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Determinants of Spatial Distribution of Organic Farming in Germany

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Abstract

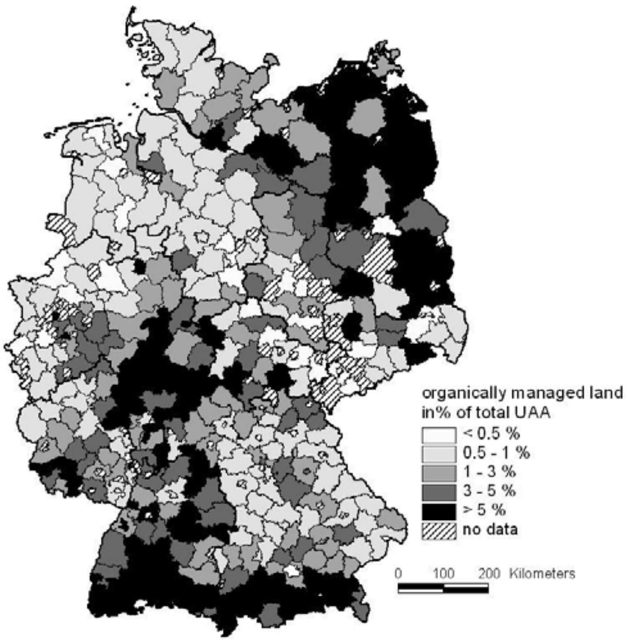
The share of organically managed land is spread unevenly throughout Germany and shows pronounced regional concentrations. The spatial distribution of organic farming is assumed to be influenced by several factors. Location factors of farms are regionally different and thus may influence the spatial distribution of organic farming. Agglomeration effects and therefore spatial dependence are also considered important in determining spatial distribution.

These factors with a potential influence on the spatial distribution of organic farming can be divided into four categories: natural factors, farm-structure factors, socio-economic factors and political factors. Their possible influence on the spatial distribution of organic farming is analysed by several statistical methods: ordinary least square regression model, spatial autoregressive models, analysis of variance and Spearman correlation. Of the analysed factors, spatial contiguity has the strongest influence on the spatial distribution of organic farming (indicating relevant agglomeration effects).

Introduction/Problem

The spatial distribution of organically managed land throughout Germany shows remarkable differences (see Figure 1). However, often contiguous regions with a similar share of organically managed land are observed.

Figure 1: Spatial distribution of organic farming in Germany (in 2001)



Source: own calculations based on Statistische Landesämter (2004)

Factors with a possible influence on the spatial distribution of organic farming can be subdivided into the following groups:

- *Natural factors* describing land use patterns (i.e. soil quality),
- *Farm-structure factors*, like the share of grassland, affecting - besides the natural conditions - the production pattern within a region.

- *Socio-economic factors* describing aspects related to consumers, processors and the proximity of farms to markets and agglomeration effects. Furthermore, socio-economic factors cover the population structure (i.e. income, population density).
- *Political factors* describing the political framework within which the farmers act; e.g. the different levels of subsidizing organic farming in different Federal States and the incidences of protection areas, like water- and nature protection areas.

However, the focus of this paper lies on the supposed relevance of agglomeration effects. A study for the German Federal State Hessen indicates the importance of agglomerations of organic farming (Hermanowski 1989). Additionally, in South-West Germany the relatively high share of organic farming has been explained by the proximity to Switzerland, which has been considered as the “most important innovation centre for organic farming” (Sick 1985).

On the one hand, the relevance of proximity, which finally allows for agglomeration effects, lies in the diffusion of innovations. For example, already organically producing farmers in a region offer the possibility to non-organic farmers to observe the successful organic practices and feel reassured that organic systems are feasible in their locale (Lohr and Salomonsson 2000). Furthermore, Latacz-Lohmann et al. (2001) consider positive network-externalities important for the agglomeration of organic farms.

Methodology

Based on the literature, several hypotheses are developed to test the influence of the factors mentioned above on the spatial distribution of organic farming. The statistical methods used are: (a) spatial autoregressive models, (b) ordinary least square regression model (OLS), (c) analysis of variance and (d) Spearman correlation analysis.

(a) To asses the influence of proximity (as a possible indication of agglomeration effects), two different autoregressive models are used: the First-Order Autoregressive Model (FAR) and the Mixed Autoregressive Model (SAR) (Le Sage 1999). The FAR-Model attempts to explain the variation in the share of organically managed land as a linear combination of the corresponding shares of the neighbouring regions without any other explanatory variables. As a result, the estimated parameter indicates to which extent proximate regions are influenced by each other. The FAR-Model has got the form $y = \rho Cy + \varepsilon$. The vector y is a logarithm of the deviations from the mean of the dependent variable (share of organically managed land in %). C is a spatial weight matrix, ρ is the scalar spatial lag coefficient that accounts for the impact of the share of organically managed land (%) in neighbouring regions and ε is the vector of normally distributed error terms (Le Sage 1999).The second model, the SAR model, includes further explanatory variables in the model to examine the influence of location factors (like share of grassland, soil quality, etc.) on the spatial distribution of organic farming. It has the form: $y = \rho Cy + X\beta + \varepsilon$, where, now, y is a vector of the logarithm of the share of organically managed land, x is a design matrix accounting for further independent variables and β is the parameter vector of independent variables to be estimated (Le Sage 1999). The results are an estimated parameter ρ for the influence of proximate regions, as well as estimated parameters for the other independent variables tested. The estimated parameters have to be interpreted similar to those of OLS-Models.

