Determinants of Agricultural Cash Rents in Germany: A Spatial Econometric Analysis for Farm-Level Data

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Summary

This article analyses determinants for 2001 farmland rental prices from 4376 farms in Germany. We derive our regression equation from a spatial reaction function to allow for spatial transmission of rental prices. Results from a general spatial model show that a € 1 per hectare higher rental price in a farmer's neighbourhood coincides with a € 0.57 higher rental price he has to pay. For policy evaluation we estimate the marginal incidence of regional EU per-hectare premiums. We find a value significantly above one and propose an explanation for this counterintuitive result based on the long-running nature of rental contracts, simultaneity of premium introduction and intervention price cuts as well as assumed stickiness of rental prices. Regional livestock density, which is indirectly influenced by different policies, is also a major determinant of rental prices.

Key words: farmland rental price, per-hectare premium, spatial econometrics, subsidy incidence

1. Introduction

Between 1993 and 2004 approximately 160 billion € have been paid for arable crops as so-called per-hectare premiums to farmers in the EU (European Commission, 2009). Who got this money in the end - farmers or landlords? Although farmers directly receive these payments, they may pass a considerable share to landowners via increased farmland rental rates. There are several econometric studies about the incidence of U.S. agricultural subsidies on farmland rental rates (Herriges et al., 1992; Kirwan, 2009; Lence and Mishra, 2003; Roberts et al., 2003)[1]. However, only Fuchs (2002) provides such an estimate for EU per-hectare premiums.[2] This is little empirical basis for evaluating the distributional effects of 160

[1] On the theory of subsidy incidence see Schultze, 1971; Schmitz and Just, 2002 and Kilian and Salhofer, 2008. Empirical evidence for the incidence on land values is given by Barnard, 2001; Featherstone and Baker, 1988; Goodwin and Ortalo-Magne, 1992; Traill, 1982 and Weersink et al., 1999.

[2] Patton et al. (2008) mainly focus on the impact of livestock premiums (headage based payments) on land rents in Northern Ireland based on data from 214 farms in an unbalanced panel from 1994 to 2002.

billion € paid by the European Commission. We, thus, aim at contributing a further piece to the incidence puzzle of this agricultural subsidy in the EU.

In line with the literature we estimate the marginal impact of subsidies on farmland rental rates as a measure of incidence. More precisely, we regress German farm-level rental prices on farm-specific economic and production characteristics as well as personal attributes of the farmer. Furthermore, we include regional agricultural, economical, and demographical characteristics as well as the level of per-hectare premiums.

Our regression analysis is different from former analyses on incidence since we apply the so-called "general spatial model" (LeSage and Pace, 2009) from spatial econometrics. Existing studies do not appropriately account for fundamental characteristics of a land market: its spatial dimension and the interrelationship of land prices at different locations. While the first characteristic may cause spatially dependent errors, the second calls for integrating spatial price transmission into the econometric model by means of a spatial lag variable (Anselin, 1988). For our case, it turns out that a combined spatial lag and spatial error model – the general spatial model – is necessary to obtain consistent and efficient regression results. Lence and Mishra (2003) as well as Fuchs (2002) account at least for spatially dependent errors.

A second advantage of our analysis is the use of farm-level data. Most analyses, including Fuchs' (2002) analysis about the EU per-hectare premiums, use regional average data instead. Marginal impacts obtained from a regression of individual observations may differ substantially from the marginal impacts based on average data regressions (Robinson, 1950; Orcutt et al., 1968). Consequently, the latter cannot be interpreted as "average behaviour" of individuals like the former.

The contribution of our study is twofold. First, we estimate the determinants of farmland rental prices by means of a general spatial model accounting for both spatial lag and error effects simultaneously. We thereby quantify spatial price transmission of rental rates. This is new to the field of agricultural land markets. Second, we quantify – based on farm-level data – the incidence of EU per-hectare premiums on farmland rental prices before decoupling .

In the remainder of this article, we first introduce a simple microeconomic model for spatially interrelated farmland rental prices. Then we describe our data before we set out the regression methodology. Estimation results from different model specifications are followed by conclusions.

2. Economic Determinants for Rental Prices

2.1 Model for land rental prices

Empirical analyses about rental prices are commonly based on a regression function such as

$$r = X\beta + \varepsilon \tag{1}$$

with the rental price r, X is the $n\times k$ matrix of k rental price determinants and control variables and ε is the error term. The derivation of (1) follows Lence and Mishra (2003) and is based on profit maximisation. For simplicity we, however, allow for only one crop with random yield $\tilde{y}$ which is a production function of a farmer's rented acreage a (measured in hectare),[3] the level of variable inputs b and random environmental conditions during the growing season $\tilde{w}$. The product price $\tilde{p}$ is also random, price for variable inputs s and fixed costs C are non-random. In our case *subsidies* are paid per hectare and can be assumed to be non-random as will be explained below. The profit $\tilde{\pi}$ in a period is random and follows

$$\tilde{\pi} = \tilde{p}\tilde{y}\left(a,b,\tilde{w}\right)a + a\ subsidies - ar - bs - C \tag{2}$$

The profit is revenues plus subsidies less rental payments and costs for variable and fixed inputs. The farmer maximizes the expected profit E[$\tilde{\pi}$] with respect to acreage a and variable inputs b. The first-order condition for rented acreage (assuming an interior solution) becomes

$$\frac{\partial E\left[\tilde{\pi}^*\right]}{\partial a} = \frac{\partial E\left[\tilde{p}\tilde{y}^*\right]}{\partial a}a + E\left[\tilde{p}\tilde{y}^*\right] + subsidies - r = 0 \tag{3}$$

Asterisks denote the optimal level of variables following from the optimal decisions on a and b. The optimal land acreage then depends on the marginal profit from production (change of per hectare profit due to (dis)economies of scale multiplied by acreage plus change of profit due to more acreage) plus subsidy per hectare and the rental price. Lence and Mishra (2003) additionally assume that "there is a relatively small geographical area, say, a county, where farmers face the same prices, all farmers are alike and are represented by (1) through ... [(3)],

[3] The production function can easily be adjusted for owned acreage by adding it to the rented acreage. However, it is assumed that land is neither sold nor bought in the considered period.

and the total supply of tillable land is fixed" (page 754). It follows an equilibrium rental price in that region (county). This equilibrium price can be put into a regression framework like (1) assuming an appropriate functional form for the production function.

