Factors influencing German and Italian farmland prices – a spatial econometric analysis

Einflussfaktoren auf die Kaufpreise für landwirtschaftliche Flächen in Deutschland und Italien – eine räumlich-ökonometrische Analyse

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Summary

A spatial econometric model of German and Italian farmland prices is estimated to identify the determinants of farmland prices. It explicitly takes spatial dependencies among neighbouring areas into account, not only in form of spatially lagged farmland prices (spatial lag model) but also in form of spatially lagged explanatory variables (spatial Durbin model). Results show that both agricultural and non-agricultural factors are important for explaining farmland prices in both countries. Differences seem to be stronger within the member states than between the countries.
Keywords: farmland prices, spatial lag model, spatial Durbin model

Zusammenfassung

Dieser Beitrag analysiert Einflussfaktoren auf die Kaufpreise für landwirtschaftliche Flächen in Deutschland und Italien mit Hilfe eines räumlich-ökonometrischen Modells. Dabei werden nicht nur räumliche Abhängigkeiten in der endogenen Variable (spatial lag Model), sondern auch in den exogenen Variablen (spatial Durbin Model) berücksichtigt. In beiden Ländern sind landwirtschaftliche und außerlandwirtschaftliche Faktoren bedeutend. Die Unterschiede scheinen innerhalb der Länder größer zu sein als zwischen den Ländern.
Schlagworte: Kaufpreise für landwirtschaftliche Flächen, spatial lag Model, spatial Durbin Model

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1. Introduction

Land is a non-renewable and scarce resource needed for all human activities. The importance of farmland for the agricultural sector is underlined by its dominant position among the agricultural farm assets (HÜTTEL et al., 2013). Hence, the recent development of increasing farmland prices in many member states of the European Union (CIAIAN et al., 2012) strengthen the need of a better understanding of the price mechanism. However, the relative increase and the absolute level of farmland prices differ not only between the member states but also within the member states (CIAIAN et al., 2012). This also applies to the development of farmland prices in Germany and Italy. In Germany, the average farmland price was comparatively constant until 2006, but then strongly increased reaching an average level of approximately 18,000 €/ha in 2014 (DESTATIS, 2015). In Italy, the trend of average farmland prices are characterised by an increase until the end of 2007, followed by a time period of a comparatively constant level with an average value of approximately 20,000 €/ha in 2014 (ISTAT). Against this background, this study aims to empirically determine the most important factors influencing farmland prices in Germany and Italy and comparing these farmland markets.

2. Data and methods

Figure 1 shows the average farmland price in Germany (a) and Italy (b) on NUTS 3 level in 2010. Due to missing data, some counties and provinces are excluded. In Germany, the northwest and southeast regions are characterized by high farmland prices. Additionally, high farmland prices occur in and near big cities. A low price level can be detected in the eastern federal states in Germany. In Italy the north, particularly the northeast, is characterized by high farmland prices, while the remaining regions showing relatively low farmland prices. Definitions and descriptive statistics for the variables, which are expected to influence farmland prices are given in Table 1.[1] For Germany, all

[1] EU direct payments could influence farmland prices, but are only available for Germany. Because they are equal within the federal states and only minor differences exist between them, they have not been included in the analysis.

data is provided by the German Federal Bureau of Statistics (DESTATIS, 2000 and 2010); except for the soil quality index which is provided by WENDLAND et al. (1993) and the average annual precipitation which is provided by the German National Meteorological Service for the time period 1981-2010 (DWD, 2014). Data sets for Italy are provided by the National Institute of Agricultural Economics (INEA, 2010) with respect to agricultural variables. Econometric variables are obtained by the Italian national statistical institute (ISTAT, 2000 and 2010).

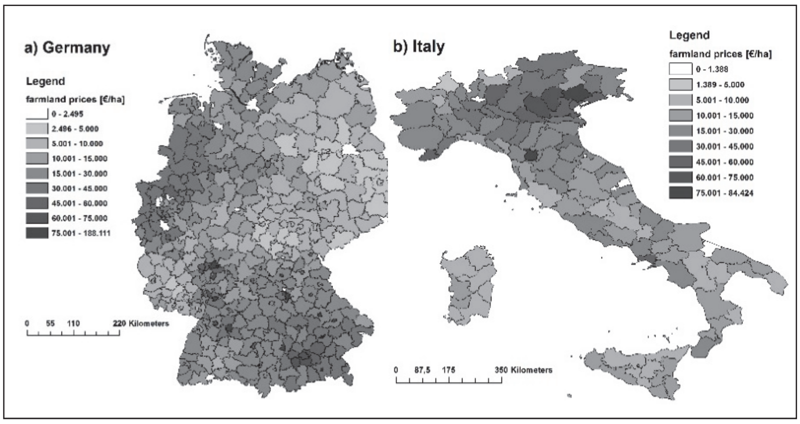

Figure 1: Farmland prices in 2010 on NUTS 3 level for a) Germany and b) Italy
Sources: OWN ILLUSTRATION according to data from DESTATIS, 2010 and INEA, 2010

