Region-specific drivers and barriers of organic farming

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Abstract. In 2002 the German federal government within its strategy for sustainable development set the aim to increase the share of organically farmed land to 20% of total agricultural land by 2010. Though shares have increased continuously, the target has not been reached yet. In order to fine-tune corresponding policy measures the current study identifies major region-specific drivers of organic farming in Germany by applying a spatial regression analysis to Germany's almost 300 rural counties. Due to the different agricultural structure in Northern, Southern and Eastern Germany, particularly concerning farm size and land use type, the analysis is conducted separately for each of those larger areas.

Preliminary results confirm the findings of earlier studies, according to which the share of organically farmed land positively and significantly relates to the regional share of grassland and the price of agricultural land. Both findings hold for Northern, Southern and Eastern Germany. In the North and the South, organic farming is further driven by the counties' topography (hilly regions are more likely to adopt organic farming practices) and the regional consumers' attitude towards organic products (measured by the votes for the green party in the last states elections). Findings for the South further indicate that organic farming is in conflict with on-farm energy production.

Findings on drivers aside material production conditions are rather heterogeneous. Assured farm succession seems to have no effect, the share of part-time farmers correlates negatively with organic farming in the South but is not significant for the other regions and regions orientation towards tourism is complementary with organic farming in the East but conflicting in the South. Finally, we identify spatial autocorrelation in the South. In contrast no neighborhood effects can be observed for North- and East-Germany.

1 Exposition

With the reform of the Common Agricultural Policy (CAP) in 1992 organic farming has been recognized an important part of EUs agricultural system and financial incentives have been established to increase the conversion rate from conventional farms across the member states. Since then the share of organically cultivated agricultural land has increased continuously in the EU and covered more than 12 million hectares (ha) (slightly less than 7% of total utilised agricultural area) in 2016 (Eurostat 2018). Given the substantial role of organic farming for restoring soil functions, maintaining biodiversity and protecting natural resources, it is of vital interest for agricultural policy to learn more about main drivers and barriers of the conversion in order to maintain and strengthen this favourable trend.

Findings of several studies in this field suggest the existence of two different kinds of factors affecting farmers' decisions to convert to organic farming. *First*, and not surprisingly, farmers' investment decisions are generally presumed to relate to material production conditions and the expected profits (Kerselaers et al. 2007, Kuminoff and Wossink 2010, Schmidtner et al. 2012, Wollni and Andersson 2014). *Second*, there is growing evidence that farmers' motivation of conversion goes beyond their economic rationales. Most likely organic farming is also affected by farmers' attitude towards the environment and their social embedding (Läpple and VanRensburg 2011, Moser and Barrett 2006, Mzoughi 2011, Toader and Ronan 2015).

Both material production conditions and social embedding differ significantly across member states, resulting in largely varying shares of organic farmland among and within member states.[1] In Germany, for example, the average share of organic farmland was slightly higher than EU average (7.5%) but regional shares could easily exceed 20%. Before this background the presented study discusses how immobile region-specific factors and neighbourhood effects could affect the adoption of organic farming in Germany's rural counties.

The remainder of this paper is organised as follows: Section 2 briefly illustrates recent trends of organic farming in Germany. The chapter is followed by a discussion of related literature and the derivation of the main hypotheses in section 3. The paper continues in section 4 with methodological remarks and the setup of a simple spatial econometrics model at county level. With regard to Germany's rather heterogeneous agricultural structure, we apply the model for three larger areas (North-, East- and South-German). The paper closes with a discussion of results and concluding remarks in sections 5 and 6.