(c) For the influence of the spatial proximity to processors of organic food, the analysis of variance is used. Therefore, around the location of organic processors (mills and dairies) a determined circumference of 20 km (dairies) and 40 km (mills) has been drawn. Every region, which lies within this circle, is considered as “close” to mills or dairies. All other regions are considered as “distant”.

(d) The Spearman correlation is used to analyse possible determinants of the spatial distribution of organic farming, which cannot be tested by OLS or the autoregressive models. This is the case for, e.g. the influence of different farm types (multicollinearity with other factors), and for land use of agricultural area, e.g. share of cereals or pulses (normal distribution of variables could not be obtained, even after different transformations).

For the statistical analysis agricultural and economical data obtained from the agricultural farm census in Germany in 1999 (e.g. Statistische Ämter des Bundes und der Länder 2001) and other sources on NUTS[1] 3 level are used.

Results and brief discussion

In the following, only the most significant determinants of the spatial distribution of organic farming are discussed. Parts of the results of the analysis, using methods (a) and (b), are presented in Table 1.

Table 1: Results of ordinary least square regression and of the spatial autoregressive models

	Germany		
Determinants	**OLS**	**SAR**	**FAR**
Natural factors			
Soil quality (Bodenklimazahl)	-0.03***	-0.015***	
Farm-structure factors			
Share of grassland (in %)	n.s.	n.s.	
Farm size (ha)	0.001 n.s.	n.s.	
Socio-economic factors			
Income (1000€ per head and year)	n.s.	n.s.	
Population density (per km^2)	n.s.	n.s.	
Spatial dependence (indicator ρ)		0.51***	0.63***
Political factors			
Support levels for organic and conventional agriculture			
• Comparison of theoretical payment level (in €)	-0.009***	-0.005***	
• Differences of payment levels arable land (€/ha)	n.s.	n.s.	
• Differences of payment levels grassland (€/ha)	0.008***	0.004***	
Nature conservation area (in %)	0.07***	0.04**	
Water protection area (in %)	0.01***	0.009*	
adj. R^2	0.23	0.26	0.37

level of significance 10%, ** level of significance 5%, *** level of significance 1%, n.s. not significant.
Used Software: MATLAB from The MathWorks; Syntax for calculation the spatial autoregressive models from Le Sage (1999).

Source: Bichler & Häring (2004)

The relationship between the *natural factor* 'soil quality' and the share of organically managed land is significantly negative.

An example for the influence of *farm-structure factors* is the positive relationship between 'farm size' and the share of organically managed land within a region. According to the statistical models used here, the share of grassland has no significant influence on the spatial distribution of organic farming.

The *socio-economic factor* 'spatial dependence' seems to have a relevant influence on the spatial distribution of organic farming (SAR ρ = 0.51***, FAR ρ = 0.63***). In the latter case, the coefficient ρ, as an indicator for the existence of agglomeration effects between regions, has to be interpreted in the following way: if the geometrical mean of the share of organically managed land in the neighbouring distincts increases by 1% the share of organically managed land within the considered region will rise at 0.63%.

Comparing the regression coefficient ρ in FAR with the correspondent coefficient in SAR, it emerges that ρ is smaller in the SAR model. This can be traced back to the fact that in the SAR model several other factors are considered. In conclusion, neighbouring regions have a strong influence on each other regarding the share of organically managed land.

[1] Nomenclature of Territorial Units for Statistics (in the European Union)

The other *socio-economic factors* ‘population density’ and ‘income per head’ are not significant. Within the category *political factors*, the different indicators for the ‘level of support’ for organic farming are tested. The positive influence of the support level for organically managed grassland on the share of organically managed land area has to be mentioned. Also tested within this category is the relation between protected areas and the share of organically managed land. This relation is also positive.

The coefficient of determination (R^2) for the FAR Model is 0.37, for SAR 0.26 and for OLS 0.23. This shows that part of the spatial distribution of organically managed land can be explained by the used independent variables.

Due to methodological constraints, e.g. precondition of normal distribution, several factors could not be tested with the multivariate models. In these cases, the methods (c) and (d) are used. (c) The factor ‘proximity to organic processors’, e.g. organic dairies, has been tested with the analysis of variance. As a result, the ‘proximity of dairies’ has a positive influence on the share of organically managed land. On the contrary, this cannot be confirmed for organic mills. (d) The influence of the factor ‘farm type’ and ‘agricultural land use’ is tested with the Spearman correlation. Regarding farm types, the strongest positive influence on the share of organic farming has the share of commercial farms (0.14**) and the share of permanent crop farms (0.22***) within a region. For the share of agricultural land use, the positive influence of the share of set-aside area (0.24***) on the spatial distribution of organic farming has to be mentioned.

Conclusions

The aim of this analysis is to investigate the influence of several factors on the spatial distribution of organic farming. The most important result is the highly significant influence of spatial dependence on the distribution of organically managed land, suggesting the existence of relevant agglomeration effects. Thus, if organic farming shall be supported politically, the results of this analysis can give an indication for accounting agricultural subsidies. Supporting of networking, information transformation and communication among the actors are promising means to increase the share of organic farming.

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