The hedonic price model has become a standard empirical approach for modelling farmland prices as a function of various factors (c.f. HÜTTEL et al., 2013). Recent studies take spatial dependencies into account by using various spatial models which can be implemented as extensions of a standard linear regression model (OLS) (LESAGE and PACE, 2009, 16). According to ANSELIN (1988) a spatial lag model takes spatial dependence in the dependent variable into account which can be a result of spill-over effects. In the case of farmland, prices in one county or province can be influenced by realized prices in neighbouring areas because buyers typically act as competitors for land within a defined radius around their farms (c.f. HABERMANN and BREUSTEDT, 2011) and, furthermore, property owners as well as prospective buyers usually use reference prices found in the same region. Spatial heterogeneity refers to the lack of uniformity of the effects of space (ANSELIN, 1988, 13). In the case of farmland, e.g. climate factors are potential explanatory variables for land prices, which have a spatial structure. If such variables are unobservable, the spatial structure often remains in the error term, which is taken into account by a spatial error model.

Tab. 1: Variable definition and descriptive statistics (N_{DE} = 385; N_{IT} = 107)

Definition	**Germany Mean (Std.Dev.)**	**Italy Mean (Std.Dev.)**
Population density [inhabitants/km²]	450.43 (585.17)	241.54 (325.86)
Relative population change (2010-2000) [%]	-3.09 (5.80)	6.68 (24.58)
Gross value added [€/capita]	25860 (10155)	22584 (6074)
Construction permits [Number]	308.71 (225.42)	325.27 (234.96)
Share of permanent crop on utilized agricultural area [%]	0.07 (0.66)	19.48 (16.90)
Average farm size [ha/farm]	76.15 (77.19)	11.13 (8.13)
Number of all farms	772.50 (696.06)	14867 (13200)
Share of farms with livestock production [%]	67.53 (20.30)	20.68 (16.09)
Livestock density [Livestock units/ha]	0.73 (0.50)	0.79 (0.88)
Wheat yield [dt/ha]	69.30 (10.17)	38.55 (14.51)
Agricultural gross value added [€/ha]	1462.21 (1203.28)	3265.41 (3671.6)
Share of utilized agricultural area on total area [%]	41.56 (15.84)	40.66 (16.45)
Soil quality index [0;100]	45.84 (12.20)	-
Average annual Precipitation [mm]	839.70 (211.59)	-

Sources: OWN CALCULATIONS based on aforementioned sources

The general spatial model contains spatial dependence in both the dependent variable and the disturbances (LESAGE and PACE, 2009, 32):

$$y = \rho W_1 y + X\beta + u \qquad \text{with } u = \lambda W_2 u + \varepsilon \qquad [1]$$

where y is an (N x 1) vector of farmland prices in €/ha (N = Number of observations), W_1 is an (N x N) weight matrix of the spatial relationships between the NUTS 3 regions and ρ is a spatial autoregressive parameter. Furthermore X is an (N x k) matrix of explanatory variables with an associated (k x 1) vector of regression coefficients β (k = Number of explanatory variables). The error term u composed of the coefficient λ, which reflects the spatial autocorrelation of the residuals u, another

(N x N) weight matrix W_2 and an (N x1) vector of normally distributed errors ε. Parameter restriction leads either to the spatial lag model (λ=0) or to the spatial error model (ρ=0).

The spatial Durbin model includes both a spatial lag of the dependent variable (WY) and spatially lagged explanatory variables (WX) and can be achieved by adding WX to [1] and setting λ=0:

$$y = \rho W_1 y + X\beta + W_2 X\theta + \varepsilon \qquad [2]$$

where θ is a vector of regression coefficients for the spatially lagged explanatory variables.