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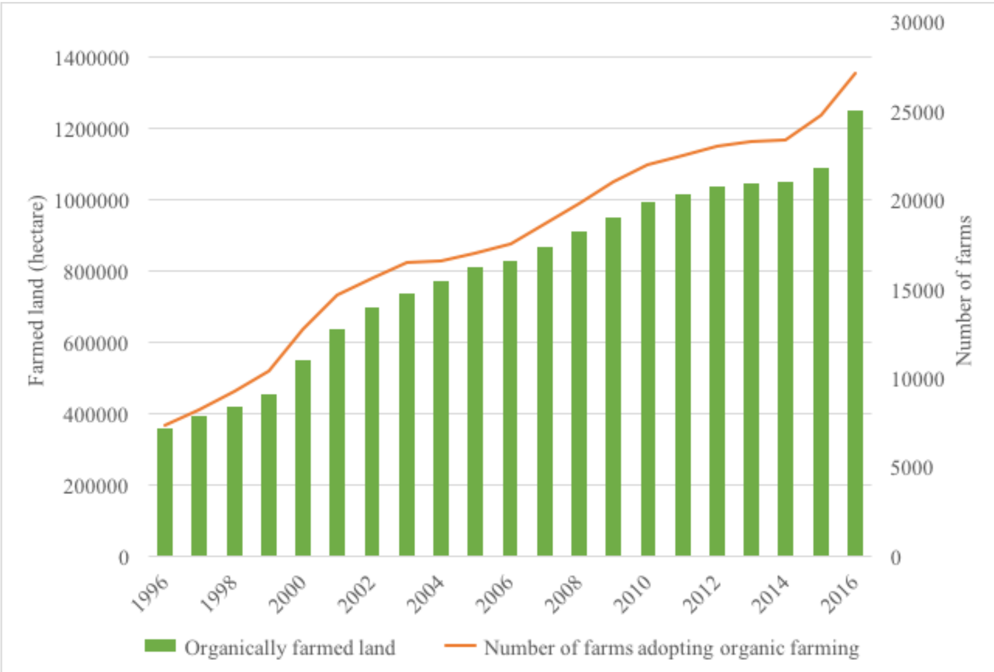
[1] Shares of organic farmland range from less than 1% in Malta to more than 18% in Austria, Sweden and Estonia (Eurostat 2018).

2 Recent trends

In line with most member states, Germanys' farmers have continuously extended the capacity for producing organically cultivated products in the last two decades. In this period (1996-2016) the number of organic farms has been increased from about 7,350 to more than 27,100, which equals a share of slightly less than 9% of all German farms in 2016. At the same time organically farmed land has been extended from 0.35 to 1.25 million hectares, which corresponds to an increase from about 2 to 7.5% of total utilized agricultural area (figure 1) (BMEL 2016).

Figure 1. Organic farming in Germany (1996-2016)

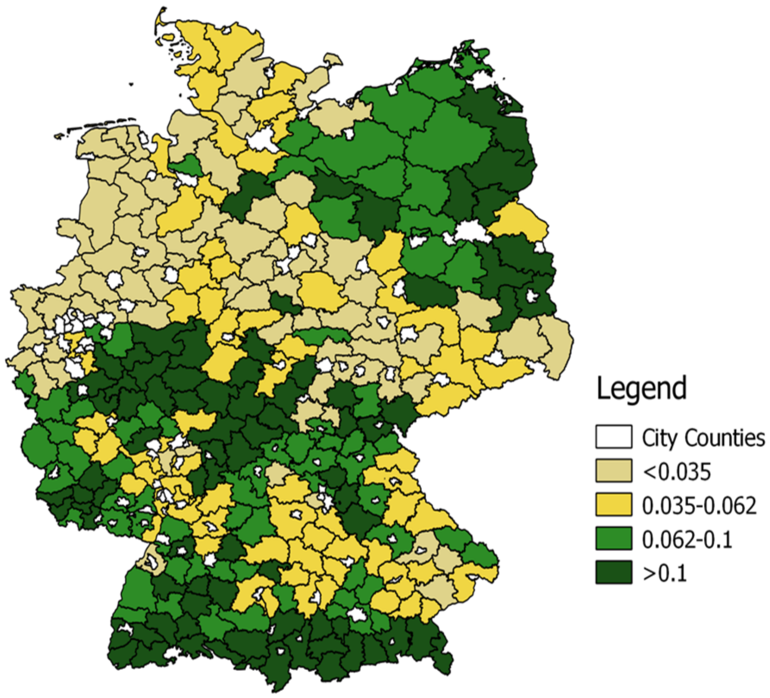


Source: BMEL 2016

Having in mind Germany's rather heterogeneous agricultural structure (in particular with regard to average size of farms and animal husbandry), it is not surprising that the trend largely differs across the federal states. While the shares of organically farmed land are rather small in North-Western States with highly intensive agriculture and large livestock units per ha – current shares amount to less than 3% in Lower Saxony, slightly more than 4% for Schleswig Holstein and 5.4% for Nordrhine-Westfalia – they are comparatively high for Germany's Southern and South-Western States (Saarland 15.7%, Hesse 12.6%, Baden-Wuerttemberg 10.7, Bavaria and Rhineland-Palatinate with about 9%). For the new German Laender, which for historical reasons have by far the largest farms, no clear trend can be observed. The shares range from 3% to 4% tor Thuringia and Saxony up to (more than) 10% for Brandenburg and Mecklenburg-Western Pomerania (BLE 2017a).

