large. But his main contribution was to notice the *sample selection problem*, meaning that firm growth is observed only on firms which have survived over time. According to Audretsch et al. (1999), as long as the likelihood of survival is independent of firm size, Gibrat's Law would be expected to hold. But if firm size is related to survival, new and small firms would be more likely to exit. Thus, the sample selection problem is inherent to growth but it has a bigger repercussion when researchers only analyze survivors firms.

In this sense, Weiss (1999) proposed the *Heckman procedure* as methodology to estimate growth and control for sample selection. Nowadays, many studies on farm growth follow the methodology proposed by Weiss (1999). However, most of these studies have access to the information on the real exit-rate of farms.

Another important issue of the firm growth theory is that empirical studies may be affected by *endogeneity* bias of initial firm size. So far, most of empirical studies on firm growth ignore this issue and only very few present answers to this problem. Among them, Weiss (1999) and Dolev and Kimhi (2008) proposed to use the lag of firm size as an instrument to control for endogeneity.

2.1 Farm Size

Results of empirical studies on Gibrat's Law are rather contradictory. Bremmer et al. (2002) and Villatoro and Langemeier (2006) did not find statiscal evidence to reject Gibrat's Law. However, Shapiro et al. (1987); Gale (1994); Weiss (1998); Kostov et al. (2005) and Gardebroek et al. (2009), all of them found statistic evidence of differences on growth rates between small and large farms. Nevertheless, the direction of the effect is also mixed. According to Mansfield (1962), these differences are outcome of the different sample types analyzed, methods, and firm size definition.

The importance on the proper measurement of firm size lies on the definition of growth, where growth is defined as a change on firm size. However, there is no widely accepted definition for farm size. According to Hallam (1993) and Weiss (1998), measures of farm size can be classified on two categories, economic size in terms of output or inputs. The most common measure on agriculture is related to inputs, particularly number of hectares or livestock. Nevertheless, Weiss (1998) remarked that inputs quantities cannot fully describe farm size, since farms do not have a linear production function; and changes in size usually involve changes in factor proportions and technology. In terms of outputs, many empirical studies use gross sales. As reported by Hallam (1993), gross sales is the most accepted way of comparing farms within and between industries, when data is corrected for inflation.

Over time, many empirical studies have also pointed that firm growth is also related to other factors, such as managerial aspects, human capital, firm lifecycle, sector specific factors and policy measures (Hallam, 1993). Some of these variables have been included in our model and we discuss them in the next section.

2.2 Others determinants of farm growth

Intensification of *farm production and type of farm* has been used in the literature. According to Bremmer et al. (2002), specialized farms are able to concentrate the management and capital to fewer commodities, accentuating the probability of enlarging production and to be more efficient and profitable. In this sense, Villatoro and Langemeier (2006) found statistical evidence that more intensive farms grew more than *less intensive farms*. Lakner (2009) could show intensive organic farms to be more technical efficient. Therefore intensity might also have an impact on farm growth. On the other hand, growth may behave different depending on the type of specialization. Bremmer et al. (2002) and Villatoro and Langemeier (2006) proved that there are differences on the growth rates according to farm type.

The *managerial capacity of farmers* and *ability to administer* the resources may also play a role on farm growth. According to Dolev and Kimhi (2008), empirical researches on farm growth suffer of omitted variable bias if *technical efficiency* is not included on the model. This study shows that after controlling for technical efficiency, Gibrat's Laws does not hold any more and that technical efficiency has positive and highly significant influence on growth.

Another important factor in the case of Germany is the high level of affiliation to organic *producer associations* among organic farmers. In Germany, 52 % of organic farms are members of any organic organization (BÖLW 2010). Most of these associations have developed their own organic standards, brand names and labels to advertise and trade their products. These farmers associations besides provide technical assistance, facilitate also the marketing of products, thus, probably positively influencing farm-growth.