We applied the maximum likelihood method for model estimation (c.f. ANSELIN, 1988). Moran's I statistic and the robust version of the Lagrange multiplier test can be used to test for spatial autocorrelation in the data and to identify the source of spatial autocorrelation, respectively. The weights of the row-standardized matrix W (we set W_1=W_2) are the inverse distances between the centroids of German counties and Italian provinces. The cut-off level is 60 km for Germany and 70 km for Italy, i.e. no impacts of counties or provinces beyond this distances are assumed. The distances used make sure that every county or province has at least one neighbour. In models containing spatial lags of the explanatory or dependent variables, interpretation of the parameters becomes more complicated, because they expand the information set to include information from neighbouring regions. As a consequence, a change in an explanatory variable for a single region can potentially affect the dependent variable in all other regions. Also feedback loops can occur where region i affects region j and region j affects back to observation i. For an interpretation of the marginal effects of explanatory variables, summary measures of the resulting average direct and average indirect impacts have to be estimated (LESAGE and PACE, 2009, 34 ff.). We only show coefficient estimates and limit our interpretation to the signs of explanatory variables. In econometric models of farmland prices the problem of endogeneity can exist for two major reasons (c.f. HENNING and LATACZ-LOHMANN, 2016): First, we use realised farmland prices instead of not observable expectations about future which can lead to an expectation error. Second, high farmland prices can result in adaptations at farm level (e.g. increasing livestock density). Thus, we tested for presence of endogeneity for all agricultural explanatory variables (non-agricultural variables are assumed to be exogenous) using variable realisation from the year 2000 as instrument variables according to WOOLDRIDGE (2009). The test shows that the endogeneity assumption can be rejected for North Italy, but for South Italy we have to use the instrument variables for livestock density and share of farms with livestock production. For Germany, we have to use the instrument variables for farm size and number of farms. The F-tests for weak instruments were significant, indicating good instrument quality.

3. Results

The agricultural structure and land market considerably differ between West and East Germany indicating that separate regressions are needed (c.f. HABERMANN and BREUSTEDT, 2011). Similarly, separate regressions were conducted for Italy by defining two sub farmland markets on NUTS 1 level: North Italy (north-west and north-east) and South Italy (centre, south and islands). The Moran's I test statistics reveal significant spatial autocorrelation for both OLS models in Germany and the OLS model of North Italy. The robust version of the Lagrange Multiplier test indicates that a spatial lag model is proper for West Germany and North Italy (using a significance level of 5% for both tests). For East Germany, the robust version of the Lagrange Multiplier test was not significant for both spatial effects. Hence, a standard linear regression for East Germany and South Italy is sufficient. For the OLS models the Breusch-Pagan-Test against heteroscedasticity was significant for East Germany but not for North Italy and the Shapiro-Wilk test indicates that the assumption of normal distribution of residuals has to be rejected for both regions. Based on the Box-Cox testing procedure, a power 0.5 transformation and a logarithm transformation of the price is used for South Italy and East Germany, respectively. In South Italy, two outliers were identified and excluded from further analyses. As a result, high coefficients of determination are achieved for both regions (see Table 2). For South Italy both, the agricultural and overall gross value added (indicators for returns to land and per capita income, respectively) have a statistically high positive influence. The number of farms also positively effects the farmland prices indicating that higher competition for land exists in regions where more farms are located. Farm size and construction permits negatively influence the farmland prices. Low farm sizes could be an indicator e.g. for farms with permanent crops with higher returns to land and thus higher willingness to pay. The negative influence of construction permits was not expected. It is possible that areas with higher urban development are characterized by worse conditions for agricultural production. For East Germany all significant explanatory variables positively influence the farmland prices. Except for population density, all explanatory variables are agricultural factors, which indicates the importance of production conditions in East Germany.

Tab. 2: Coefficient estimates for South Italian and East German farmland prices

Variable	East Germany	South Italy
Intercept	6.4954***	57.2168***
Population density	0.0005***	
Construction permits		-0.0208*
Gross value added		0.0022***
Number of farms	0.0004**	0.0004**
Farm size	0.0024***	-1.0294***
Agricultural gross value added		0.0065***
Wheat Yield	0.0146**	
Soil Quality Index	0.0129***	
Livestock density	0.1952*	
Adj. R^2	64.13	90.02

Note: °, *, **, *** Significance at the 10, 5, 1 and 0.1 per cent level, respectively. Only statistically significant variables are shown.
Source: OWN CALCULATIONS

