Efficiency Cluster in Organic Grassland Farming in Germany
– Methodological and Practical Implications

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Efficiency Cluster in Organic Grassland Farming in Germany
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Abstract: This paper investigates regional cluster of organic grassland farms with respect to technical efficiency. The data-base consists of organic grassland and mixed farms in Germany from 1994/95 to 2005/06. In a first step five inputs and one output are analyzed by means of a stochastic frontier production function, allowing for heteroscedasticity and technical effects. The selection of determinants of technical efficiency is based on location theory. Since organic farming has regional centers, technical efficiency (TE) of organic farms is found to be affected by regional variables (such as agglomeration effects). In a second step we identified regional clusters of organic farms and analyzed the technical efficiency of the regional clusters. The results show that organic farms in distinct regions show different efficiency performance - suggesting that there are agglomeration and urbanization effects in the organic market.

Keywords: Efficiency, Agglomeration Effects, Organic Farming

I. INTRODUCTION & BACKGROUND

Organic farming has developed from different centres: The Demeter movement, inspired by the works of Rudolf Steiner in 1924, has his roots in East Germany, being cut after 1945. The Bioland-producer association was founded in southern Germany and Switzerland going back on the work of Hans Müller and Hans-Peter Rusch. During the 1970s and 1980s the organic farms could mainly develop in the environments of university towns and big cities, where consumers were willing to pay the high prices for organic food. On the EU-Level the EU-regulation EU-VO 2092/91 set the rules for organic farming and gave a definition for organic farming. Therefore it was possible to convert to organic farming just according the EU-rules (the so called ‘EU-Bio’ in contrast to the organic farms who were member of a farming association).

Fig. 1: History of organic farming in Germany
Source: own elaboration; see also VOGT 2000, p.19

After the MacSharry Reform of 1992 payments for organic farming were introduced on the EU-Level. A lot of East German farms converted to organic farming finally resulting in a very high share of organic farming in North-Eastern Germany. The role of regional networks and learning groups for the farms converting to organic farming are described in many sources (Vogt 2000, Padel 2001a, 2001b). There seems to be evidence, that not only the classical location-factors (such as resource availability in a location) should play a role for the production function of a single organic farm but also the influence of the neighbouring farms and the socio-economic environment supporting organic farms. The objective of this paper is to show the influence of agglomeration and the socio-economic environment on the single farm production frontier.

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farming in Germany based on data from 1994/95 to 2005/06 including regional variables into the typical set of variables. Five inputs and one output are analysed by means of a stochastic frontier production function, including the ‘heteroscedasticity’- (Jondrow et al. 1982) and the ‘technical effects-model’ (Battese & Coelli 1995). The selection of determinants of technical efficiency consists of five groups of indicators, which are 1) farm structure and resources, 2) human capital and management capacities, 3) institutional choice and 4) subsidies. An additional group of regional determinants (5) is added to the typical set of variables in the technical effects model. Using the result of the stochastic frontier analysis we performed a cluster analysis to show regional differences between different efficiency clusters.

The variables of the production frontier and the technical effects model are derived from accounting data of organic farms. Location information is available for each farm in the UTM-Format. We used dummies for the four regions in Germany. The concentration for organic farms on the county level is introduced as an indicator for primary agglomeration and the distance to the next organic dairy for secondary agglomeration. Both reflect the theoretical concepts of regional economics. The election results for the Green Party are used to measure the support of a certain socio-economic environment, which might have a positive impact on technical efficiency. This variable goes back to the experience, that organic consumers are willing to support the single organic farms especially in the initial phase of a conversion. Therefore the support of a certain socio-economic environment should exert a positive impact on the single farm’s efficiency.

In the next paragraph II the background-literature is cited to reflect the state of empirical knowledge, paragraph III describes the methods and data, which are used in this study. In paragraph IV the results are discussed and the paragraph V some conclusions are drawn.

II. BACKGROUND

An extensive literature deals with the determinants of technical efficiency in farming in general (e.g. Battese & Coelli 1995; Brümmer & Loy 2000; Balmann & Czasch 2001; Curtiss 2002; Davidova & Latruffe 2007; Kumbhakar et al. 2009). This literature has identified the following four categories of determinants of technical efficiency:

1) farm structure and available natural resources;
2) management capacities and human capital;
3) institutional choice (legal form, tax-options);
4) market orientation and policy support.

