Bargaining and market power in a GIS-based hedonic pricing model of the agricultural land market

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Abstract

Agricultural land markets differ greatly from the textbook-case of perfect competition. This is why standard hedonic pricing techniques should be revised before applying this technique to this market. The objective of this paper is to determine (a) the deviation from the competitive market price of agricultural land in the Netherlands due to market power and the existence of an excess surplus and (b) the effect of bargaining power on the division of excess surplus between the eventual seller and the buyer in the market for agricultural land.

Key-words: land market, hedonic pricing, market power, bargaining power, spatial econometrics

Introduction

Agricultural land markets differ greatly from the textbook-case of perfect competition. This is due to specific characteristics of the land market and land itself. Land is heterogeneous and cannot be relocated, and the market is to a great extent local and thin. This means there are few buyers and sellers and mostly neighboring farmers are buyers, leading to bargaining and market power effects. Excess surplus is created on the property market because, in a thin market, there is not much entry and exit, so surpluses are not eliminated. This means market power determines the size and the direction of the excess surplus, with the final buyer and seller of land having to bargain over how the excess surplus is divided between them. Thus, the price on the land market is both influenced by relative market power and relative bargaining power. Bargaining and market power in the local land market are explicitly modeled in this paper using a hedonic pricing model.

The reason why this paper focuses on local market conditions is that for some decades already, the structure of the agricultural sector in The Netherlands is changing. The average farm size is growing as the number of farms declines. Because farms need to scale-up in order to stay in business, they also need to extend their area. This results in transactions of land between farms located near each other. So, local market conditions are expected to play an important role in the land market motivating our emphasis on market and bargaining power in agricultural land markets.

In this paper we focus on part of the total land market, i.e. the market for agricultural land. It is clear that in a densely populated country like The Netherlands the land market for agriculture interacts with markets for industrial land use, housing and other land uses. But as Shonkwiler and Reynolds (1986) point out, hedonic pricing models require that products be purchased for the same use by different customers. So, market segmentation has to be introduced to account for the fact that parcels with different uses have different shadow prices. We therefore only take transactions of land into account that have a farming destination after sale. Of the 55451 parcels in the database[1] that were sold in 2003 about 71% were either bought by a farmer, or subsequently used for agricultural purposes or both. This high proportion indicates that the market for agricultural land plays an important role in rural areas in The Netherlands, which makes it an interesting market to analyze.

[1] This database contains all transactions that are of interest to Government Services for Land and Water Management (DLG) in The Netherlands. These are parcels with a green purpose. Included in green purposes are: agriculture, nature and recreation. For example farm land sold to the municipality for industrial purposes is included in this database, whereas housing transactions are not.

The objective, therefore, is to determine (a) the deviation from the competitive market price of agricultural land in the Netherlands due to market power and the existence of an excess surplus, and (b) the effect of bargaining power on how the excess surplus is divided between the seller and the eventual buyer. Therefore, a hedonic pricing model that allows for bargaining power and market power is discussed in the next section. Specific attention is given to the origins and division of the excess surplus in a market under imperfect competition. The third section discusses the empirical specification of the model, including the functional form, the estimation procedure and the estimation of the number of sellers and buyers in the local market. An overview of our GIS database and additional data sources is provided in section four, while the empirical results are provided in section five. Final conclusions and policy implications ensue.

Theoretical model

First introduced by Rosen (1974), hedonic pricing is often used to model prices in property markets. Models assume that implicit prices of property characteristics can be revealed from observed prices of heterogeneous properties and the specific characteristics associated with them. Furthermore, in these models, the marginal WTP is equal to the marginal WTA, and equals the marginal price of the characteristic. It is assumed that they are not only equal, but they also intersect, because there is free entry and exit in the market, so no excess surpluses exist. This situation is shown in figure 1. For values X_i* and X_i** of a particular characteristic *i* the slopes of the bid (θ_1 and θ_2) and offer (Φ_1 and Φ_2) curves are equal, and they also intersect. Furthermore, *P* is the hedonic price function[2].