The derivation of (1) is adequate if rental prices in the regression represent regional rental prices equal for all farmers in that region. However, two important drawbacks for empirical analyses have to be stated. First, this derivation can be at odds with estimating (1) for farm-level data because intra-regional variation of rental prices is assumed away in the derivation. Second, if (1) does not account for spatial dependencies among (regional) rental price observations the implicitly assumed spatial price transmission on the land market takes two fundamentally different states: within the region price transmission among renting farmers is perfect (by assumption there is only one price in the region), while it is zero between two farmers in different but neighbouring regions (because prices in different regions are assumed to be independent).

2.2 *Model allowing for spatial price transmission of land rents*

An alternative empirical specification may follow from adding a spatial lag ($\rho W_1 r$) to (1). The so-called spatial lag model (Anselin, 1988)[4] is given as

$$r = \rho W_1 r + X\beta + \varepsilon \qquad (4)$$

The spatial lag includes an $n \times n$ matrix W_1 of spatial weights that represents the spatial structure among all observations and the spatial autoregressive parameter ρ which is to be estimated. Using farm-level rental prices (4) allows for both: intra-regional heterogeneity of farmers (and rental prices) as well as rental price transmission (if $\rho \neq 0$) that does not fundamentally change at a region's border. Analogously to (1) this specification can be derived from profit maximisation. But (4) is more general than (1) because it allows for imperfect competition on the land market in the sense that a farmer i has a certain power to set the rental price, i.e. $a_i = a_i(r_i)$. This is comparable to the common model of monopolistic competition in which sellers have partial control over prices. Farmer i's profit becomes

$$\tilde{\pi}_i = \tilde{p} y_i \left(a_i\left(r_i\right), b_i, \tilde{w}_i\right) a_i\left(r_i\right) + a_i\left(r_i\right)\ subsidies - a_i\left(r_i\right) r_i - b_i s - C_i \qquad (5)$$

[4] Anselin (1988) also calls this specification mixed regressive, spatial autoregressive model, while LeSage and Pace (2009) call it spatial autoregressive (SAR) model.

The farmer here maximizes his expected profit with respect to variable inputs b_i and his rental price r_i. The first-order condition for the rental price becomes

$$\frac{\partial E\left[\tilde{\pi}_i^{**}\right]}{\partial r_i}=\frac{\partial E\left[\tilde{p}\tilde{y}_i^{**}\right]}{\partial a_i}\frac{\partial a_i\left(r_i\right)}{\partial r_i}a_i\left(r_i\right)+E\left[\tilde{p}\tilde{y}_i^{**}\right]\frac{\partial a_i\left(r_i\right)}{\partial r_i}+subsidies\frac{\partial a_i\left(r_i\right)}{\partial r_i}-\frac{\partial a_i\left(r_i\right)}{\partial r_i}r_i-a_i\left(r_i\right)=0 \tag{6}$$

Two asterisks denote the optimal level of variables following from the optimal decisions on r_i and b_i under imperfect competition on the land market. If we now allow neighbouring farmers to compete for the same plot of land farmer i's equilibrium rental price is affected by the rental prices r_{-i} of his competitors. Hence the land amount farmer i rents becomes a function of the rental price he pays and the prices his competitors pay: $a_i = a_i\left(r_i, r_{-i}\right)$. The $-i$ subscripts stand for other farmers than i. Farmer i's optimal rental price becomes

$$r_i^{**}=\frac{\partial E\left[\tilde{p}\tilde{y}_i^{**}\right]}{\partial a_i}a_i\left(r_i\right)+E\left[\tilde{p}\tilde{y}_i^{**}\right]+subsidies-a_i\left(r_i,r_{-i}\right)\left(\frac{\partial a_i\left(r_i,r_{-i}\right)}{\partial r_i}\right)^{-1} \tag{7}$$

The optimal price then depends on the terms analogous to (3) plus change in rental expenditures for the rented acreage due some price setting power.

More generally, (7) represents a reaction function R of the type

$$r_i = R\left(r_{-i}, X_i\right) \tag{8}$$

which shows that a farmer i's rental price depends on (exogenous) characteristics X_i and the rental prices r_{-i} of other farmers. Following Anselin (2002) a spatial lag model such as (4) "is an implementation of the reaction function by specifying a linear functional form for R and by restricting the set of interacting agents to the "neighbour" structure expressed in the spatial weights" (page 249) of W_1.

Brueckner (2002) refers to such a framework of strategic interaction that yields a spatial reaction function as *spillover* model. The *spillover* characteristic in our model results from (imperfect) competition on the land market.

2.3 *Impact of selected policies on land rents*

Previous studies include various determinants of land rents in *X*. In the following paragraph we focus on two determinants which are of particular importance from a policy perspective. We first explain how per-hectare premiums may influence land rents. Secondly we turn to the impact of livestock density on farmland rental rates. Livestock density is affected by different policies which, thus, may influence land rents indirectly.

In the literature the impact of agricultural subsidies on land prices is referred to as incidence. We quantify the incidence of per-hectare premiums - paid in the EU between 1993 and 2004 – on farmland rental rates. These EU payments were enacted in 1992 to compensate farmers for the reduction of intervention prices (European Commission, 1997). Intervention prices were reduced by one third (50 ECU/tonne) in three steps from 1993-1995. The per-hectare premiums were paid for land cultivated with cereals, oilseeds, protein plants or set aside (Table 1). These payments were the product of a reference yield times a crop-specific institutional amount. Thus, they were coupled to production. Member states were responsible for drawing up regionalisation plans to define yield regions to which they had to assign the reference yield.[5] It was calculated as the average yield of the period 1986-90, excluding the highest and lowest yields. In contrast to several U.S. subsidies analysed in the incidence literature farmers in our sample were able to predict the payment level without uncertainty[6].

Table 1. Levels of compensatory payments applicable since 1995/96

Land use	Institutional amount	Regionalisation
cereals (grain and silage)	54.34 ECU/t	multiplied by the regional cereals reference yield
oilseeds (rapeseed, sunflower, soybean)	433.5 ECU/ha	adjusted by the regional reference yield of cereals or oilseeds
protein crops (peas, beans, lupins)	78.49 ECU/t	multiplied by the regional cereals reference yield
set-aside	68.83 ECU/t	multiplied by the regional cereals reference yield

Source: European Commission (1997).