Several studies investigate the technical efficiency of organic farms specifically (Oude Lansink et al. 2002; Tzouvelekas et al. 2001; Sipilainen and Oude Lansink 2005; Gubi 2006; Lohr and Park 2006; Francksen et al., 2007; Kumbhakar et al. 2009). The development of technical efficiency during the conversion period from conventional to organic farming is addressed in some of these studies. Lohr and Park (2006) analyse the technical efficiency of organic farms in the USA. The influence of the farm manager’s experience is studied by splitting the sample into farms with more than five years of experience in organic farming, and farms with less than five years. The authors find that efficiency grows with years of experience in organic production. Sipilainen and Oude Lansink (2005) study dairy farms in conversion in Finland and find that the learning process following the decision to convert to organic farming takes about 6-7 years.

Initial studies of the location of organic farming in the 1980s and 1990s hypothesised that organic farms would cluster in the neighbourhoods of cities with high population densities and therefore a high potential for direct marketing (e.g. Schulze-Pals 1994: 25-28). After the introduction of per-hectare payments for organic farming by EU-regulation 2078/92 in 1993, many farms converted in parts of East Germany where agro-climatic conditions are less favourable (Schulze-Pals 1994). One determinant of the spatial distribution of organic farming might therefore be lower opportunity costs due to less profitable conditions for conventional farming.

Bichler et al. (2005) were the first to empirically model the determinants of the spatial distribution of organic farming in Germany. They confirm that there is a high concentration of organic farms in German regions with less favourable soil quality (see Figure 1). They also find a higher prevalence of organic farming
in regions in which the difference between the subsidies provided for organic and for conventional grassland is large, and in regions in which greater shares of land have been designated as water protection or nature conservation areas. In some West German regions, local per capita income and farm size are also found to have a positive influence on the share of organic farms. Finally, Bichler et al. (2005) confirm that the spatial distribution of organic farms is influenced by the proximity to big cities with high population densities.

A number of studies have analysed the role of information spillovers on the spatial distribution of organic farming. Burton et al. (1999) find that farmers in the UK who are converting from conventional to organic production receive most of their information from other organic farmers in the same region. Gerber et al. (1996) for Germany and Padel (2001a and 2001b) for Wales confirm that neighbouring organic farmers are the main source of information for converting and converted organic farms. Ilbery et al. (1999) find that among other things regional networks of farmers and support groups encourage the regional concentration of organic farms in Wales and England. The importance of information exchange between farmers is probably greater for organic than for conventional farming, because until recently there were relatively few specialized extension and education/training services for organic farmers. Therefore, most knowledge and information had to be generated by organic farmers themselves and was disseminated via local working groups (Gerber et al. 1996). Where specialized extension services exist, they have been found to have a positive impact on organic conversion rates (Frederiksen & Langer, 2004).

If information spillovers between organic farms are important, it is reasonable to expect that location will have an impact on farm-level efficiency. However, we are aware of no studies on the impact of location on the efficiency of organic farms. The impact of location on efficiency has been studied in other agricultural contexts. For example, Tveteras & Battese (2006) show that a high regional concentration of aquaculture farms in Norway is associated with lower output but higher efficiency. Jaenicke et al. (2009) show that total sales per employee increase with the number of organic processors and traders located in a county in the United States. Larue and Latruffe (2008) find that regional concentration, distance to the nearest slaughterhouse, and the population density in neighbouring regions influence the technical efficiency of pig farms in Western France. Nivievskiy (2009) finds evidence of spatial efficiency clusters in Ukrainian dairy farming, with proximity to other efficient farms and to dairy processors exercising a positive effect on efficiency and total factor productivity.