[2] This linear representation of the hedonic price function is a simplification of the actual hedonic price function.

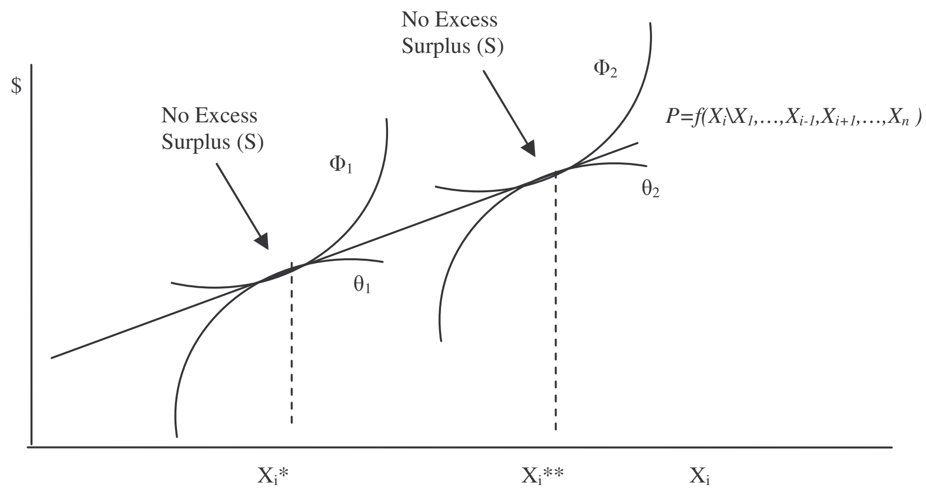

Figure 1: Hedonic pricing model without excess surplus

A drawback of these original hedonic pricing models is that they do not take the influence of bargaining and market power into account. In fact, standard hedonic pricing theory assumes perfect competition in explaining transaction prices. However, markets become increasingly thin when traded goods are heterogeneous. In a thin market there is not enough entry and exit to drive the market to equilibrium. In situations with perfect competition, equilibrium sales would take place at the point where the marginal WTP is equal to the marginal WTA and there would not be an excess surplus. But because of a limited number of participants in local land markets, there is no entry of prospective buyers with downward-shifted bid functions or entry of prospective sellers with upward-shifted offer functions. This means that there remains an excess surplus over which buyers and sellers can bargain.

King and Sinden (1994) introduced bargaining in hedonic pricing models. They determined the excess surplus over which buyers and sellers could bargain through additional survey information about the maximum willingness to pay (WTP) of buyers and made some additional assumptions on the minimum willingness to accept (WTA) of sellers. The bargaining power can then be determined by relating the actual price paid to the excess surplus. However, if only actual price paid but not WTA and WTP is available, this approach does not work. Harding et al. (2003) extended the hedonic pricing theory by explicitly allowing for bargaining power. In their empirical application on the market for houses they estimated the bargaining power directly from the characteristics of the buyers and sellers. But Harding et al. (2003) simply state that an excess surplus exists and do not put any effort into defining the size and the direction of the excess surplus.

The excess surplus in Harding et al. (2003) is given in figure 2. At the point X_1* and X_1** the slopes of the bid and offer curves are equal. So, marginal benefits equal marginal costs, but yet there is a surplus. The positive surplus is divided between the buyer and the seller, depending on the bargaining power of each of the two.