5 The number of yield regions was quite different among the member states (e.g. UK: 7 regions, Germany: 27, France: 107, Italy: 256, and Spain: 400; compare European Commission, 1997).

6 A small qualification is that uncertainty followed from potential penalties if the so-called base area was exceeded. Usually these thresholds were not binding for our farmers in Lower Saxony in contrast to regions with substantial changes in the regional cropping pattern after the introduction of the payments. Examples are German federal states on the former GDR territory. For more details compare European Commission (1997).

The incidence of subsidies on land rental values depends on the specific type of the subsidy and the competition on the land market. If subsidies are coupled to production they generally exhibit production effects and result in incomplete incidence, because the subsidy is partly necessary to cover production costs (Roberts et al., 2003). If subsidies do not impact production decisions, as is the case for truly decoupled payments, and the land market is highly competitive theory predicts complete incidence as Patton et al. (2008) find for so-called less favoured area payments in the EU. They were paid for each hectare within specific regions irrespective of the hectare's agricultural usage. If the level of payments is uncertain before the rental contracts are set up as in the U.S. an incomplete incidence can be expected because a risk-averse renter demands a share of the expected subsidy as risk premium. Kirwan (2009) as well as Lence and Mishra (2003) provide empirical evidence for the incidence of various U.S. payments.

What level of incidence can we expect for Western German rental data and per-hectare premiums? On the one hand there are two arguments for a high incidence: the empirical impact on production decisions seems to be limited and competition for land is high in Western Germany. On the other hand the payments were introduced as compensation for price reductions. Consequently, the total effect on profitability may not be clear to all landowners and some renters may have managed to negotiate rents below their marginal profit from the rented acreage. Overall, we can only formulate the general hypothesis that the incidence is positive for our case.

In Germany the farmers are further subsidised. Between 2000 and 2004 a total sum of 564.6 Mill. € has been paid as investment aid for livestock operations, especially for stables and other buildings (Dirksmeyer et al., 2006). This may indirectly influence land rental values via increased animal density. Land is an important production factor for livestock operations in Germany, because farmers are restricted in the level of manure they are allowed to deploy on their acreage. If a farmer wants to keep more livestock than a certain threshold level (approximately two animal units per hectare, i.e. 1000 kg live weight) he must either get additional acreage or give manure to farmers operating below this threshold. In addition, livestock operations with low animal density are privileged by German tax regulation. This additionally motivates farmers to rent more land to reduce their livestock density. We include regional livestock per hectare in our regression, such as Fuchs (2002). In addition, we test if farmers above the two animal unit threshold pay higher cash rents. Policy evaluation in this case is thus only indirect.

3. Data

We take our farm-level data from profit-and-loss-statements of farms located in the German federal state of Lower Saxony. They were collected by Landdata Ltd., the market leader of farm accountancy services in Germany. Additionally, we include county-level averages based on an agricultural census survey und additional official statistics provided by the Federal Statistical Office of Germany. We further use county-level climate variables from the German Weather Service (DWD).

We base our estimations on 4,376 renting farms. For most variables, we use averages for the years 1999-2001 (see Table 2) to reduce the impact of volatile agricultural yields and prices. Our sample farms represent the typical range of farms in Lower Saxony. On average the farmer is 48 years old and operates on 77 hectares (55% rented acreage). Most farms combine crop and livestock production.

Our endogenous variable *rent* represents a farms rental payments divided by rented acreage. On average our farmers pay a cash rent of € 259 per hectare. The variable does not distinguish between contracts that have been set up between relatives and contracts at arm's length. In Germany, a considerable share of the rent contracts is signed for several years (Swinnen et al., 2008, p.54) and hence our variable includes contracts signed in different years. We take cash rent values from 2001 to cover rental decisions from a stable political environment after the introduction of EU payments in 1993.

Some details about our subsidy variable: our farms are located in nine of ten yield regions in Lower Saxony. We use the payments for cereal acreage, because payments for other cultures do not obtain additional information for the regression: Payments for set-aside and protein plants are perfectly correlated with the payments for cereal acreage. Payments for oilseeds do not vary among our yield regions. On average the sample farmers received € 285 premium payments per hectare of cereal acreage.

The average livestock density on the county-level is 0.93 animal units per hectare with a maximum above 2 animal units. The average livestock on the farm-level is about 1.1 animal units per hectare with a large variation among farms. We constructed two variables for the farm-level livestock density: one with densities above 2 animal units per hectare (zero otherwise) and a second variable with densities below 2 animal units per hectare (zero otherwise).

Table 2. Variable Definition and summary statistics (N = 4376)

Variable	Definition	Mean	Std. Dev.	Min.	Max.
rent	Annual cash rent per hectare in € (2001 farm average)	258.9	150.3	13.20	1495
value added	Farm net value added (FADN) minus wages paid and per-hectare premiums (in € per hectare)	447.5	474.9	-7324	4267
premium	Per-hectare premiums for cash crops (in € according to nine different yield regions)	284.7	36.5	226.50	371.2
animaldens	Animal density in 500kg (= animal unit (AU)) per hectare	1.144	1.099	0	13.45
animaldens_cty	County mean of animal density	0.930	0.457	0.148	2.374
pasturediff	Share of rented pasture land to total rented area multiplied with regional absolute difference between arable and pasture cash rent	23.68	26.34	0	197.2
rentshare	Share of rented to total operated acreage	0.552	0.259	0.00513	1.392
sugarbeet	Share of sugar beets in cropping pattern	0.0509	0.0804	0	0.4704
potato	Share of potatoes in cropping pattern	0.0433	0.0975	0	0.9408
soil	Farm average soil quality (Ertragsmesszahl / 100)	35.54	14.37	10	100
farmsize	Farm size in hectares	77.25	47.16	8.329	760.0
fam_labour	Family workers per hectare	0.0230	0.0138	0.000118	0.245
capital	Capital stock minus value of land, milk- and sugar beet quota (€/ha)	3737	2368	19.58	35848
education	Education of farmer: (1) no education up to (5) university or similar degree	1.716	1.029	1	5
age	Age of farm manager	47.81	10.22	0	89
income	Average income (1999) per inhabitant on county level (€)	15558	1176	13222	19056
unemployment	Unemployment rate on county level (percentage of labour force, 1999)	8.909	2.201	5.700	14.8
pop_change	Relative population change on county level (1995-2005)	0.0469	0.0473	-0.0746	0.132
pop_density	Population density (1999) on county level (inhabitant/km^2)	166.8	109.4	42.46	490.8
farmsize_cty	Average farm size on county level (ha)	40.74	6.561	24.35	65.20
temperature	County annually average temperature	8.663	0.384	7.1	9.2
precipitation	County annually average precipitation	715.0	72.09	545.2	973.8

Source: Authors' calculations from profit-and-loss-statements (Landdata Ltd.), Census of Agriculture (Federal Statistical Office of Germany) and climate data from DWD (German Meteorological Service).