Based on this review of the literature, we propose to consider – in addition to the four ‘traditional’ categories of factors that influence efficiency mentioned above – variables that account for location effects. First, a large share of organic farmers in a region might create external advantages that are referred to as localisation economies in location theory (Krugman, 1991). Localisation economies arise when many firms from the same industry locate in a region.

\[1\] This is generally true for the Western European countries that we have studied, and certainly for Germany.
They include access to pooled markets for skilled labour, the regional emergence of firms that provide specific intermediate inputs, and ease of communication leading to technological spillovers. All of these factors are expected to have a positive impact on technical efficiency as the number of organic farmers in a region increases.

Second, the efficiency of organic farming might also benefit from urbanisation economies (Maier & Tödtling 1995). Urbanisation economies are the effects on a firm’s economic performance that arise from regional economic activity in other sectors. At first glance it may seem incongruous to discuss urbanisation in connection with a distinctly rural activity such as organic farming. However, in a densely populated and comparatively decentralised country such as Germany, rural and urban areas lie close together and are strongly interlinked. It is reasonable to expect that organic farms will perform better in regions that are characterised by a local communities that are sensitive to environmental concerns and willing to pay higher prices for organic products. Such regions will provide sufficient demand to sustain direct marketing, specialised retail outlets such as organic farmers’ markets and restaurants that specialise in organic food, and service providers that cater to the needs and preferences of organic farmers (e.g. a Waldorf school for children). We capture urbanisation effects with two variables. Since we are studying organic grassland farms, we use a farm’s distance from the nearest organic dairy processor as an indicator of local demand conditions. In addition, we use the local election results of the Green Party as a measure of overall local level of acceptance for organic farming. The Green Party in Germany has traditionally championed environmental issues and organic farming, and most organic farmers and their supporters come from a socio-economic background that is associated with support for the Green Party (see e.g. Gerber et al. 1996).

III. METHODS AND DATA

The framework of Stochastic Frontier Analysis (SFA), defines the frontier of output given inputs as ‘best practice’. Dating back to AIGNER et al. (1977), SFA allows estimating firm-specific technical efficiency conditional on the specification of a production function and distributional assumptions for the composed error term. A model might be compactly written as:

\[ y_{it} = f(x_{jit}; \beta) \ast \exp\{w_{it}\} \quad \text{with} \quad w_{it} = v_{it} - u_{it} \quad (1) \]

\[ y_{it} = f(x_{jit}; \beta) \ast \exp\{v_{it} - u_{it}\} \quad (2) \]

where output \( y_{it} \) is the sum of agricultural turnover and \( j = 5 \) inputs of

- \( x_1 \): agricultural material costs,
- \( x_2 \): other operating expenses\(^2\)
- \( x_3 \): capital, measured as annual depreciation
- \( x_4 \): labour, measured by total labour in agricultural working units per year and
- \( x_5 \): land, measured by utilised agricultural area in hectares.

The functional form specification \( f(\cdot) \) should be sufficiently flexible in order to avoid confounding technical inefficiency with miss-specification. The translog functional form is used as a starting point. \( \beta \) denotes the vector of coefficients for the translog specification. The error \( w_{it} \) has two components:

The first error term \( v_{it} \) depicts stochastic effects which are not under the control of the farmer, such as weather, luck or unforeseen events. It is assumed to be identically and independently normal distributed: \( v_{it} \sim iid \ N(0, \sigma_v^2) \). The second error term, \( u_{it} \) captures the effects of farm-specific inefficiency; this is a one-sided error term which is non-negative. Using the assumption of a truncated normal distribution for this term provides several advantages, since it allows for a straightforward incorporation of determinants of technical efficiency via the mode of the distribution (Kumbhakar & Lovell 2000, p. 90), \( \mu \), and for heteroscedasticity by using the scaling parameter \( \sigma_u \).

Therefore we used a truncated normal distribution

\(^1\) ‘Other operating expenses’ is a mixture of rather fixed costs, that are mainly costs from buildings, machinery, insurance.
such that \( u_i \sim iid N^+ (\mu, \sigma_u^2) \). Note that \( \sigma_u^2 \) is in this case not equal to the variance of the one-sided error.

The model framework includes also an inclination to model heteroscedasticity. Here we model the effect of a non-constant error- or inefficiency term. To model the determinants we used the so called ‘technical effects model’ presented by BATTESSE & COELLI 1995. This approach models the mode of the truncated normal distribution as dependent variable using a set of independent determinants \( Z_{it} \):

\[
\mu_{it} = z_{it} \delta_{k} + e_{it}
\]

The results of this model are just discussed briefly since we use them just as a data base for further analysis.