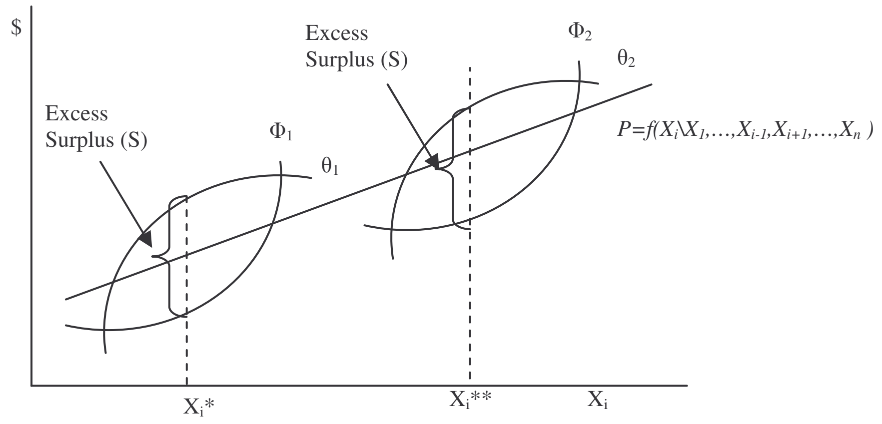

Figure 2: Excess surplus (Harding, et al., 2003)

Harding et al. (2003) assume that compared to the hedonic price function the excess surplus is evenly spread over the eventual buyer and the seller and that bargaining power causes a parallel shift in the hedonic pricing function. However, the question is how one can say anything about bargaining power if one doesn't know the excess surplus. One needs an estimate of the excess surplus in order to derive the bargaining power.

In this paper it is assumed that the direction of the excess surplus is determined by the market power. The more potential buyers there are the less market power the buyers have and the bigger the chance that there are buyers who are WTP more (shifting bid-curves up). The same argument holds for the sellers: more sellers results in less market power and a greater chance that some sellers are WTA less (shifting offer curves down). Thus, the excess surplus depends on the relative number of potential buyers and sellers in the local land market. Figure 3 shows this.

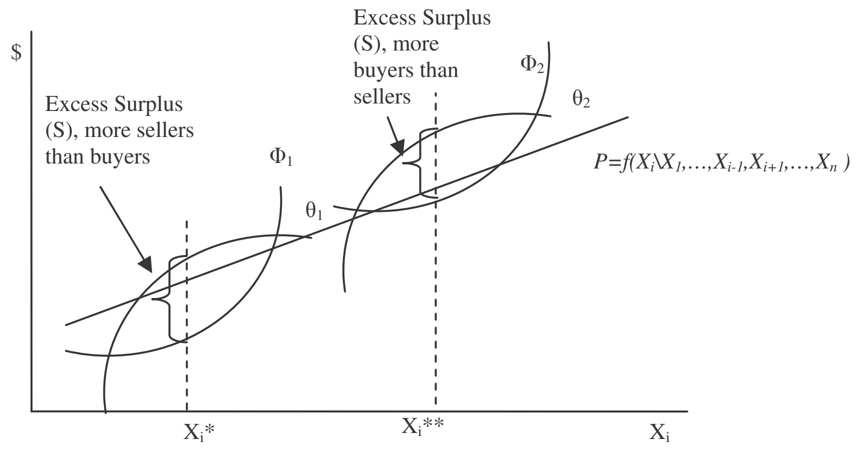

Figure 3: Excess surplus in this paper

Without knowing the maximum WTP and the minimum WTA of the eventual buyer and seller it is not possible to determine the exact size and magnitude of the excess surplus. We estimate the deviation from the hedonic price function due to market power as the average of the bid and the offer curves at the point where the marginal WTP is equal to the marginal WTA. This deviation from the competitive market price is determined by the relative market power.

This is an extension of the Cournot model, which assumes that an increase in the number of competing sellers decreases the price. The competitive market price in the Cournot model is only attained if the number of sellers grows infinitely large. Stiglitz (1987) argues that the Cournot model does not necessarily hold if search costs are involved. A decrease in the number of competing sellers can also increase search costs and with that prices could decrease. However, we assume these search costs play no role because markets are defined locally and all potential buyers and sellers can find each other easily.

Similar to Harding et al. (2003), it is assumed that bargaining causes parallel shifts in the hedonic pricing function. The same is assumed for market power. This means that attribute shadow prices are assumed unaffected by the bargaining process and the market form. Harding et al. (2003) tested whether the shadow prices were influenced by the occupancy status of the house (this variable was used as an indicator of the bargaining power) finding that the assumption of a constant shift is a reasonable approximation.