In addition to the determinants mentioned in the second section, we use farm net value added (FADN) minus wages paid and per-hectare premiums comparable to other studies (e.g. Kirwan 2009; Roberts et al., 2003; Patton et al. 2008). We included the share of pasture land over total rented land multiplied by the absolute county difference between arable and pasture cash rents to account for lower willingness to pay for pasture land. The acreage shares of sugar beets and potatoes are included. We further control for a farm's soil quality (linear and squared) and the share of rented acreage. To account for economies of scale we include the farm size measured in hectare. We further include a farm's capital stock to control for capital costs. Labour costs are supposed to be accounted for by the number of family workers per hectare[7] as well as by the regional average income and by the regional unemployment rate in line with the literature on labour migration (e.g. Todaro, 1969; Mundlak, 1978) and farm exits (e.g. Barkley, 1990). We use a farmer's age (linear and squared) and his education (Bierlen et al., 1999) to proxy e.g. bargaining abilities or impacts of a farmer's life-time working cycle. We also include the population change and population density such as Drescher and McNamara (2000).

4. Methodology

We now introduce technical aspects for estimating the determinants of farmland rental rates in our sample.

4.1 Spatial Econometric Models

Basically, spatial dependencies are modelled as extensions of a standard linear regression model (Anselin 1988 p.32; Anselin and Bera, 1998). The most general representation is as follows

$$\begin{aligned} r &= \rho W_1 r + X\beta + \varepsilon \\ \varepsilon &= \lambda W_2 \varepsilon + \mu \\ \mu &\sim N(0,\Omega) \\ \Omega_{ii} &= h_i(Z\alpha) \end{aligned} \tag{9}$$

It differs from (4) by more detailed specifications of the error term ε. The error ε consists of an error lag $W_2\varepsilon$ times the spatial error coefficient λ which is to be estimated. W_2 is an $n\times n$ spatial weight matrix comparable to W_1. The disturbance μ is an $n\times 1$ vector of error terms allowing for heteroskedasticity. Z is an $n\times l$ matrix of exogenous variables with α as an $l\times 1$ vector of parameters. The standard homoskedastic situation ($h=\sigma^2$) follows from $\alpha=0$.

[7] Wages paid to non-family workers are already considered in our variable *value added.*

Special forms of this general spatial model can be derived by imposing parameter restrictions[8]:

$\rho = 0, \lambda = 0, \alpha = 0$	standard linear regression model such as (1)
$\lambda = 0, \alpha = 0$	spatial lag model such as (4)
$\rho = 0, \alpha = 0$	spatial error model
$\alpha = 0$	homoskedastic general spatial model
no parameter restrictions	heteroskedastic general spatial model.

As we introduced above cash rent levels may be influenced by neighbouring cash rent levels, because farmers take neighbouring farmers as competitors for land into account. Hence spatial price transmission may exist ($\rho \neq 0$) and the spatial lag model is necessary.

Furthermore unobserved effects that exhibit a spatial structure may lead to spatial dependence in the error term. For example, on the land market, different climate conditions or differences in the regional road infrastructure that we cannot fully include in our variables may call for a spatial error specification. Hence, we test the significance of both spatial components by means of the general spatial model. Under homoskedasticity ($\alpha = 0$) the general spatial model can be consistently estimated by maximum likelihood (compare Anselin and Bera, 1998)[9]. In contrast, Kelejian and Prucha (forthcoming) propose a method for estimating the general spatial model which is robust against unknown heteroscedasticity: the generalized spatial two-stage least square (GS2SLS) procedure. They apply generalised method of moments (GMM) in this procedure. We use the same spatial weight matrix W for W_1 and W_2.

The weight matrix W illustrates the spatial relationships among our observations. The weights w_{ij} are the inverse distances between the municipalities in which farms i and j are located. The economic rationale behind these weights is transportation costs. Inverse distances are supposed to reflect a lower impact of distant farms on the local rental market. Hence, for a given farm i the weights of farms that are located in nearby municipalities are larger than the weights of farms in distant municipalities. Weights are equal for farms located in the same municipality. Further the weights in W satisfy $w_{ij} > w_{ip}$ if farms i and j are located in the same municipality and if p is located in another one. In addition, we row standardize W. We also introduce a cut-off level at 10 km, i.e. the weight between two farms is set to zero if the

[8] See LeSage and Pace (2009) for details.
[9] According to simulations of Lin and Lee (2005), heteroskedasticity may bias the results only moderately.

respective municipalities are more than 10 kilometres away from each other. Hence we assume that rents beyond this distance do not impact each other.

We now turn to the marginal effects of our cash rent determinants. The regression coefficients β in a spatial autoregressive or in a general spatial model cannot be interpreted as marginal impacts of the respective exogenous variable like in ordinary least squares (OLS). In OLS, the value of the endogenous variable for a specific observation i changes by $\beta_k*\Delta x_{ki}$ irrespective of changes of x_k for other observations. This is different in models including a spatial lag because of spill-over effects among neighbouring observations (see Easterly 1998 for a descriptive explanation as well as Case et al., 1993). Therefore, after reformulating the spatial lag or general spatial model the marginal effect of x_k on r becomes

$$\frac{\partial r}{\partial x_k} = (I - \rho W)^{-1} \beta_k \tag{10}$$

The matrix $(I - \rho W)^{-1}$ is a so-called spatial multiplier[10]. I is the identity matrix. Obviously, the marginal effect depends on the spatial relationships among observations represented by W and thus can be different among observations. The diagonal elements of this spatial multiplier matrix illustrate the direct effect on i's rent resulting from a change of i's value for x_k. These impacts include feedback loops where the change of i's rent affects j's rent and then back. An additional indirect effect stems from the off-diagonal elements if other observations such as j exhibit changes in x_k. The change of i's rent resulting from $\Delta x_k = 1$ for all observations unison is the sum of the direct and indirect impact. In our case this total impact on the rental price is the product of β_k and the so-called neighbour multiplier (Easterly, 1998). This neighbour multiplier is the row-sum of the spatial multiplier and in our case of a row-standardized W it is equal for all observations.