For further analysis we performed a cluster-analysis based on the geographical information we had. We had the geographical location of every farm on the village level. So we used the centre village as farm-location and aggregated the observation of the farms from the same village. We calculated a distance matrix with the ‘Euclidean distance’ matrix of the UTM-values:

\[
d_{kj} = \sum_{j=1}^{J} (x_{k,j} - \bar{x}_{i,j})^2
\]

Using the difference matrix we performed a cluster analysis with the ‘Partitioning around medoids (PAM)’-package in R.

We use accounting data for organic grassland and mixed farms in Germany from 1994/1995 to 2004/2005. ‘Grassland-farms’ are specialized farms that get more than 66% of their turnover from products based on grassland (such as milk, meat from suckler-cows, sheep or goats etc.), or mixed farms that derive at least 33% of their turnover from such products. While some production of sheep, goats and suckler cows is grassland-based, the majority of grassland is used in dairy production. The data were collected according to the agricultural accounting standard of the German Federal Ministry for Nutrition, Agriculture, and Consumer Protection, and made available by LAND DATA. They consist of an unbalanced panel with 1,717 observation from \( i = 396 \) farms over \( t = 11 \) years (Tab. 1).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Var</th>
<th>Min</th>
<th>Mean</th>
<th>Max</th>
<th>Std. dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum of agric. Turnerov (€)</td>
<td>y</td>
<td>586</td>
<td>91.8</td>
<td>931.2</td>
<td>72.2</td>
</tr>
<tr>
<td>Material costs (€)</td>
<td>x_1</td>
<td>915</td>
<td>38.8</td>
<td>527.2</td>
<td>41.1</td>
</tr>
<tr>
<td>Other expenses (€)</td>
<td>x_2</td>
<td>902</td>
<td>21.0</td>
<td>187.1</td>
<td>15.7</td>
</tr>
<tr>
<td>Depreciation (€)</td>
<td>x_3</td>
<td>140</td>
<td>22.6</td>
<td>234.6</td>
<td>16.3</td>
</tr>
<tr>
<td>Labour (AWU)</td>
<td>x_4</td>
<td>0.13</td>
<td>1.8</td>
<td>15.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Area (ha)</td>
<td>x_5</td>
<td>0.70</td>
<td>65.8</td>
<td>1,041.8</td>
<td>83.0</td>
</tr>
</tbody>
</table>

| Source                  | own calculation |

Monetary variables were deflated using the official price index for agricultural products and for agricultural inputs which are provided by the German Federal Office for Statistics (Destatis 2006). All input variables were normalised by dividing by sample means, except for the linear trend which enters in deviations from the sample mean. The regional distribution of the farms in the sample is similar to that reported in official statistics.

We estimated the model with Oxmetrics 6.0 and the program package sfamb for ox. The clusteranalysis and the maps are produced with the cluster- and the spedep-package for R in MacOS X.

IV. RESULTS AND DISCUSSION

The main results are documented elsewhere; we will focus on the result of the technical effects model in order to see the main determinants of technical efficiency. Besides the ‘classical’ determinants of technical efficiency such as farm structure, management capacities/human capital, institutional choice and market orientation/policy support ‘regional variables’ play a significant role determining the efficiency of a farm. The results in Tab. 2 show the regional variables to be significant suggesting, that there is some regional disparity.

The regional dummies show the difference in Technical efficiency to Southern German farms, which is the reference group. The East German farms seem to perform worse than the southern German, which surprises a little bit, since farms in East-Germany have advantages with respect to land-availability.

The regional share of organic farms has a significantly positive impact on efficiency. This might

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be explained by agglomeration effects and learning by ‘looking over the fence’. From History of organic farming in Germany we know, that local and regional working groups of organic farmers played an important role by developing the farming system ‘organic farming’ (Padel 2001b).