A comparison of shares at county level basically confirms this pattern. However, it also reveals strong differences within the federal states (figure 2). In Bavaria, for example, shares are rather high for alpine regions in the very south but comparatively small in the Northern part. Note that city counties remain considered by figure 2 (white spots) and for further analysis.

Figure 2. Regional disparities of organic farming in Germany (shares of organic farmland)



Source: Destatis 2018a

The favorable development should not hide the fact, that average shares are well below the national target of 20%, which is arguably the minimum share to restore the nutrient cycle and sustainably reduce environmental impacts of modern agricultural systems. Furthermore, the demand for organically produced goods has increased at even higher rate in recent years and cannot be satisfied by the domestic market. Some of these goods could easily be produced by domestic farmers, so the further extension of organic farming would meet an already existing and growing demand.

3 Related literature and main hypotheses

Conventional agriculture has long been recognized an important driver of transgressing planetary boundaries. Not only does it contribute significantly to the production of Greenhouse gas emissions – in Germany its share added to 7.5% of all GHG in 2015[2] – but it is also largely responsible for the loss of biodiversity, land-system changes and the disruption of phosphorous and nitrogen cycles. Before this background organic farming is often considered a means to address these environmental concerns and sustain agricultural production. It is therefore of crucial importance to learn more about driving factors and potential barriers for farmers to adopt principles of organic farming.

As mentioned already, farmers' decisions are driven by local production conditions and social embedding. Given the regional disparities of organic farming, the focus of the presented paper is how these factors are affected by spatial patterns and local characteristics.

3.1 Region-specific factors affecting farmers' production conditions

Farmers' decision to convert to organic farming can basically be considered an investment decision (Schmidtner et al. 2012). This means farmers convert to organic farming, if (expected) profits of conversion exceed (expected) gains of adhering to conventional farming practices. As profits of conversion generally relate to local production conditions, the conversion rate shall be affected by region-specific, largely immobile factors, such as soil quality, topography, land use, degree of professionalization and the proximity to regional markets for organic food products.

With regard to soil quality, empirical findings for Germany (Bichler et al. 2005) and Finland (Pietola and Lansink 2001) suggest that specific benefits of organic farming come to bear for regions with low soil quality and comparatively low yields per ha. In contrast, effectiveness of conventional practices seems to increase with soil quality. We therefore presume a negative impact of soil quality on regions' share of organically farmed land (*Hypothesis H1*). In order to measure soil quality, official German statistics often refer to the so-called *Ertragsmesszahl*. However, data at county level are incomplete and hard to compare. As it is probably reasonable to presume that average soil quality is reflected by the average price of agricultural land, this indicator is used as a substitute for soil quality.[3] Admittedly high prices could affect farmers' decision apart from soil quality. If, as suggested by Latacz-Lohmann (2012), revenues per ha are smaller for organic compared to conventional farming, low prices for land would further increase the probability of conversion to organic farming and vice versa.

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[2] This is clearly below energy-related GHG emissions but still above industrial process-related emissions.

[3] Of course, land prices do not only reflect soil quality but many other characteristics. In fact, price levels for agricultural land seem to rise with regional per-capita income. The problem diminishes as we set up different models for North-, East- and South Germany (see section 4 for details), but surely it does not vanish.

In addition to soil quality, production conditions also relate to regions' topography. Intensified and highly capitalized agriculture seems to be particularly effective for larger flat areas. This is in contrast to hilly regions, which are better suited for extensive practices and show lower opportunity costs of conversion (Wollni and Andersson 2014). The share of organically farmed land can therefore be expected to increase with average slope of land (*H2*).

The uptake rate of organic farming further depends on current land use patterns. The transformation of large scale monoculture plantages, for example, entails much higher costs compared to the conversion of grassland farming, which is generally considered to maintain biodiversity and protect soil fertility as well as groundwater quality. Following this line of reasoning, the share of organic farmland should increase with the share of grassland (*H3*).

Aside from food production, agricultural land is increasingly used for energy production. This includes energy plants (used for biofuels or biogas), wind turbines and open space photovoltaics. Though both trends, organic farming and on-farm energy production, started around the turn of the millennium, it is not clear whether these are complementary or conflicting. The findings in the literature are ambivalent.