Financial factors may have also a strong impact over farm growth. Villatoro and Langemeier (2006) showed that farms with relatively lower levels of solvency and relatively higher levels of liquidity grew more rapidly than their counterparts. In contrast, Gardebroek et al. (2009) found that high level of liquidity and leverage have a significant negative impact on dairy processing firm growth. The mixed results of these two factors are explained by their threshold effect, where for example in the case of solvency, decreasing its level allows firms to expand up to some threshold where firms will be more vulnerable to fail (Gardebroek et al., 2009; Langemeier and Jones, 2000).

One of the most relevant theories about the impact of life-cycle on farm growth is the *'learning processes'* in which entrepreneurs evolve by learning and acquiring experience (Jovanovic 1982). As found by Sipilainen and Lansink (2005), organic farming methods are usually unknown for farmers when they switch from conventional to organic farming and they require certain period to gain experience. Thus, it is expected that the conversion status reflects this learning process (Lakner, 2009).

Human capital is commonly represented by factors like farmer's age, gender, education, and off-farm work. Farmer age or firm age are common indicators used also to measure the learning process proposed by Jovanovic (1982). Villatoro and Langemeier (2006) had results in favour of Jovanovic's theory. In contrast to Weiss (1999) and Juvancic (2006) who found that younger farmers had higher growth rates.

Another factor related to human capital is off-farm employment. According to Kimhi (2000) and Weiss (1999), off-farm work can be considered as a first step out of the agriculture, but it can also prevent the cessation of farms by stabilizing household income. Langemeier and Weeden (2006) found that non-farm income had a positive correlation with growth; contrary to Weiss (1999) and Juvancic (2006). Researches do not have a clear result about the effect of education on farm growth. On one hand, it can be inferred that higher education level increases probabilities of farmers to adapt to changing conditions, implying higher growth rates. On the other hand, higher education levels may also provide more opportunities to work outside of the farm, indicating higher probabilities to leave the sector (Weiss, 1999).

Farm growth is also influenced by external factors such as *public policies*. Organic farms in Germany are characterized by a high dependency of policy support, particularly in the case of dairy and arable farm in the Southern region (Offermann et al., 2009). Subsidies may prevent farms from cessation; this was demonstrated by Glauben et al. (2006). Nevertheless, a high dependency on subsidies may also lead to a poor capacity of adapt to changes or react to new market requirements.

Offermann and Nieberg (2000) found that *marketing channels* have influence on the profitability of organic farms. The products prices change depending on the channel. Prices in direct marketing sometimes reach twice those prices obtained from wholesales. However, the importance of the marketing channel varies depending on the product.

3 Methods

Based on the literature review and the characteristics of the data, the model specification is a regression of farm growth (*G*) on farm size from the previous year (Y_{t-1}), its square and a set of additional explanatory variables (*X*):

$$G_t = \alpha_1 \ln Y_{t-1} + \alpha_2 (\ln Y_{t-1})^2 + \beta X_{t-1} + u_t \quad (3)$$

Growth (*G*) was calculated as the first difference of log farm size (*Y*):

$$G_t = \ln Y_t - \ln Y_{t-1} \quad (4)$$

Farm size *Y* was measured using the total revenue from agriculture, since it was considered the variable that better represents the process of economic growth for our group of farms. The set of additional explanatory variables *X* are explained in Table 1.

Table 1: Definition of additional explanatory variables for the growth model estimation