Tab. 2: Estimated Coefficients for the ‘Technical Effects Model’

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coeff.</th>
<th>t-value</th>
<th>Marginal effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>$\delta_0$</td>
<td>-0.073</td>
<td>-0.35</td>
</tr>
<tr>
<td>In conversion</td>
<td>$\delta_1$</td>
<td>0.133</td>
<td>2.58</td>
</tr>
<tr>
<td>No agric. Eduction</td>
<td>$\delta_2$</td>
<td>-0.069</td>
<td>-0.72</td>
</tr>
<tr>
<td>Age of the farmer</td>
<td>$\delta_3$</td>
<td>0.0004</td>
<td>0.25</td>
</tr>
<tr>
<td>Expenses for leg. Advice</td>
<td>$\delta_4$</td>
<td>0.008</td>
<td>1.82</td>
</tr>
<tr>
<td>Soil quality</td>
<td>$\delta_5$</td>
<td>-0.100</td>
<td>-2.52</td>
</tr>
<tr>
<td>Equity share</td>
<td>$\delta_6$</td>
<td>-0.001</td>
<td>-0.18</td>
</tr>
<tr>
<td>Sum of land-rent</td>
<td>$\delta_7$</td>
<td>-0.031</td>
<td>-3.87</td>
</tr>
<tr>
<td>Volume of milk quota</td>
<td>$\delta_8$</td>
<td>-0.012</td>
<td>-2.87</td>
</tr>
<tr>
<td>Intensity of livestock</td>
<td>$\delta_9$</td>
<td>-0.441</td>
<td>-4.75</td>
</tr>
<tr>
<td>production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grassland share</td>
<td>$\delta_{10}$</td>
<td>-0.068</td>
<td>-2.10</td>
</tr>
<tr>
<td>Legal status = GbR</td>
<td>$\delta_{11}$</td>
<td>-0.171</td>
<td>-2.04</td>
</tr>
<tr>
<td>Part-time farm</td>
<td>$\delta_{12}$</td>
<td>-0.085</td>
<td>-1.26</td>
</tr>
<tr>
<td>Volume of subsidies</td>
<td>$\delta_{13}$</td>
<td>0.015</td>
<td>2.32</td>
</tr>
<tr>
<td>Regional variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share organic farmers</td>
<td>$\delta_{14}$</td>
<td>-0.130</td>
<td>-1.98</td>
</tr>
<tr>
<td>Eastern Germany</td>
<td>$\delta_{15}$</td>
<td>0.221</td>
<td>2.27</td>
</tr>
<tr>
<td>Northern Germany</td>
<td>$\delta_{16}$</td>
<td>-0.363</td>
<td>-2.73</td>
</tr>
<tr>
<td>Western Germany</td>
<td>$\delta_{17}$</td>
<td>-0.346</td>
<td>-3.27</td>
</tr>
<tr>
<td>Votes for the Green Party</td>
<td>$\delta_{18}$</td>
<td>-0.099</td>
<td>-1.76</td>
</tr>
<tr>
<td>Distance nearest dairy</td>
<td>$\delta_{19}$</td>
<td>0.108</td>
<td>2.52</td>
</tr>
</tbody>
</table>

The distance to the nearest organic dairy shows, that also the distance to a secondary enterprise has an influence on the on-farm efficiency. This might be partly explained with price effects, since organic dairy pay a mark-up for organic production whereas other dairies often pay ‘conventional prices’. But it might also be explained by the access to special information provided by the dairy company.

Fig. 2 shows the differences with respect to efficiency in Germany. Here we can observe, that in Southern Germany, where roughly
Efficient farms in the three Southern clusters (Allgäu, Bodensee and Munich) are rather small (38-49 hectares) and have a high turnover per Agricultural Working Unit (AWU), whereas Saxony and Brandenburg have high average farm sizes (118 to 120 hectares). The turnover per AWU is low in Brandenburg, but in Saxoy and Lower-Saxony we find almost the same dimension of turnover (50,000-69,000 thousand €).