Assume the hedonic price function takes the following linear form:

$$P = s_1X_1 + s_2X_2 + \ldots + s_nX_n + M + B = sX + M + B \qquad (1)$$

where P is the price of the properties traded on the thin local market and s denotes the shadow prices of the property characteristics. X are all characteristics of the property, M is the market power (determining the direction of the excess surplus) and B is the eventual bargaining power. Replace M in equation (1) by its proxy N and an error term:

$$P = sX + aN + e_a + B \qquad (2)$$

where a is the coefficient of the proxy for market power and e_a is the associated error term so that $M = N + e_a$. B is described in the same way as in Harding, et al. (2003) - as a function of the characteristics C of the buyer and the seller:

$$B = b^{sell}C^{sell} + b^{buy}C^{buy} + e_b \qquad (3)$$

This leads to

$$P = sX + a_k N_k + e_a + b^{sell}C^{sell} + b^{buy}C^{buy} + e_b \qquad (4)$$

Furthermore, assume that sX exists of an observed part; $s^O X^O$, and an unobserved part; $s^U X^U$. This unobserved or omitted variables part could be correlated with the characteristics of sellers and buyers, which means that people with certain characteristics value unobserved attributes of a property different than people with other characteristics. Thus,

$$S^U X^U = d^{sell}C^{sell} + d^{buy}C^{buy} + e_d \qquad (5)$$

Substituting equation (5) into (4) gives:

$$P = s^O X^O + a_k N_k + (b^{sell} + d^{sell})C^{sell} + (b^{buy} + d^{buy})C^{buy} + \varepsilon \qquad (6)$$

Where $\varepsilon = e_a + e_b + e_d$. This leaves us with an identification problem, which can be solved by assuming that the unobserved attributes are not correlated with the characteristics of the buyers and sellers. This implies that d^{sell} and d^{buy} are 0. An alternative is to assume (Harding et al., 2003):

- symmetric bargaining power → $b^{sell} = -b^{buy}$
- symmetric demand → $d^{sell} = d^{buy}$

Thus,

$$P = s^O X^O + a_k N_k + b(C^{sell} - C^{buy}) + d(C^{sell} + C^{buy}) + \varepsilon \qquad (7)$$

In this paper we assume that the unobserved attributes are not correlated with the characteristics of buyers and sellers, rather than assuming symmetric bargaining power and symmetric demand. In section five, about the empirical results, we will ground this decision.

Empirical specification

Several empirical issues arise in the estimation of a hedonic pricing function. First, we have to define a proxy variable for market power. Market power is defined in the following way: $N = (NAS - NAB) / (NAS + NAB)$, where *NAS* and *NAB* are the number of actual sellers and buyers, respectively, in the local markets during the last five years. This measure also takes the dynamics of the land market over time into account. To calculate *N* two steps have to be taken. First, we need to determine what a local market is. In this research local markets are defined by the distribution of the distances between the location of the buyers and the location of the parcel that is sold to them. From this distribution the distance that corresponds with the 90th percentile is chosen as the radius of the local market. The maximum distance is not chosen in order to ignore outliers. Based on our data, we find that 90% of the agricultural buyers that are not located in urban areas are located within 6.7 km of the parcels they bought (see table 1). This measure of distance is used to define local markets around each parcel sold.

Table 1: Distance between buyers and the parcels they buy

Percentage of buyers located within the given distance	*Distance in meters*
50%	642.43
80%	2639.12
90%	6696.57
95%	17282.21
100%	205840.70

Second, the number of buyers and sellers in the local market has to be determined. It is assumed that all sellers were able to sell their land, with no potential sellers unable to sell land. In other words, the number of sellers in the market is equal to the observed number of sellers. To determine the number of buyers we cannot make this assumption. It is plausible that potential buyers did not obtain land within the local market, e.g. because their bid was too low. However, if there are more potential buyers than plots of land for sale within a local market, it can be expected that some buyers bought land on another local land market. Therefore, the number of actual sellers and actual buyers may be different within a local market. If the number of sellers equals the number of buyers within a given local market, N equals zero. With more sellers than buyers within a local market (buyers from other local markets buy the offered land), N is positive and if there are more buyers than sellers, N is negative.