On the one hand, several studies point to the competition for land between energy and organic farming. This is true for all farmers, but since yields per hectare are much smaller for organic compared to conventional food production, opportunity costs are particularly high in case of organic farming (Simon et al., 2007). On the other hand, the concepts of organic and on-farm energy production both relate to the idea of a closed eco-cycle and seek to minimize the use of fossil fuels (Jørgensen et al., 2005). Thus, farmers with a strong attitude towards the environment could in principle promote both, all the more as digestates from biogas production could be used as organic fertilizers (SRU, 2007).

Empirical findings, however, show that synergy effects are hardly ever realized. Instead the pronounced adoption of agricultural biogas clearly fosters intensification of agricultural production in general and monocropping of maize in particular (Graß, 2008; Stürmer et al., 2013). We therefore presume that the share of organic farmland decreases with accumulated installed capacity related to agricultural biogas, open area PV units and wind energy (*H4*) (Schaffer and Düvelmeyer 2016).

Aside from region-specific production conditions, farmers' investment decisions are also influenced by market conditions. As mentioned already, the global and domestic market for organic products has rapidly increased in recent years and demand in Germany already exceeds domestic supply. Therefore, domestic producers of organic products could easily enlarge their market share. Given that all farmers have equal access to national and global food markets, this might explain an increasing conversion rate overall, but not necessarily regional differentiations. However, in contrast to conventional products, a substantial share of organic food is sold in regional markets. Therefore, favorable regional market conditions might positively affect farmers' willingness of conversion.

In search of an appropriate indicator literature either focuses on market size, measured by proximity to urban areas or population density (e.g. Koesling et al. 2008), or on ecological attitude of the regional population. Given that consumers of organic products regularly put a greater emphasis on environmental rather than taste and health arguments (or at least say so) (Obermowe et al. 2011), we presume that the share of organic farmland correlates positively with the ecological attitude of a region's population (*H5*).

3.2 Region-specific factors affecting farmers' social and regional embedding

There is broad consensus that farmers' motivation to adopt principles of organic farming goes beyond purely economic reasoning. Instead, organic farming is deeply rooted in a commitment to society and responsibility for environment (Läpple and VanRensburg 2011, Moser and Barrett 2006, Mzoughi 2011). This particularly holds for family farming (Toader and Ronan 2015), which is dominating the German agricultural system.[4] However, due to the reluctance of the younger generation, the share of small farms run by a family members might decrease significantly in the future. Therefore, the question of farm succession could play an important role for the general orientation of the farm. In this regard, we presume that assured farm succession foster conversion of conventional to organic farm practices as the latter are more likely to maintain soil quality for the next generation (*H6*).

Admittedly, assured farm succession is not primarily a region- but rather a farm-specific factor. What justifies a consideration in a regional context is that we observe a strongly varying share of farms with assured farm succession among counties (between 10 and 50%) and significant spatial dependencies for this variable in all study regions.[5]

Another specific characteristic of the German agricultural system is the substantial share of farms run on a sideline basis (not only but especially in the South). Assuming that intrinsic values as well as health and taste issues are more pronounced by part-time farmers, who work and earn their living mostly outside the agricultural sector, leads to the hypothesis that organic farming is more successful in regions with high shares of land cultivated on a sideline basis

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4 Currently nine out of ten farms in Germany are primarily operated by the farmer and family members (Deter 2014).

5 The corresponding Moran's *I* values for assured farm succession range from 0.50 (p-value 0.000) for the North, 0.13 (0.043) for the East to 0.87 (0.000) for the South.

(*H7*). The fact, that this group of farmers hardly disposes of expensive agricultural machinery but prefers labor intensive practices, further strengthens this argument.

Finally increasing shares of organic farming could relate to a region's general development goal. This might be renewable energy (which is basically covered by *H4*) or an orientation towards tourism. Assuming, for example, that the wealth of a region is based on its touristic attractiveness, conformity and compliance with expectations of the population (and local governments) could positively affect farmers' decision to adopt organic farming. If farmers benefit directly from tourism (e.g. in form of agrotourism), economic reasoning further strengthens this trend. Accordingly, the share of organic farmland should positively correlate with the region's annual overnight stays (as a measure for touristic attractiveness) (*H8*).