One of the differences might be explained by soil quality. Though organic Grassland farming is a rather extensive system, the Indicator for soil quality shows, that soil quality in the Southern clusters is quite high (3,400-4,000) in comparison to the East German cluster (2,600-3,600). This finding makes sense since the Ertragsmesszahl (EMZ) takes into account not only soil texture but also local

Especially the Intensity (measured in Animal Units per hectare) seems to be higher in the Southern cluster (1.0-1.3 Units/ha), whereas in Est Germany there is a rather low intensity (0.43-0.96). This is especially interesting, since Intensity is highly significant and is economically one of the main determinants of technical efficiency with a high marginal effect. Besides Northrine-Westfalia, in Bavaria and Baden-Württemberg the costs for land are higher, so farms have to face high investment costs in the case of a land purchase (see prices at Destatis 2009). Besides scarce land endowment, organic farms might be less competitive on the land-market, since for example farms with biogas-plants have a higher willingness to pay for rented land. These farms are able to pay up to 1,000 Euro/ha in Lower-Saxony, which is higher than the average willingness to pay (Bahrs & Held 2007). This figure might be even higher in Southern Germany. Therefore organic Grassland-farms might have to use scarce grassland more intensively than farms in other regions.

The Fig. 4 shows the different cluster of organic farms in Germany with their calculated average efficiency score. We used a simple cluster technique to get the observation on the village level into regional cluster. The differences in the average cluster range from 0.33 in Brandenburg to 0.84 at the Bodensee in Southern Baden-Württemberg. In General it seems as if the clusters in Southern Germany next to the Alps are more efficient. Especially the regions of Allgäu (0.8), Bodensee (0.84) and the Region of Munich (0.82) are quite efficient.

Fig. 4 shows the distribution of the efficiency scores. As we can see, especially the cluster of Lower-Saxony has a wide distribution of efficiency scores.

Tab. 3 shows the farm characteristics of the clusters and the natural resources of the clusters. As we can see, there are large differences with respect to factor endowment, economic key figures and natural resources.
**Fig. 5:** Distribution of efficiency scores in the efficiency cluster. Source: Own calculation, n=1717

**Tab. 3:** Farm Characteristics in the Clusters

<table>
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<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brandenburg</td>
<td>0.33</td>
<td>0.17</td>
<td>72</td>
<td>22,278</td>
<td>200</td>
<td>2.6</td>
<td>51</td>
<td>2,582</td>
<td>158</td>
<td>46</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Saxony</td>
<td>0.54</td>
<td>0.26</td>
<td>24</td>
<td>50,302</td>
<td>118</td>
<td>2.0</td>
<td>43</td>
<td>3,603</td>
<td>146</td>
<td>127</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Lower Saxony</td>
<td>0.64</td>
<td>0.32</td>
<td>47</td>
<td>69,125</td>
<td>67</td>
<td>1.6</td>
<td>60</td>
<td>3,677</td>
<td>129</td>
<td>56</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>Frankonia</td>
<td>0.64</td>
<td>0.18</td>
<td>168</td>
<td>48,414</td>
<td>115</td>
<td>2.4</td>
<td>42</td>
<td>2,465</td>
<td>210</td>
<td>21</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>Altmühltal</td>
<td>0.68</td>
<td>0.20</td>
<td>137</td>
<td>53,670</td>
<td>52</td>
<td>1.5</td>
<td>39</td>
<td>3,026</td>
<td>228</td>
<td>38</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>Rhineland-Pf.</td>
<td>0.69</td>
<td>0.20</td>
<td>64</td>
<td>49,858</td>
<td>87</td>
<td>1.9</td>
<td>60</td>
<td>2,637</td>
<td>158</td>
<td>91</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Schwarzwald</td>
<td>0.70</td>
<td>0.22</td>
<td>49</td>
<td>47,843</td>
<td>68</td>
<td>1.8</td>
<td>80</td>
<td>3,508</td>
<td>230</td>
<td>39</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>Stuttgart</td>
<td>0.72</td>
<td>0.19</td>
<td>147</td>
<td>46,697</td>
<td>51</td>
<td>1.6</td>
<td>55</td>
<td>2,967</td>
<td>238</td>
<td>40</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Donaual</td>
<td>0.74</td>
<td>0.16</td>
<td>30</td>
<td>57,270</td>
<td>44</td>
<td>1.6</td>
<td>48</td>
<td>2,866</td>
<td>234</td>
<td>72</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>Hohenlohe</td>
<td>0.77</td>
<td>0.17</td>
<td>111</td>
<td>47,351</td>
<td>51</td>
<td>1.8</td>
<td>41</td>
<td>3,218</td>
<td>216</td>
<td>31</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>Wendland</td>
<td>0.79</td>
<td>0.19</td>
<td>34</td>
<td>85,472</td>
<td>156</td>
<td>2.4</td>
<td>46</td>
<td>3,090</td>
<td>119</td>
<td>19</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Northrhine-W</td>
<td>0.80</td>
<td>0.13</td>
<td>80</td>
<td>60,629</td>
<td>67</td>
<td>1.9</td>
<td>55</td>
<td>4,143</td>
<td>144</td>
<td>52</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>Allgäu</td>
<td>0.80</td>
<td>0.15</td>
<td>279</td>
<td>50,048</td>
<td>49</td>
<td>1.7</td>
<td>80</td>
<td>3,444</td>
<td>247</td>
<td>20</td>
<td>1.06</td>
<td></td>
</tr>
<tr>
<td>Munich</td>
<td>0.82</td>
<td>0.18</td>
<td>375</td>
<td>52,731</td>
<td>38</td>
<td>1.7</td>
<td>70</td>
<td>3,864</td>
<td>257</td>
<td>47</td>
<td>1.28</td>
<td></td>
</tr>
<tr>
<td>Bodensee</td>
<td>0.84</td>
<td>0.16</td>
<td>100</td>
<td>56,611</td>
<td>42</td>
<td>1.6</td>
<td>88</td>
<td>4,023</td>
<td>234</td>
<td>10</td>
<td>1.25</td>
<td></td>
</tr>
</tbody>
</table>
The Fig. 6 shows the average support for organic farming in the different clusters. The results in Tab. 2 show that farms with a high volume for subsidies are slightly less efficient. The literature gives contradicting results on this topic (see e.g. McCloud & Kumbhakar 2007). If we cluster the farms according their location we find no difference with respect to subsidies. In Figure 6 the colours are given according to the federal states a cluster is in.