4.2 Further Econometric Aspects

Rental price analyses may particularly suffer from endogeneity which may follow from two problems: correlation between exogenous variables and the error term as well as errors in variables due to expectation errors. We test for the first problem by means of a Hausman test (Wooldridge, 2002, p.118-122). We used a set of truly exogenous variables (owned acreage,

[10] The impact of the spatial multipliers can be decomposed into different distinctive effects (see Anselin, 2003; Abreu et al., 2004).

owned arable acreage[11], temperature, precipitation, soil quality, farmer's age and education) as well as their squares, cross-products and county dummies as instruments to test the remaining farm-level variables in the heteroskedastic general spatial model. Only the share of potatoes exhibits significant endogeneity. We, thus, estimated an additional heteroskedastic general spatial model with the above instrument for the share of potatoes.

In addition, expectation errors may arise in our variables. The observed cash rent levels depend on expected future profits as we assumed in (4). However expected profits are not observable to us. Lence and Mishra (2003) instrument them with actual profits from the previous year. Kirwan (2009) uses realised net returns in his analysis. We prefer to use three-year averages of recent net profits because they are probably higher correlated with the expected net profits. We also use three-year averages of the other farm-level variables. In contrast to above incidence analyses for U.S. subsidies that depend (partially) on the actual price our EU per-hectare premiums do not cause substantial problems with expectation errors. As explained above they were exogenously predetermined in 1992 and stayed in force until 2004. However we can not exclude expectation errors about long-term future policy changes.

5. Results and Discussion

We estimate two OLS regressions without accounting for either a spatial lag or spatial error. Model I is OLS and model II is OLS with a dummy for each county (see table 3). The third model includes a spatial error in line with Fuchs (2002) and Lence and Mishra (2003). Model four includes both a spatial lag and a spatial error (general spatial model). The fifth and sixth model are also general spatial models. Model V allows for heteroskedasticity while model VI also includes instruments.

Model specification

We first cover specifications issues. Moran's *I* test statistics (Moran, 1950) of 10.02 for model I and 5.78 for model II reveal significant spatial autocorrelation for both OLS models, even if county dummies are included. The spatial error model (III), as applied in Fuchs (2002) or Lence and Mishra (2003), does not seem to be sufficient in our case, because in the general spatial models (IV, V, and VI) the coefficients for both, the spatial error and the spatial lag are significant. A White test, however, reveals heteroskedasticity in the general spatial model

[11] Between 1991 and 2003 in Western Germany the annually sold agricultural acreage was roughly 40000 ha (DLV, 2004). This value was very stable and equals 0.35 % of the total farmed acreage. Hence the owned acreage is not adjusted by farmers in response to any unobserved effects or cash rent developments and is, thus, truly exogenous.

estimated by maximum likelihood (IV). The test statistic is 206.6 for a critical value of 37.65 (25 degrees of freedom) if the squared residuals from (IV) are regressed on the right-hand side variables (except *Wy*) by OLS. Though specification V adjusts for heteroskedasticity according to our Hausman tests the variable of potato share has to be instrumented (see above) resulting in specification VI.

Parameter estimates

The interpretation of parameter estimates is based on model VI. Both spatial components are significant. The positive sign of the spatial lag estimator ρ with a coefficient of 0.566 indicates that an increase of the average neighbouring cash rent by one € per hectare raises farmer *i*'s cash rent by 57 Cents per hectare. This is empirical evidence for spatial price transmission on the land rental market in our sample. Consequently, rental market models should account for spatial transmission, e.g. by means of a spatial reaction function as we propose in (8). The effect of spatial price transmission has neither been detected in the empirical literature nor has been included in theoretical models about agricultural rental markets yet.

We now turn to the exogenous variables. We refer to the more descriptive marginal effects (last column in table 3) instead of the common regression coefficients. The latter are multiplied by the estimate for the neighbour multiplier 2.3 to yield the marginal effects. We find that the value added per hectare (without premiums) positively affects the paid cash rent. A revenue increase by € 1 increases the cash rent by 7 Cents. Fuchs (2002) reports a similar effect of 0.1 for his variable of farm net value added without premiums. While Lence and Mishra (2003) obtain values between 0.3 and 0.45 for corn or soybean revenues, Patton et al. (2008) yield a coefficient of 0.31 for dairy net market returns. For different model specifications, Kirwan (2009) obtains coefficients between 0.31 (-0.02) and 0.44 (-0.05) for his sales (variable costs) variable.

Table 3. Cash rent determinants (N = 4376)