3.3 Neighborhood effects

A large body of empirical studies in regional science indicates that spatial dependence is an important driver of regional development and the diffusion of new production patterns (e.g. Anselin, 1988; Autant-Bernard and LeSage, 2011). This is due to cooperation and direct communication of economic actors in regional markets and institutions. As both, regional markets and institutions, play a crucial role for the agricultural sector, organic farming might well be affected by neighborhood effects. Indeed, several empirical studies for Denmark, Norway, USA and Germany (Bichler et al. 2005, Bjorkhaug and Blekesaune 2013, Eades and Brown 2006, Frederiksen and Langer 2004), find evidence that "regions with high shares of organic farming tend to be close to other regions with high shares of organically farmed land" (Schmidtner et al. 2012, 679).

Neighborhood effects enter farmers' decision making in different ways. Concerning the economic rationale, knowledge spillovers might lower transaction costs and increase productivity. Institutions such as farmers' association or regional initiatives to protect the environment could strengthen the social pressure on farmers to conform with the region's sustainable development strategy (e.g. *genfreie Region*). Finally, neighborhood effects could result from similar production condition (e.g. topography, soil quality).

Following this reasoning we expect positive spatial dependence for the share of organic farmland (*H9*).

4 Data and methodological remarks

4.1 Defining study regions

Almost three decades after unification, West and East Germany are still divided. Not politically, but in terms of per capita income, sectoral structure, full-day care, motorisation, home-ownership rate and many other areas. Thus, it is not surprising that this is true for the agricultural structure as well. Average size of East German farms, for example, are almost five times larger than West German farms.

Besides the East-West divide another line can be drawn between the Northern and Southern part of West Germany. The agricultural system in the North is characterized by a more intensive use of agricultural land and comparatively high livestocks per ha. In contrast, the share of grassland and part-time farming is clearly higher in the South.

In addition (or due) to differences in the general agricultural structure, North-, East- and South-Germany show strongly varying shares of organic farmland (from 4.4% in the North, 7.7% in the East up to 10.0% in the South) and offer different financial support for the conversion of farmland. Though financial support generally refers to the EU and the national funding scheme, legislation gives Federal states some room for fine adjustment to regional specifities. This explains, why average payments for the first and the second year of organic farming range from 240 €/ha for East Germany, 300 €/ha for South Germany up to 430 €/ha for North-Germany.[6]

Given these structural differences, the spatial econometrics model is applied separately for North-, East- and South-Germany. To be clear, North Germany encloses the rural counties of the federal states of Lower-Saxony, Schleswig-Holstein and North-Rhine Westfalia[7], East Germany includes the rural counties of Brandenburg, Mecklenburg-Western Pommerania, Saxony, Saxony-Anhalt and Thuringia and South Germany the rural counties of Hesse, Rhineland-Palatinate, Saarland, Baden-Wuerttemberg and Bavaria (figure 3).

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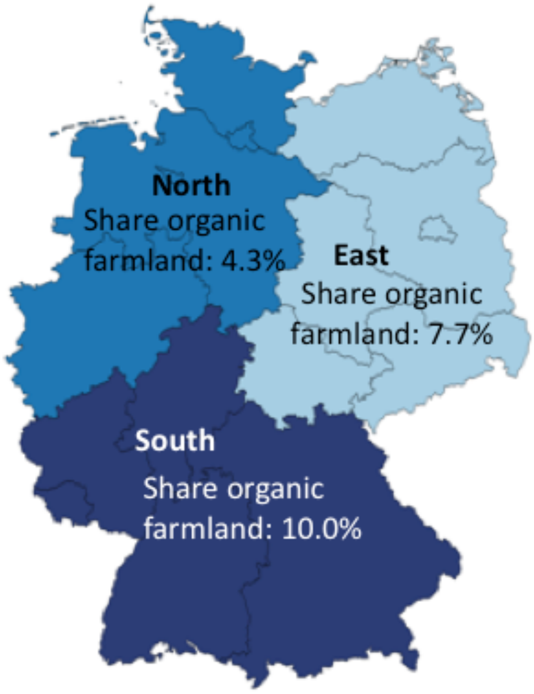
[6] As payments are fixed at state level, they also vary within the three study regions: from 364 to 520 €/ha in North Germany, 209 to 280 €/ha in East Germany and 225 to 350 €/ha in the South. Interestingly highest subsidy rates in the South are lower than lowest rates in the North. Seemingly general production conditions are much more favorable for organic farming om the South (BLE 2017b).