Variable	Units	Definition
Share of Grassland	%	**Share of grasslands** from the total farm land
Livestock intensity	GVE*/ha	'**Grossvieheinheiten**' is a measure for animal units, which are defined by the German building legislation ('Baugsetzbuch').
Technical efficiency	Index	**Technical efficiency scores**, which were estimated by stochastic frontier (see below); 0 < TE <1
Association costs	€	**Expenses made for associations,** in most cases to the general farmers association and to the organic producer organization.
Debt to assets ratio	%	**Total farm debts** as a proportion of the total farm assets
Invert current ratio	Index	**Current liabilities** as a proportion of the current assets.
Economic advisory	€	**Expenses for economic advisory services**. They may also include the expenses from technical advisory.
Conversion status	0/1	**Dummy for conversion status** of the farm; STATUS = 1, if the farm is fully converted; STATUS = 0, if otherwise
Age	years	Farm operator age in years.
Part-time farming	0/1	D**ummy for off-farm employment**; PT = 0 if operator is full time farmer; PT = 1 if the farmer has a part-time job.
Education	-	The reference group is farmers without any agricultural education.
	0/1	Dummy for **apprenticeship in agriculture**; APP = 1; if the farmer has an apprenticeship; APP = 0;otherwise
	0/1	Dummy for **practical master in agriculture** MASTER = 1; if the farmer has an practical master; MASTER = 0; otherwise.
	0/1	Dummy for **university degree in agriculture**, UNI = 1; if the farmer has a university degree; UNI = 0; otherwise
Subsidies	€	Agri-environmental payments for organic farming.
Farm shop	0/1	Dummy **for farm shop**, FSHOP = 1 if the farms has its own farm shop; FSHOP = 0; otherwise.
Vector for years	Years	Vector of ten years dummies.

*: GVE = Grossvieheinheiten, i.e. Animal Units

The *technical efficiency data* for each farm was estimated using *Stochastic Frontier Analysis* (see e.g. Coelli et al., 2005). For this study, the stochastic frontier production function model was specified in a translog-form such as:

$$\ln Y_{it} = \beta_0 + \sum_{j}^{5} \beta_j \ln X_{jit} + \beta_t t + 0.5 \sum_{j=1}^{5} \sum_{k=1}^{5} \beta_{jk} \ln X_{jit} \ln X_{kit} + 0.5 \beta_t t^2 + \sum_{j=1}^{5} \beta_j \ln X_{jit} t + v_{it} - u_{it} \quad (5)$$

Where, y_{it} is the total revenue from agriculture and j = the five inputs used:

x_1 = agricultural material costs.

x_2 =other operating expenses.

x_3 = capital, estimated as annual depreciation.

x_4 =labor, measured as total labor in agricultural working units per year.

x_5 = land, measured as utilized agricultural area in hectares.

There are different assumptions with respect to the distributions of u_i (see Kumbakhar and Lovell, 2000, p. 90). In our estimation u_{it} was assumed to have a truncated normal distribution, $u_{it} \sim idd\ N^+ (\mu, \sigma^2_u)$. The efficiency scores are between 0 and 1 and represent the technical efficiency of a farm estimated by the model. We used these estimated scores as explanatory variable for farm growth.

For the estimation of the econometric *growth model* we used the fixed effect method (FE) for panel data. The advantage of FE lies on the assumption of an unobserved firm effect, a_i, which captures all time constant and unobserved factors that affect each i and is correlated with the explanatory variables. The objective of the FE is to remove the unobserved effects, eliminating for example unmeasured constant factors or measurements errors. For removing this factor, the FE estimation demeans the data for each i as follows:

$$\bar{y}_i - y_i = \beta_1(x_{it2} - \bar{x}_{i1}) + \cdots + \beta_k(x_{itk} - \bar{x}_{ik}) + a_i - a_i + u_{it} - \bar{u}_i,\ t = 1, 2, \ldots T. \quad (6)$$

The specification of model includes one dummy variable for each year to capture time events common to all farms. The Wooldridge test for serial correlation in panel data models was used to test for autoregressive model of order one, AR(1).

To test if the variance of the idiosyncratic errors is constant, Greene (2007) proposed the modified Wald statistic, which is robust when the assumption of error normality is violated. This method examines for the group wise heteroscedasticity in the residuals of a fixed effect regression model. Moreover, due to the definition of farm growth, endogeneity of initial farm size was also tested.

The Wooldridge Test for serial correlation demonstrated presence of serial correlation; while the modified Wald Test for heteroscedasticity indicated heteroscedasticity in the sample. Moreover, we found statistical evidence for endogeneity of initial farm size and farm size squared.