	OLS	**OLS (county dummies)**	**SEM**	**SAC**
	(1)	**(2)**	**(3)**	**(4)**
ρ				0.419*** (0.101)
λ			0.308*** (0.012)	-0.225*** (0.023)
value added	0.0317*** (0.011)	0.032*** (0.011)	0.029*** (0.005)	0.030*** (0.005)
animaldens <2AU	2.964 (5.816)	2.951 (5.719)	2.624 (4.348)	3.716 (4.221)
animaldens >2AU	4.303 (4.435)	4.203 (4.375)	5.143** (2.454)	4.677** (2.366)
animaldens_cty	128.9*** (10.34)	167.0*** (35.25)	125.9*** (12.65)	82.59*** (1.677)
premium	1.609*** (0.122)	1.539*** (0.369)	1.608*** (0.076)	0.869*** (0.070)
farm-level controls				
pasturediff	-0.923*** (0.088)	-0.944*** (0.092)	-0.899*** (0.084)	-0.863*** (0.078)
rentshare	31.39*** (9.821)	25.32*** (9.804)	25.34*** (8.079)	27.28*** (6.720)
sugarbeet	247.0*** (40.37)	251.6*** (44.84)	239.5*** (38.19)	182.0*** (24.58)
potato	74.60*** (24.57)	46.84* (25.30)	71.24*** (23.95)	62.75*** (21.43)
soil	-0.530 (0.706)	-0.882 (0.734)	-0.212 (0.649)	-0.323 (0.552)
soil2	0.017** (0.008)	0.021*** (0.008)	0.013* (0.007)	0.012** (0.006)
farmsize	0.050 (0.076)	0.059 (0.076)	0.058 (0.053)	0.070 (0.052)
fam_labour	653.9 (492.8)	565.8 (489.7)	547.2*** (178.6)	591.7*** (162.0)
capital	0.022 (1.304)	0.053 (1.304)	-0.135 (0.982)	-0.124 (0.956)
education	3.112 (1.929)	2.586 (1.901)	2.937 (1.916)	3.090* (1.874)
age	-1.620 (1.073)	-1.785 (1.090)	-1.938* (1.041)	-1.729* (1.024)
age2	0.013 (0.012)	0.015 (0.012)	0.016 (0.011)	0.015 (0.011)
regional controls				
income	-0.018*** (0.003)	-0.015 (0.011)	-0.016*** (0.005)	-0.010*** (0.003)
unemployment	-2.958* (1.770)	-1.994 (5.439)	-2.459 (2.360)	-2.113 (1.292)
population change	509.2*** (74.25)	62.0 (388.1)	514.9*** (88.78)	250.7*** (21.39)
population density	-11.04*** (2.917)	-4.896 (8.078)	-11.91*** (4.219)	-4.924** (2.264)
farmsize_cty	-1.774*** (0.464)	-0.708 (2.534)	-1.981*** (0.585)	-0.672** (0.341)
temperature	6.013 (8.441)	-21.55 (24.15)	7.477 (8.908)	2.606 (5.174)
precipitation	-0.306*** (0.050)	-0.210** (0.102)	-0.295*** (0.057)	-0.178*** (0.037)
constant	204.2 (144.0)	284.9 (282.1)	184.3 (176.2)	115.7 (75.32)
Rsqr	0.261	0.280	0.275	0.282

Standard errors in parenthesis. For (1) and (2) white errors are given. *, **, *** Significance at the 10, 5 and 1 per cent level, respectively.

Table 3. ***(continued)***

	GS2SLS	GS2SLS IV	GS2SLS (marginal effects)
	(5)	(6)	(7)
ρ	0.505*** (0.057)	0.566*** (0.055)	
λ	-0.228*** (0.038)	-0.327*** (0.042)	
value added	0.029*** (0.005)	0.030*** (0.005)	0.070*** (0.013)
animaldens <2GV	3.743 (4.225)	3.367 (4.169)	7.757 (9.645)
animaldens >2GV	4.802** (2.376)	4.040* (2.344)	9.308* (5.613)
animaldens_cty	74.45*** (10.15)	69.63*** (10.24)	160.4*** (18.66)
premium	0.725*** (0.134)	0.652*** (0.137)	1.502*** (0.210)
farm-level controls			
pasturediff	-0.844*** (0.080)	-0.836*** (0.079)	-1.926*** (0.281)
rentshare	25.22*** (8.100)	27.08*** (8.240)	62.39*** (18.81)
sugarbeet	163.6*** (34.07)	143.6*** (33.12)	330.8*** (78.26)
potato	58.36*** (21.72)	107.6* (56.49)	247.9** (122.0)
soil	-0.287 (0.565)	-0.349 (0.555)	-0.804 (1.268)
soil2	0.012* (0.006)	0.012* (0.006)	0.028** (0.014)
farmsize	0.074 (0.053)	0.080 (0.053)	0.183 (0.127)
fam_labour	550.0*** (177.7)	542.6*** (176.5)	1250*** (415.5)
capital	-0.155 (0.961)	-0.156 (0.954)	-0.358 (2.198)
education	2.982 (1.881)	2.816 (1.868)	6.487 (4.370)
age	-1.928* (1.025)	-1.926* (1.016)	-4.438* (2.454)
age2	0.017 (0.011)	0.017 (0.011)	0.039 (0.025)
regional controls			
income	-0.010*** (0.003)	-0.009*** (0.002)	-0.020*** (0.005)
unemployment	-2.662* (1.389)	-2.705** (1.245)	-6.233** (2.997)
population change	196.8*** (64.75)	148.7** (59.56)	342.5*** (121.5)
population density	-2.827 (2.680)	-1.921 (2.486)	-4.425 (5.531)
farmsize_cty	-0.516 (0.392)	-0.441 (0.372)	-1.017 (0.819)
temperature	-3.074 (7.201)	-4.081 (6.353)	-9.402 (14.97)
precipitation	-0.175*** (0.042)	-0.155*** (0.037)	-0.358*** (0.086)
constant	237.6* (139.6)	236.2* (131.3)	
Rsqr	0.281	0.285	

Standard errors in parenthesis. *, **, *** Significance at the 10, 5 and 1 per cent level, respectively.
Standard errors for marginal effects (7) are calculated according to the delta method (Greene, 2003, p.913)

The marginal effect of the per-hectare premiums is significantly above one in model VI.[12] In yield regions with € 1 higher premiums than in other yield regions the rental price is € 1.50 higher (last column in table 3). This result is striking on first sight: the rental price increases more than the marginal profit due to premium increase. Before suggesting an explanation we refer to literature results on subsidy incidence. Kirwan (2009) reports a marginal incidence level of around one quarter for U.S. direct government payments net of Conservation Reserve Program payments. Roberts et al. (2003) obtain incidence levels between 34-41 cents for an additional U.S. government payment dollar. In contrast, Fuchs (2002) yields only 7%

[12] The hypothesis that the marginal effect is equal or below one is rejected at a significance level of 0.0168. The test was conducted by using the delta method to calculate standard errors (compare Greene, 2003, p.913).

marginal incidence for EU per-hectare premiums. For specific subsidies marginal incidence levels around 100% are reported: Lence and Mishra (2003) yield coefficients of nearly one for market loss assistance (MLA) and production flexibility contracts (PFC) in the U.S. Patton et al. (2008) reveal that some EU payments – the so-called less favoured areas payments – have even fully capitalized into Northern Ireland cash rents.

But how can one explain incidence levels above one? Our incidence estimate means that in a region with a one € higher premium the rental prices are € 1.50 higher, i.e. the marginal incidence is 1.5. This, however, does not necessarily imply that the total premium payment (more than) fully capitalizes into land rents. The marginal incidence only refers to a marginal change of premiums. The following considerations may give a possible explanation for our high incidence level. In the 1992 CAP Reform a substantial intervention price reduction was supposed to be compensated by newly introduced per-hectare premiums. As given above these premiums compensate according to regional yields. Hence farmers obtaining yields above the regional average have not been fully compensated while farmers that formerly obtained yields below average may exhibit increased profits. An increased demand by the latter may have allowed landlords to circumvent rental price cuts. High-yield renters may accept the "old" rental price in renegotiations as long as they still obtain additional profit from the rented land. Barnard (2001) refers to this phenomenon as land markets being "sticky downwards" (as well as "sticky upwards").