[7] The city states of Hamburg and Bremen/Bremerhaven remain unconsidered.

Figure 3. Study regions: North-, East and South Germany.



Source:

4.2 Data and definition of main variables

The spatial analysis for North-, East- and South-Germany is based on regional data at county level (NUTS 3). Due to their minor importance for the agricultural system, city counties are excluded from the analysis. This leaves 295 rural regions, out of which 80 define the North-, 58 to the East- and 157 the South-German study region.

Most of the variables that enter the spatial regression model originate from the official agricultural surveys for 2010 and/or 2016 (Destatis 2018a and 2018b). This is true for the counties' share of organically farmed agricultural land in 2016 (the dependent variable), the share of grassland and part-time farmers as well as assured farm succession. All data vary strongly across counties. Share of grassland, for example, is particularly high in regions devoted to pasture farming, share of farmland operated at a sideline basis averages at about 23% for all counties but is clearly higher in the South and assured farm succession, which describes the transfer of a family-operated farm to a successor from the next younger generation, is comparatively high in Bavaria and Lower Saxony but low in Rhineland-Palatinate, Saarland and some parts of Baden-Wuerttemberg.

The land prices refer to the average sales prices of agricultural land for the years 2005 to 2012, regularly published by the statistical offices of the Federal States (e.g. Amt für Statistik Berlin-Brandenburg 2013), topography is measured by the mean slope of a given landscape (depicted as the tangent of the angle of the respective surface in relation to the horizontal plane), on-farm energy production accounts for the accumulated installed electrical capacity per hectare related to agricultural biogas, open area PV units and wind energy registered between 1991 and 2012 (DGS 2014) and touristic attractiveness is measured by overnight stays per year and county (Destatis 2018c). Finally, ecological attitude of a region's population is measured by the county-specific results of the Green Party in the most recent States elections, published by the Statistical Offices of the Federation and the Länder (2015). All figures differ strongly across counties and most are spatially dependent.

4.3 Statistical analysis

As proposed by hypothesis *H9*, a region's share of organically farmed land could be affected by the neighboring regions' adoption of organic farming. One way to test for neighborhood effects is the calculation of Moran's *I*:

$$(1) \qquad I = \frac{N \sum_{i=1}^{N} \sum_{j=1}^{N} [w_{ij}(y_i - \overline{y})(y_j - \overline{y})]}{\sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij} \sum_{i=1}^{N} (y_i - \overline{y})^2}$$

N: Number of counties (North: 80, East: 58, South: 157)

w_{ij}: elements of matrix W (1 if i is neighbor to j and 0 otherwise)

y_i: share of organically farmed agricultural area in county i (with the average given by $\overline{y}$)

The Moran's *I* measures to what extent the share of the organically farmed agricultural land is alike for neighboring regions. The values could range from -1 to +1, where positive (negative) values indicate positive (negative) neighborhood effects. Values close to zero suggest that the adoption of organic farming is independent from the adoption in neighboring regions (Fornahl and Brenner, 2009).

Neighborhood in this context is defined by the well-known matrix *W* of vicinities. Such a matrix can be composed of binary weights (neighbor or not), distance-based weights or a combination of both. For the presented study, we apply a simple contiguity matrix where the element w_{ij} of the matrix is 1, if region i is a neighbor of region j and 0 otherwise (e.g. LeSage, 1997). In the case of significant Moran's *I* values, it can be concluded that spatial autocorrelation exists and a spatial regression model should be applied.

For the presented study, the Moran's *I* values are positive and highly significant for the North (0.42, p-value: 0.000) and the South (0.45, 0.000). Neighborhood effects in the East are less clear, but still positive and significant (0.10, 0.062). Therefore, a spatial lag model is set up for all three study regions according equation (2):

(2) $$\ln y = \rho W \ln y + \beta \ln X + u$$

y: n-dimensional vector of the share of organically farmed agricultural land in North- (n=80 counties), East- (n=58), and South-Germany (n=157)

X: nxk matrix of the k explanatory variables

ρ: autoregressive parameter

W: nxn matrix of vicinity

u: noise residual

As mentioned already, the dependent variable (y) is the natural logarithm of the county-specific share of organically farmed agricultural land. The vector of explanatory variables includes the natural logarithm of the price of agricultural land per hectare, the average slope within the respective county, the percentage of agricultural land used as grassland, the installed capacity of renewable energy per hectare of agricultural land, the share of votes for the Green party, the share of farms run by farmers over 45 years of age with ensured farm succession, the percentage of farms run on a sideline basis and the number of overnight stays per hectare of the respective county.