Consequently, for the final estimation we used a fixed effects model with instrumental variables and cluster robust standard errors in order to control for serial correlation, heteroscedasticity and endogeneity, obtaining this way unbiased and consistent coefficients.

4 Data

The data is an unbalanced panel data of 332 farms from Bavaria and Baden-Wuerttemberg, with observation over 12 years (1993/1994 to 2004/2005). The information is bookkeeping data provided by Land Data GmbH.

Due to the characteristics of the data, it was not possible to track entry and exit of farm. On other hand, few small farms (less than 10 hectares) are present in the dataset, meaning that the panel data is rather a representation of single farms, which hire external services of bookkeeping companies. Very large farms are slightly underrepresented in the sample. However, the group of single farms has a strong relevance for the organic market. All monetary variables are expressed in real terms, using 2000 as the base year we used the standard agricultural price indices from the federal statistical office (e.g. Destatis 2006)

5 Results

The results for the model are presented on Table 2. The number of observations for the final econometric model was reduced to 1,760, because of the application of instrumental for farm size and farm size squared with the lagged values.

Table 2: Results of the FE estimation for economic farm growth
source: own calculations

Variables	Farm Growth	
	Coefficients	**Cluster Robust Std. err.**
Ln Farm Size	-57.95	210.2
$(\text{Ln Farm Size})^2$	1.41	9.4
Share of grasslands areas	0.28	0.2
Livestock intensity	11.63	3.1 ***
Technical efficiency	-116.02	29.49 ***
Association costs	-0.003	0.003
Solvency	-0.16	0.1
Liquidity	0.01	0.01
Economic advisory	-0.01	0.002 ***
Dummy for conversion status	-2.66	5.1
Age	-0.06	0.2
Dummy for part-time farms	-7.80	11.5
Dummy apprenticeship	-10.85	7.8
Dummy practical master	-8.71	9.4
Dummy university degree	7.62	9.8
Payed subsidies	0.00004	0.0003
Dummy farm shop	17.38	5.5 ***
Observations	1,760.00	
F-statistic	21.41	
R-squared	41.06	

Note: Standard deviation in parentheses; asterisks denote significance at ***1% level of significance
Source: owns calculations

The model for economic growth of organic farms was statistically significant with a $p < 0.001$. The R-squared of 40 % indicates that the econometric model does not explain a large proportion of the variance. Other determinants, such as product prices, farmer's attachment to organic farming as well as farmer's attitude toward risk may also play a role on the unexplained variation.

According with the results presented in Table 2, livestock intensity and farm shop are statistically significant and positively related with the economic growth of organic farms; while technical efficiency and costs of economic advisory have a negative effect. The other variables in the model did not have impact a statistic on growth.

The result of farm size is unexpected since is not statistic significant. However, there is wide empirical evidence that growth rates tend to decrease systematically with the increase of firm size. Moreover, these studies affirm that Gibrat's Law tends to hold when small firms are excluded from the analysis (Mansfield, 1962; Evans, 1987; Sutton, 1997; Fariñas and Moreno, 2000; Audretsch et al., 2002).

Livestock intensity has a positive impact on growth; where an increase of 0.1 LU/ha increases growth rate by 116.3 percentage points. However, the average of livestock intensity in the sample is 1.08 LU/ha and the stocking density for organic farming is limited at 2.0 LU/ha. Then, experiencing a substantially increase in growth based on the intensification of livestock production is unlikely, due to the restriction in the stocking densities.

Contrary to what we expected, the coefficient of *technical efficiency* is negative. The result implies that less efficient farms are adapting and growing faster than more efficient farms. According to the results, an increase on technical efficiency of 1 percentage point, holding all other factors fixed, decreases the growth rates by 1.16 percentage points. This result can be directly related the issues of an 'optimal size' of production, where small farms may adjust and grow up to reach the optimal size of production, while those farms above the optimal size grow at lower rates.