For the estimation follows: regional variation of profits (without premium) has decreased while regional rental price variation has not changed substantially. Consequently, the covariance between regional average profit and regional rental price has decreased, too, and profit variation explains only a lower portion of rental price variation in the new situation. However, the per-hectare premiums are correlated to the regional average grain yield and, thus, they may well account for regional rental price variation. If the partial correlation coefficient between rental prices and premiums is sufficiently high and the premiums' absolute variation is sufficiently small the premiums' marginal impact may be above one.

The low incidence of per-hectare premiums in Fuchs' (2002) panel estimation may be explained by the time period (1989-1999) he uses. The per-hectare premiums were introduced in three steps between 1993 and 1995. However, according to Swinnen et al. (2008) in the majority of Fuchs' (2002) regions rental contracts are long-term (e.g. Belgium, France, Germany, Netherlands, Scotland) and thus only a few rental contracts are renegotiated each year. Hence it takes some time until the influence of EU payments becomes visible in the regional farmland rental price. Thus the partial correlation between payments and rental rates increases in the first years after premium introduction. Thus, an incidence estimate for a panel from 1989 to 1999 is probably biased downwards. Furthermore regional variables including the per-hectare premiums suffer from modest multicollinearity. The marginal incidence of the per-hectare premiums decreases to 0.97 if demographic variables are excluded. Consequently incidence estimations on regional subsidies should account for such multicollinearity.

We now turn to the impact of animal density. For reasons explained in the data section we constructed two variables for the farm-level animal density: one below and one above two animal units (AU) per hectare. We only yield a significant influence for the latter variable. If a farmer keeps more than two AU per hectare an additional AU increases his cash rent by € 9.31. Below this threshold we do not find a significant impact. A one AU per hectare increase in the county leads to a cash rent increase of € 160. The estimate for regional livestock density shows the importance of the local competition for land as hypothesised above. Drescher and McNamara (2000) as well as Fuchs (2002) also find a positive impact of regional livestock density. The impact of animal density is important for policy makers deciding on investment aid for new animal operations. Though such subsidies may support incomes of livestock farmers to a certain degree, they also increase cash rents for all tenants in that county. The overall effect on farmers' incomes may hence be negative.

Other farm characteristics that we use to control also contribute to the explanation of cash rents. Because they are not in the focus of our analysis we only briefly discuss them. In line with Bierlen et al. (1999) as well as Drescher and McNamara (2000), we find a significant positive impact of the soil quality. Our control for pasture land (*pasturediff*) also yields the expected negative sign. Cash rents also increase with higher shares of high-value crops in the cropping pattern such as sugar beets or potatoes. Bierlen et al. (1999) also show significant cash rent increases if the contracted parcel is planted with cotton. Interestingly older farm managers seem to pay lower cash rents. On the one hand many older farmers without a farm successor may demand less land. On the other hand older farmers may benefit from long-standing rental relationships with their landlords.

Interestingly farm family labour significantly increases rental rates. Marginal adjustments of family labour may cause relatively high transaction costs. Consequently, low opportunity costs of family members may increase the willingness to pay for additional acreage.

With respect to our regional variables on the county level the negative sign of the variable for average income may suggest that in regions with good job opportunities (e.g. in urban fringes) farmers are willing to pay less money to the landlord because they claim a higher payment for their on-farm labour. In contrast, increasing population in a county may reduce the supply of rental land since agricultural land maybe dedicated to non-agricultural usage.

6. Conclusions

This article analyses determinants of 2001 farmland rental prices from 4376 farms in the Federal State of Lower Saxony in Germany. We consider several farm-level economic, socio-economic and agronomic characteristics as well as regional variables on agricultural and demographic structure in our estimation.

We derive a regression equation from a spatial reaction function to allow for imperfect spatial transmission of rental prices. We have to estimate a general spatial model to account for both spatial transmission of rental prices and spatially dependent error terms.

The spatial price transmission amounts to 0.57. In other words a € 1 per hectare higher rental price in a farmer's neighbourhood coincides with a € 0.57 higher rental price he has to pay (everything else equal). This effect of competition on local rental markets has not been examined in the literature yet.

We also contribute to the empirical puzzle about the incidence of agricultural subsidies. Our estimate for the marginal incidence of regional per-hectare premiums in the EU – introduced by the CAP in 1993 – is significantly higher than one. This is counterintuitive on first sight since the subsidy more than fully capitalizes into the land rental price (at the margin). However, an explanation based on the long-running nature of the rental contracts in Germany, the simultaneity of premium introduction and intervention price cuts as well as assumed stickiness of rental prices is proposed.

Finally, rental prices per-hectare are € 160 higher in counties with a livestock density that is higher by one animal unit (equals 500 kilogram live weight) per hectare. Consequently, subsidies for livestock farming (e.g. investment aid) may support incomes of livestock farmers, but they also increase cash rents for all tenants in that county. The overall effect on farmers' incomes may hence be negative.

References

Anselin, L. (1988). *Spatial Econometrics: Methods and Models*. Dordrecht: Kluwer.

Anselin, L. and Bera, A.K.. (1998). Spatial Dependence in Linear Regression Models with an Introduction to Spatial Econometrics. In: Ullah, A. and Giles, D.E.A. (eds.): *Handbook of Applied Economic Statistics*. 237-289, New York: Marcel Dekker.

Anselin, L. (2002). Under the hood – Issues in the specification and interpretation of spatial regression models. *Agricultural Economics* 27: 247-267.

Anselin, L. (2003). Spatial Externalities, Spatial Multipliers, and Spatial Econometrics. *International Regional Science Review* 26: 153-166.

Abreu, M., de Groot, H.L.F., and Florax, R.J.G.M. (2004). Space and Growth - A Survey of Empirical Evidence. Tinbergen Institute Discussion Paper TI 04-129/3. Available at SSRN: http://ssrn.com/abstract=631007.

Barnard, C., Nehring, R.D., Ryan, J., Collender, R. 2001. Higher Cropland Value from Farm Program Payments: Who Gains? *ERS/USDA: Agricultural Outlook*, 26–30.