According to equation (2) the model further accounts for spatial autocorrelation of organic farming. In case of positive autocorrelation, the estimator for the autoregressive parameter ρ takes values between 0 and 1, where the estimator increases with spatial autocorrelation.

5 Discussion of results

5.1 Region-specific factors affecting farmers' production conditions

According to hypotheses *H1* to *H5*, organic farming has been expected to decrease with price for land (as a measure for soil quality) and installed capacity for renewable energy and to increase with the average slope of land, the share of grassland and the green attitude of the regional population (as a proxy for the potential of regional sales).

Table 1. Findings of spatial econometrics analysis for the three study regions[8]

	coefficients	standard error	p-value	VIF
North Germany				
Price of land	-0.641 ***	0.155	0.000	1.490
Av. slope of land	0.362 ***	0.090	0.000	1.785
Share of grassland	0.289 **	0.102	0.004	1.934
Renewable energy	0.052	0.103	0.614	1.462
Ecol. attitude consumers	0.606 **	0.188	0.001	1.320
Farm succession	-0.260	0.390	0.505	1.389
Share of part-time farming	0.129	0.290	0.656	1.897
Regional touristic attractiveness	0.053	0.071	0.460	1.176
ρ	0.107		0.421	
East Germany				
Price of land	-1.098 *	0.527	0.037	3.015
Av. slope of land	-1.199 **	0.380	0.002	1.921
Share of grassland	0.848 *	0.348	0.015	1.701
Renewable energy	0.251	0.309	0.417	1.199
Ecol. attitude consumers	0.039	0.665	0.674	1.640
Farm succession	-0.267	1.054	0.953	3.035
Share of part-time farming	-0.316	1.292	0.807	1.579
Regional touristic attractiveness	0.621 **	0.201	0.002	1.496
ρ	-0.323		0.112	
South Germany				
Price of land	-0.189 *	0.086	0.028	2.150
Av. slope of land	0.200 *	0.085	0.018	3.344
Share of grassland	0.258 ***	0.056	0.000	2.844
Renewable energy	-0.112 *	0.067	0.097	3.183
Ecol. attitude consumers	0.162 *	0.066	0.015	1.969
Farm succession	0.137	0.150	0.361	1.823
Share of part-time farming	-0.314 *	0.156	0.044	2.678
Regional touristic attractiveness	-0.093 *	0.044	0.037	1.464
ρ	0.458 ***		0.000	

Signif. codes: 0.001 '***' , 0.01 '**' , 0.1 '*'

Source: own calculations

[8] In order to check for collinearity of explaining variables, we calculated the variance inflation factor (VIF) for all coefficients (but the autoregressive parameter). The results are in the normal range with the highest value of 3.344.

The results, given by table 1, reveal a heterogeneous picture for the different study regions. Considering the North, land prices, topography, share of grassland and ecological attitude behave as expected. Against it, the production of renewable energy, basically wind in the North, has no significant impact. The results for East Germany strengthen the land price and the grassland argument, but neither renewable energy production nor ecological attitude of the population have significant impacts. Topography is highly significant, but surprisingly with a different sign. Thus, organic farming seems to be more widespread in comparatively flat areas. Finally, findings for the South confirm all assumptions referring to the production conditions.

It can be concluded that land prices and grassland have significant impacts on organic farming, regardless the studying regions. Ecological attitude of the regional population seems to be important for the North and the South but not for the East. This could be explained by the much larger size of Eastern farms and arguably lower relevance of regional markets. The renewable energy hypothesis only holds for the South. This may relate to the comparatively high share of agricultural biogas, which is more land consuming (at least, if we count for cultivated energy plants) compared to wind energy (that is dominant in the North and East).

5.2 Region-specific factors affecting farmers' social and regional embedding and neighborhood effects

In contrast to the assumption formulated in hypothesis *H6*, we find no significant impacts of assured farm succession for any of the three study regions. Maybe this is due to the derivation of this indicator that is only calculated for farmers older than 45 years and largely neglects young, arguably more innovative farmers. However, there is no clear evidence that younger farmers are more likely to adopt organic farming practices than older ones. In fact, recent results of empirical studies suggest that young farmers are more focused on increasing yields per ha than older farmers. Against it the conversion rate is higher among older farmers (Wollni and Andersson 2014, Parra-Lopez et al. 2007). So maybe farm succession simply does not matter, at least not as a regional factor.