Tab 4: Average organic Subsidies per hectare in different Regions in Germany

<table>
<thead>
<tr>
<th>Region</th>
<th>Euro/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Est Germany</td>
<td>152.00</td>
</tr>
<tr>
<td>North-West Germany</td>
<td>137.50</td>
</tr>
<tr>
<td>Bavaria</td>
<td>235.20</td>
</tr>
<tr>
<td>Baden-Württemberg</td>
<td>229.50</td>
</tr>
</tbody>
</table>

We can first of all see that most of the clusters are located in Southern Germany (Bavaria & Baden-Württemberg), where 80% of the farms are. The Farms in Bavaria (orange) and Baden-Württemberg (red) receive almost the same volume of subsidies, which is 230 – 235 €/ha, whereas farms in East Germany (green, 152 €/ha) and in West and Northern Germany (blue, 138 €/ha) receive less subsidies.

This shows that the volume of subsidies is given according to the federal states (see in detail Nieberg & Kuhnert 2006). So any influence from subsidies on technical efficiency can be seen as mainly driven by the location of a farm in one or the other federal state. Thus the location of a farm in Baden-Württemberg or Rhineland-Pfalz is influencing the volume of subsidies and thereby influencing the efficiency. Thereby policy might have a rather accidental influence on technical efficiency, which might in some cases be better than any other policy design (if available).

V. CONCLUSIONS

The presented paper presents results from a Stochastic Frontier Analysis using the location information of the single farms. We could show that technical efficiency is influenced by location factors such as agglomeration and localization effects. Also socio-economic factors seem to play a role. The performance of the farms inside the clusters raises the question, if the farms in the data-set are using a homogeneous and therefore comparable technology. One of the assumptions of the basic efficiency analysis is a homogenous technology. This data-set was used on purpose in order to capture the regional heterogeneity of the farms.

Finally, one methodological conclusion could be to use the modelling framework of meta-frontier analysis (Battese et al. 2004). Here we might see the different regional resource endowments and farm-structures as influencing the production technology.
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