Barkley, A.P. (1990). The Determinants of the Migration of Labor Out of Agriculture in the United States, 1940-85. *American Journal of Agricultural Economics* 72: 567-573.

Bierlen, R., Parsch, L.D. and Dixon, B.L. (1999). How Cropland Contract Type and Term Decisions are Made: Evidence from an Arkansas Tenant Survey. *International Food and Agribusiness Management Review* 2: 103-121.

Brueckner, J.K. (2003). Strategic Interaction among Governments: An Overview of Empirical Studies. *International Regional Science Review* 26: 175-188.

Case, A.C., Rosen, H.S. and Hines, J.R.Jr. (1993). Budget Spillovers and Fiscal Policy Interdependence – Evidence from the States. *Journal of Public Economics* 52: 285-307.

Dirksmeyer, W., Forstner, B., Margarian, A. and Zimmer, Y. (2006). Aktualisierung der Zwischenbewertung des Agrarinvestitionsförderungsprogramms (AFP) in Deutschland für den Förderzeitraum 2000 bis 2004 – Länderübergreifender Bericht. *Bundesforschungsanstalt für Landwirtschaft.*

DLV. (2004). Bodenmarkt 1. Berlin: Deutscher Landwirtschaftsverlag.

Drescher, K and McNamara, K.T. (2000). Analysis of German Agricultural Land Prices. In: Tillack, P. and Schulze, E. (eds.): *Land Ownership, Land Markets and Their Influence on the Efficiency of*

Agricultural Production in Central and Eastern Europe. Kiel: IAMO-Schriftenreihe, Vauk-Verlag, 210-227.

Easterly, W. and Levine, R. (1998). Troubles with the Neighbours: Africa's Problem, Africa's Opportunity. *Journal of African Economies* 7: 120-142.

European Commission. (1997). Situation and Outlook – Cereals, Oilseeds and Protein Crops. CAP 2000 Working Document. Directorate General for Agriculture. http://ec.europa.eu/agriculture/publi/pac2000/cereals/cereal_en.pdf.

European Commission. (2009). Financial reports on the European Agricultural Guidance and Guarantee Fund (EAGGF). Different years. http://ec.europa.eu/agriculture/fin/finrep_en.htm

Featherstone, A.M. and Baker, T.G. 1988. Effects of Reduced Price and Income Supports on Farmland Rent and Value. *North Central Journal of Agricultural Economics* 10: 177-189.

Fuchs, C. (2002). The Influence of Per-hectare Premiums on Prices for Rented Agricultural Area and on Agricultural Land Prices. *Agrarwirtschaft* 51: 396-404.

Goodwin, B.K. and Ortalo-Magne, F. 1992. The Capitalization of Wheat Subsidies into Agricultural Land Values. *Canadian Journal of Agricultural Economics* 40: 37-54.

Herriges, J.A., Barickman, N.E. and Shogren, J.F. (1992). The Implicit Value of Corn Base Acreage. *American Journal of Agricultural Economics* 74: 50-58.

Kelejian, H.H. and Prucha, I.R. (forthcoming). Specification and Estimation of Spatial Autoregressive Models with Autoregressive and Heteroskedastic Disturbances. *Journal of Econometrics*.

Kilian, S. and Salhofer, K. 2008. Single Payments of the CAP: Where Do the Rents Go? *Agricultural Economics Review* 9: 96-106.

Kirwan, B.E. (2009). The Incidence of U.S. Agricultural Subsidies on Farmland Rental Rates. *Journal of Political Economy* 117: 138-164.

Lence, S.H. and Mishra, A.K. (2003). The Impacts of Different Farm Programs on Cash Rents. *American Journal of Agricultural Economics* 85: 753-761.

LeSage, J.P. and Pace, R.K. (2009). *Introduction to Spatial Econometrics*. Boca Raton. Chapman & Hall/CRC Press.

Lin, X. and Lee, L.F. (2005). GMM Estimation of Spatial Autoregressive Models with Unknown Heteroskedasticity. Working Paper, Ohio State University, Columbus.

Moran, P.A.P. (1950). Notes on Continuous Stochastic Phenomena. *Biometrika* 37: 17-23.

Mundlak, Y. (1978). Occupational Migration Out of Agriculture - A Cross-Country Analysis. *Review of Economics and Statistics* 60: 392-398.

Orcutt, G.H., Watts, H.W. and Edwards, J.B. (1968). Data Aggregation and Information Loss. *American Economic Review* 58: 773-787.

Patton, M., Kostov, P., McErlean, S. and Moss, J. (2008). Assessing the influence of direct payments on the rental value of agricultural land. *Food Policy* 33: 397-405.

Roberts, M.J., Kirwan, B., and Hopkins, J. (2003). The Incidence of Government Program Payments on Agricultural Land Rents: The Challenges of Identification. *American Journal of Agricultural Economics* 85: 762-769.

Robinson, W.S. (1950). Ecological Correlations and the Behavior of Individuals. *American Sociological Review* 15: 351-357.

Schmitz, A. and Just, R.E. 2002. The Economics and Politics of Farmland Values. In Moss, C. and Schmitz, A. (eds.): *Government Policy and Farmland Markets: Maintenance of Landowner Wealth*. Ames, IA. Iowa State Press.

Schultze, C.L. 1971. *The Distribution of Farm Subsidies: Who Gets the Benefits?* Washington, DC. Brookings Inst. Press.

Swinnen, J., Ciaian, P. and Kancs, A. (2008). Study on the Functioning of Land Markets in the EU Member States under the Influence of Measures Applied under the Common Agricultural Policy. Report to the European Commission, Centre for European Policy Studies, Brussels. http://ec.europa.eu/agriculture/analysis/external/landmarkets/index_en.htm

Todaro, M.P. (1969). A Model of Labor Migration and Urban Unemployment in Less Developed Countries. *American Economic Review* 59: 138-148.

Traill, B. 1979. An Empirical Model of the U.K. Land Market and the Impact of Price Policy on Land Values and Rents. *European Review of Agricultural Economics* 6: 209-232.

Weersink, A., Clark, S., Turvey, C.G. and Sarker, R. 1999. The Effect of Agricultural Policy on Farmland Values. *Land Economics* 75: 425-439.

Wooldridge, J. (2002). Econometric Analysis of Cross Section and Panel Data. London. MIT Press.