The *costs of economic advisory services* exhibited a negative and highly significant coefficient. However, the result has little economic relevance since an increase of one Euro on economic advisory would decrease growth rates by 0.01 percentage points.

The dummy variable for the presence of an *on-farm shop* has a positive and economically significant influence on growth. Holdings with an on-farm shop grew, on average, 17 percentage points more than those holdings without a shop. This outcome is in line with Recke et al. (2004) and Nieberg and Offermann (2008), who found that more successful farms were more involved in direct marketing. A previous study of these authors, Offermann and Nieberg (2000), pointed out that, in the organic sector product prices from direct marketing can double those received from the wholesalers. On the other hand the share of direct-marketing in the organic market has been decrasing since 2002 (Rippin and Hamm 2007), which can also be seen in the sample (see **Figure 2**).

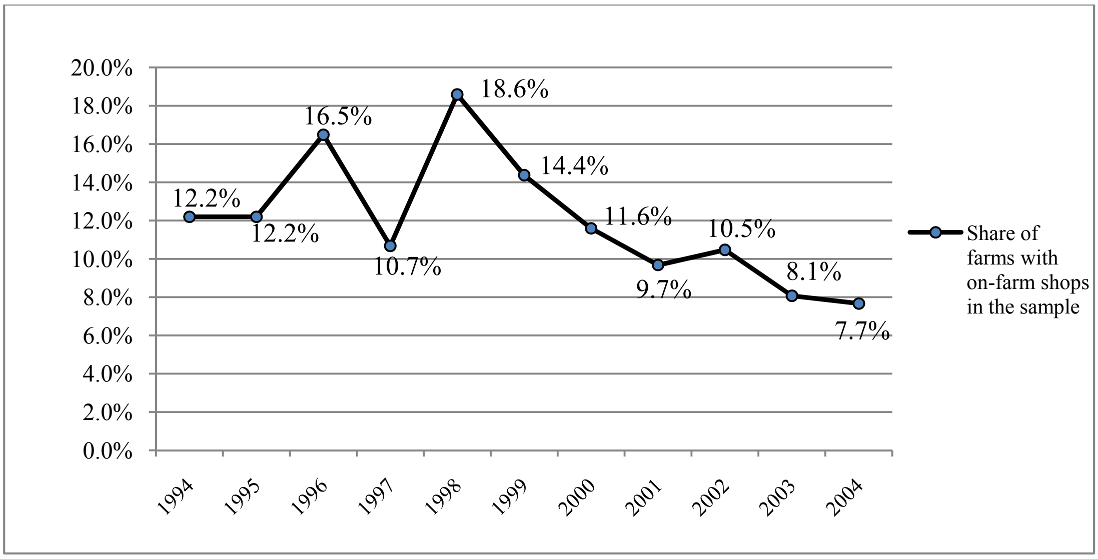

Figure 2: Share of farms with on-farm shops in the sample 1994-2004
__source:__ own calculations

This can be consequence of the higher participation of conventional supermarkets and large retail outlets in the distribution of organic products in Germany, and due to a professionalization trend on the farms, since a lot of farmers intensify or skip their direct-marketing over time. Therefore direct-marketing might only contribute to a substantial farm growth, if the farmer (and his or her family) concentrates activities in that field.

6 Conclusions

Economic growth of organic farms in Bavaria and Baden-Württemberg is highly influenced by market involvement of the farms. Particularly, direct marketing through selling organic products in on-farm shops opened the opportunity for farms to increase the growth rates of total revenues, which is especially true for organic farms, since organic farms are highly involved in direct marketing (Recke et al., 2004). For future studies, it is important to consider other market-related variables such as product prices and other marketing channels.

Other factors such as livestock intensity and costs of economic advisory also showed statistical significance. However, the practical importance of these two factors is more limited since the economic impact on growth due to the model is rather small. Further research might take a more detailed look at the relation between growth and technical efficiency, e.g., by considering the relationship between farm growth and the ‘optimal size’ of farms, jointly with the effect of economies of scale on growth.

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