A second specification issue is the choice of the functional form. According to Taylor (2003) little theoretical guidance exists for the choice of functional form. One approach could be to use Box-Cox transformations that take the double-log, semi-log and several other functional forms as special cases, and choose the functional form based on goodness-of-fit criteria. According to Cassel and Mendelsohn (1985), using best-fit-criteria does not necessarily lead to more accurate estimates of characteristic prices. Rasmussen and Zuehlke (1990) state that the introduction of empirically unnecessary non-linearities may 'over-parameterize' the problem, resulting in less precise point estimates. Cropper et al. (1988) used simulations to find that, when some variables are not observed and proxies are used, simple models (such as linear or double-log) perform best. Based on these findings and because we have many parameters to estimate (due to the high number of explanatory variables), we use a simple linear functional form, with transformations on some explanatory variables.

An issue in estimation concerns spatial autocorrelation. Whereas autocorrelation is mostly associated with time-series and panel data, geographical cross-section data can also be subject to autocorrelation. Autocorrelation occurs when the spatial variables do not accurately reflect the underlying spatial processes. Spatial autocorrelation is sometimes called error dependence, or $Corr(\varepsilon_i, \varepsilon_j) \neq 0$. In the presence of spatial error-dependence, the traditional hedonic price function can be re-specified to include a spatially autoregressive process in the error term as follows:

$$P = s^O X^O + a_k N_k + b^{sell} C^{sell} + b^{buy} C^{buy} + \varepsilon, \quad (8)$$

where $\varepsilon = \rho W \varepsilon + \mu$ and $\mu \sim N(0, \sigma^2 I)$

Here W is the spatial weighting matrix containing the spatial weights. These weights are specified a priori between all pairs of observations. If observations are microlevel agents, each element of the spatial weighting matrix (w_{ij}), weights the degree of spatial dependence according to the distance or proximity between observations i and j (Bell and Bockstael, 2000).

The above relationship implies

$$P = s^O X^O + a_k N_k + b^{sell} C^{sell} + b^{buy} C^{buy} + (I - \rho W)^{-1} \mu \quad (9)$$

Spatial autocorrelation is tested for using several test-statistics. First of all Moran’s I statistic, derived from a statistic developed by Moran (1948), secondly the Lagrange Multiplier test (LM-err) suggested by Burridge (1980) and thirdly the test of Kelejian and Robinson (1992) (KR). In order to use the first two test statistics the spatial weighting matrix has to be specified a priori. The Kelejian and Robinson test has as an advantage that it doesn't require this a priori specification of the spatial weighting matrix.

Beside spatial autocorrelation, also spatial lag dependence can play a role in spatial models. In the presence of spatial lag-dependence the hedonic pricing function can be re-specified in the following way:

$$P = \lambda WP + s^O X^O + a_k N_k + b^{sell} C^{sell} + b^{buy} C^{buy} + \varepsilon, \qquad (10)$$

The appearance of spatial lag dependence is tested using the SARMA test statistic (Anselin, 1988), which is a Lagrange Multiplier test.

If spatial autocorrelation is present it can be taken into account using the spatial Generalized Method of Moments (GMM) estimator of Kelejian and Prucha (1999). The advantage of this GMM-estimator is that the calculation of the estimator, even for extremely large sample sizes is still quite straightforward. A disadvantage of this estimator is that it requires the a priori specification of a weighting matrix. Conley (1999) and Conley and Molinari (2005) try to overcome this problem. Their estimator is the standard minimizer of the quadratic form in the sample moment condition, where the covariance matrix is obtained in non-parametrically. Spatial two-stage-least-squares can be used to overcome the endogeneity of the spatially lagged dependent variable.

