A Spatial Hedonic Analysis of Agricultural Land Prices in Bavaria

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***Abstract* - We apply a spatial hedonic pricing approach to a dataset of more than 13.000 agricultural land sales transactions between 1999 and 2007 in order to identify the factors influencing agricultural land prices in Bavaria. Our results confirm strong influence of land quality, urban pressure and land market structure. In addition, involvement of public authorities as seller or buyer increases sales prices. We also confirm a strong spatial relationship. Neglecting this, leads to biased estimates. The Fischler Reform did not considerably change the market and its determinants.**

INTRODUCTION

Eventually, the question of what determines agricultural land values has occupied economists since more than 200 years (Smith, 1776; von Thünen, 1842) and has been an important research topic in agricultural economics throughout the last century (Lloyd, 1920; Scofield, 1957; Shaik et al., 2005). Although, a few econometric contributions date back as early as the late 1930's, regression analysis of land value determinants took off in the 1960's (e.g. Herdt and Cochrane, 1966) and continues since then (Alston, 1986; Weersink et al., 1999). Recently, spatial econometric techniques have been introduced in agricultural land price studies. Pyykkönnen (2005) was to our knowledge the first who accounted for spatial relationships in a European land price study when he estimated the determinants of Finnish land prices. Breustedt and Habermann (2011) were the first who used a general spatial model to quantify the incidence of EU per hectare payments on land rental prices. We present an approach where we use a general spatial model similar to Breustedt and Habermann (2011) to analyze a unique dataset of agricultural land sales transactions in Bavaria.

DATA

Our analysis is based on a dataset of more than 13000 agricultural land sales transactions in the years 1999, 2001, 2005 and 2007. The first two years denote the era of coupled direct payments before the Fischler reform whereas the last two years denote the time of decoupled direct payments after the Fischler reform. The dataset is unique in the sense that transaction specific information on sales price, soil quality, plot size, land use (cropland vs. grassland), municipality affiliation and whether a public authority was a seller or buyer is known. Descriptive statistics are given in Table 1. Moreover, we add information on population growth, the share of rented land in relation to total land, average agricultural plot size and the distance to the next urban center of the respective municipality, as well as county averages of sales prices for building land. These variables should account for regional differences in urban pressure and land market structure. We also add average direct payments in the respective municipality to account for the fact that agricultural subsidies may capitalize into land values.

Table 1. Descriptive Statistics.

Variable		Mean	SD
Sales price	€/m^2	2.18	1.37
Soil quality rating	pt.	44.00	12.77
Size of transacted plots	ha	1.76	2.06
Public seller	%	16.45	
Public buyer	%	3.43	
Municipal population growth	Persons	19.62	65.42
Share rented vs. total land	%	46.30	10.73
Municipal average plot size	1.04	1.04	0.44
City distance	km	29.76	14.02
Price of building land	€/m^2	79.03	59.31
Direct payments	€/ha	278.45	93.23
Transactions	#	13690	

METHOD

In analyzing the determinants of agricultural land prices we follow a hedonic pricing approach. Rosen (1974) starts from the assumption that the price of a good (L) depends on its characteristics (X) (e.g. soil quality).

$$L = \alpha + X\beta + u\,, \tag{1}$$

where in our case L is a *m*x*1* vector of per acreage land prices, α is the constant term, X a *m*x*n* matrix of parcel specific characteristics with *n* explanatory variables, β a vector of parameters to be estimated and u is the error term.

Given that spatial factors have an influence on land prices the hedonic pricing model can be extended to

$$L = \alpha + \rho W_1 L + X\beta + u\,, \tag{2}$$

$$u = \lambda W_2 u + \varepsilon. \tag{3}$$

Where W_1 and W_2 are the *n*x*n* standardized spatial weight matrices, ρ the spatial lag parameter, λ the spatial error coefficient and ε the uncorrelated error term.

We refer to a spatial lag model if a spatially lagged dependent variable is introduced as in

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equation (2) and to a spatial error model if a spatially lagged disturbance term is included as in equation (3). The spatial lag parameter ρ measures how much an observed price in a land sales transaction is influenced by the price of the geographically nearest neighboring land sales transactions (spatial dependence). The spatial error coefficient λ should absorb unobserved effects obtaining a spatial structure (spatial heterogeneity) which would otherwise end up in the error term. While a spatial lag model has a direct interpretation a spatial error model's purpose is to obtain unbiased estimates for the other coefficients.

A Moran's I test indicates spatial autocorrelation in our dataset. The Lagrange Multiplier (LM) test does not recommend us to strictly prefer one of the two specifications and therefore we use a general spatial model which combines the spatial lag with the spatial error model.[2] In estimating our model we apply a generalized two stage least squares approach which accounts for heteroskedasticity in the disturbance terms developed by Kelejian and Prucha (2010). Since the dataset is highly unbalanced we estimate separate cross - sections for each year.

Results

Due to space limitations we only present a selection of explanatory variables for the general spatial model regressions (Table 1).

Table 2. General spatial model regression results.

Variable	1999	2001	2005	2007
	Coefficients			
Public seller	0.7608***	0.5849***	0.9898***	1.0981***
Public buyer	0.7563***	0.6221***	0.7544***	0.6712***
Soil quality	0.0558***	0.0527***	0.0480***	0.0555***
Direct paym.	0.0003	0.0001	0.0016	0.0009
Share rented	0.0367***	-0.0204***	-0.0289***	-0.0372***
City distance	0.0157***	-0.0075*	-0.0005	-0.0104***
Pr. build. land	0.0061***	0.0042***	0.0043***	0.0052***
Spat. lag ρ	0.2675***	0.3093***	0.3336***	0.2435***
Spat. error λ	0.4076***	0.4246***	0.3461***	0.3793***

***p<0,01, **p<0,05, *p<0,10

An average spatial lag coefficient of 0.288 indicates that an increase in sales prices of a particular transaction by €1 increases the price of neighboring transaction by about 29 cents. Agricultural land prices increase by 75 cents/m^2 when either the seller or the buyer of the plot is the public administration and by 53 cents/m^2 for a 10 point higher rating in the soil quality index. While we find a significant capitalization of EU direct payments into agricultural land prices at least after the Fischler reform in 2004 with standard OLS regressions (not reported here) the coefficients are smaller and not significant when we estimate a general spatial model. A 10% higher share of rented land in the respective municipality leads to -31 cents/m^2 smaller land prices. This might has to do with the regional land sales market structure. If given the choice, managers of rapidly growing farms would rather rent land than to buy it because capital is needed to finance machinery and buildings. Land prices reduce by -8.5 cents/m^2 for additional 10 km further distance to the next city or regional center. Moreover, the prices of agricultural land rise by 5 cents/m^2 with every 10 €/m^2 increase in building land prices.

[2] LeSage (1999) provides an extensive review of the different specifications.

Discussion

Our analysis confirms the substantial influence of land productivity, urban pressure and the regional land market structure in land price determination. In addition involvement of public authorities significantly increases sales prices. Our analysis also confirms that land prices have a spatial dimension. Neglecting these spatial relationships leads to biased and erroneous estimates. The 2003 Fischler Reform did not change the land market and its determinants in a significant way.

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