The share of part-time farming is only significant for the South, however not in the direction we expected. Maybe part-time farmers indeed follow main principles of organic farming but avoid administrative efforts and financial expenses of certifying their land (as they largely produce for their own purpose). This would be in contrast to full-time farmers, who are more likely to certify their land in order to receive financial support and bio seals. In addition, full-time farmers are more likely to be organized in regional sections of farmers' associations, which in turn enhances the chance for communication and knowledge spillovers concerning organic farming. This indicates that organic farming might benefit from higher degrees of professionalization.

Concerning farmers' coherence with the regional orientation towards tourism, the share of organic farmland correlates significantly with the counties' touristic attractiveness in the East and the South, although in different directions. While touristic attractiveness seems to have small but significant negative impacts on organic farming in the South (which is in contrast to *H8*), the effect is positive and significant in the East. No significant impacts can be found for Northern Germany.

Finally, the results indicate clear positive neighborhood effects of organic farming in the South. As illustrated by figure 2, shares are continuously high for an East-West belt ranging from Bavarian counties of the Pre-Alpes and the Allgäu to the border regions in the South-West (including counties of the Saarland, Rhineland Palatinate and Baden-Württemberg). Interestingly, and against the significant and positive Moran's *I* values, we find no significant neighborhood effects in the North and the East. One plausible explanation could be, that we control for topography and grassland, which otherwise could add to spatial dependence.

6 Concluding remarks

In recent years, the analysis of potential drivers of organic farming has become a field of rising interest in the political and scientific debate. Some studies focus on farm attributes and social factors driving farmers' behavior, others discuss general production conditions and neighborhood effects. Findings so far indicate that farmers' decision to adopt organic farming principles is driven by farmers' economic rationale and by their social embedding and moral responsibility for the environment.

The presented study focuses on region-specific patterns affecting these factors. The empirical findings, based on county data for North-, East- and South Germany clearly confirm the relevance of certain material conditions (namely soil quality, topography, grassland and relevance of regional markets). In addition, our findings point to potential conflicts between the adoption of renewable energy and organic farming in the South (which is characterized by comparatively small farm sizes).

Following the idea that farmers' incentives to adopt organic farming practices go beyond their economic rationale we considered the role of assured farm succession, part-time farmers, farmers' coherence with counties' touristic interests and neighborhood effects. Admittedly findings reveal a rather disparate and sometimes counter-intuitive picture. Farm succession, for example, has no significant impact on farmers' investment decisions (at least there is no generalizeable effect at regional level in any study region), a high share of part-time farmers, whose incentive could be expected to be more altruistic compared to full-time farmers, seems to have no positive impact on organic farming (maybe due to administrative barriers of certification) and even touristic interests are not always complementary. Last but not least, presumed neighborhood effects only hold for the Southern counties.

Policy implications, drawn from the above analysis, are threefold. *First*, the heterogeneous results indicate that there is no one policy measure that fits all. Instead funding schemes and other support mechanism need to address a complex system, largely affected by immobile region-specific characteristics.

Second, there is no doubt that farmers' willingness to adopt organic farming strongly relates to local production conditions and the underlying (opportunity) costs of conversion. But, besides the economic rationale, farmers' decision is also affected by other factors. Thus, support mechanism should not be limited to financial subsidization. This could include the removal of administrative barriers, the support of regional markets and institutions and the provision of modern communication platforms.

Third, and in more general, Germany's agricultural system is in the process of a far-reaching transformation from a conventional agriculture to a more complex system. Further intensification of conventional production in some areas goes in hand with increasing shares of organic farmland in other areas. In addition, agricultural land is more and more used for energy plants and on-farm generation of renewable energy.[9] At the same time, corresponding policies still focus on either one of the fields and rarely take an integrated view. To overcome this shortcoming and to make use of synergies, we therefore propose a stronger amalgamation of policies and institutions related to modern agricultural systems (Kuchler and Linnér, 2012). This might also contribute to resolve the identified conflict between on-farm energy production and organic farming in the South.

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[9] Not to mention the growing demand of the bioeconomy sector for renewable raw materials.

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