The estimated coefficients of the spatial models for Italy and Germany are given in Table 3. Both spatial lag models show a significant positive sign of the spatial lag estimator ρ with a similar coefficient of 0.377 and 0.379 for West Germany and North Italy, respectively. This indicates that an increase of the average neighbouring farmland price by one € per hectare raises the farmland price at location i by 38 Cents per hectare in both regions. The spatial-lag model for North Italy shows, that the variables population density, population change, and agricultural gross value added are significant and have a positive influence on farmland prices. The spatial lag model for West Germany also shows a positive influence of all significant explanatory variables. Farmland prices increase with population density, overall and agricultural gross value added as well as the share of agricultural land. Hence, agricultural returns are just as important as the non-agricultural factors in both

regions which highlights the importance of taking into account both impacts of agricultural returns and impacts of the demand for non-agricultural land use for explaining farmland prices, particularly if a significance level of 10% is considered.
The comparison with the Spatial Durbin Model shows that the consideration of spatially lagged explanatory variables results in a lower or not significant spatial lag coefficient, while the log likelihood value significantly increases according to the likelihood ratio test. A lower spatial lag coefficient in the Spatial Durbin model is reasonable because the spatially lagged explanatory variables contribute to the explanation of the spatial effects, which have solely been captured by the spatial lag coefficient so far.

Tab. 3: Coefficient estimates for North Italian and West German farmland prices

	West Germany		**North Italy**	
Variable	Spatial lag	Spatial Durbin	Spatial lag	Spatial Durbin
Spatial lag	0.3768***	0.1945°	0.3790**	-0.0362
Intercept	-23044*			
Population density	12.445***	11.123***	16.4459**	16.55**
Population change	472.01°		877.3213*	812.95*
Gross value added	0.2389**	0.1497°		
Construction permits	8.3890°	9.9937*		
Number of farms		-2.5583*	0.9152°	1.7751***
Agr. Gross value added	5.4029***	5.5498***	2.0555**	3.0676***
Share of UAA	251.51**			
Permanent crop				-372.39°
Lag of population density		11.692*		38.375**
Lag of livestock farms		355.15*		
Lag of Wheat yield		-549.58**		
Lag of number of farms		5.7531°		2.4132**
Lag of permanent crop		-9085.9°		-1285.60**
Log likelihood	-3343.212	-3322.656	-483.948	-463.639

Note: °, *, **, *** Significance at the 10, 5, 1 and 0.1 per cent level, respectively. Only statistically significant variables are shown.
Source: OWN CALCULATIONS

In both regions, most of the significant explanatory variables of the spatial lag model are still significant in the spatial Durbin model. In North Italy, the spatially lagged term of population density and number of all farms increase the farmland prices. For West Germany, the spatially lagged term of population density, share of farms with livestock production, and number of farms have a positive influence on farmland prices, too. This indicates that a higher number of competitors for land in neighbouring areas led to farmland price increases in the observed area.

The share of permanent crops and its spatially lagged term have a negative impact in North Italy. In West Germany, the spatially lagged terms of the share of permanent crops and wheat yield level negatively influence the farmland prices. While there is no plausible argument for the negative sign of the spatially lagged wheat yield for West Germany, the negative sign of the share of permanent crops might indicate that these farm types prefer to rent land and to invest in their field inventories instead of buying land and thus, lower demand for land leads to decreasing farmland prices. This has to be further analysed.

Discussion and Conclusions

Strong increases of farmland prices during the last decade lead to discussions as to whether further interventions in farmland markets are necessary. Hence, reliable results of the most important factors influencing farmland prices are needed. The results of this study show that farmland markets are extremely heterogeneous and for both countries agricultural as well as non-agricultural factors should be taken into account for explaining farmland prices. Otherwise, interventions could be ineffective or leading to unintentionally market distortions. We found comparable results for West Germany and North Italy, but results differ between West and East Germany as well as between North and South Italy. This might indicate that differences are higher within the countries than between the member states.

Unfortunately, data on farmland prices are generally not available on low aggregation level for both countries. Hence, we have to rely on NUTS 3 level data meaning that spatial effects, that only occur locally, cannot be considered. Thus, the high aggregation level can influence the estimation results. This might be an explanation for the not expected signs of some explanatory variables. Hence, further research with detailed data bases is needed to determine the most important influencing factors. Based on this, questions can be answered if stronger interventions are needed and if so, to support them.

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