Data

Our data consists of all transactions of farmland in The Netherlands in 2003. These transaction data are merged with different data-bases containing Geographical Information System (GIS) data. These GIS data contain different (spatial) characteristics of the parcels sold in the transactions. The data used in this study were obtained from several sources. An overview of all databases is given in appendix 1.

The most important data source is the Infogroma database containing information on transactions and the location of each parcel sold within a transaction. In total we use 945 observations of transactions of land, because we could match these with all other data sources and because both the seller and the buyer were farmers in these transactions. Characteristics of farmers are originating from the “Landbouwtelling”, a database that contains census data of all farmers in The Netherlands[3]. In total there were 85189 farmers in The Netherlands in 2003, of whom we know 3793 bought land and 3429 sold land in 2003. We could not use all observations, because for most transactions only the seller or the buyer was a farmer. Furthermore, farmers were often involved in more than one transaction. Also some observations could not be used because we couldn’t match them with other databases. Other sources we used were data on parcel registration (BRP)[4], which captures information on the exact form, location, rent and crops grown, on all parcels used for agricultural purposes. Data on actual land use and zoning plans until 2010 are available from municipal, provincial and central governments. Country wide data are available on income and population of areas. The combination of population data and land use is used to construct the Reilly index (Isard, 1956): $R_i = \sum_{k=1}^{K} Pop_k \big/ d_{i,k}^2$, where R_i is the Reilly index for parcel i, Pop_k is the number of inhabitants of “red-area” k and $d_{i,k}$ is the distance between parcel i and the k-th “red-area”. A red-area is an area that is a concatenation of all neighboring areas that are used for living, working, industrial purposes etc. Finally, information on roads and railways are used. All this spatial information is used to define spatial explanatory variables. The more spatial

[3] Only farms that are larger than 3 NGE are included in this census data. 1 NGE represents €1390 of gross value added.
[4] This data is collected from all farmers in The Netherlands who are obliged to declare which parcels they own or rent due to the manure legislation.

information is directly taken into account, the smaller the potential omitted variable bias and the smaller the spatial dependence among the errors, because spatial dependence is often due to omitted variables.

The variables included in the hedonic pricing model (including market and bargaining power variables) are provided in table 2.

Table 2: Variables included in hedonic pricing model, number of observations = 945

Variable	*Database nr**	*Mean*	*SD*	*Min*	*Max*
Dependent variable					
Transaction price per ha (€10.000)	1	3.9471	4.7027	0.1116	85.1100
Market power indicators					
N_1 = Measure 1	2	-0.0096	0.1861	-0.7646	0.7462
N_2 = Measure 2	2	-0.0499	0.1646	-0.6364	1.0000
N_3 = Measure 3	2	-0.0622	0.6794	-6.4957	5.8790
N_4 = Measure 4	2	-0.0935	0.1151	-0.7054	1.0000
Bargaining power indicators					
$Kids^{buy}$ (=1 if buyer has kids aged above 15, 0 otherwise)	2	0.0233	0.1509	0.0000	1.0000
$Kids^{sell}$ (=1 if seller has kids aged above 15, 0 otherwise)	2	0.1312	0.3378	0.0000	1.0000
Sex^{buy} (=1 if farm operator at buyers farm is a male, 0 otherwise)	2	0.9333	0.2496	0.0000	1.0000
Sex^{sell} (=1 if farm operator at seller farm is a male, 0 otherwise)	2	0.9291	0.2568	0.0000	1.0000
Age^{buy} (age of oldest farm operator at buyers farm)	2	50.9005	11.1176	24.0000	84.0000
Age^{sell} (age of oldest farm operator at sellers farm)	2	53.8921	11.7669	23.0000	95.0000
Inc^{buy} (income proxy (total NGE's) for buyer)	2	215.9215	467.6663	3.3700	5024.0400
Inc^{sell} (income proxy (total NGE's) for seller)	2	76.1911	134.5293	3.0600	2179.1000
$Personal^{buy}$ (=1 if farm of buyer is a personal enterprise, 0 otherwise)	2	0.1270	0.3331	0.0000	1.0000

Personal^{sell} (=1 if farm of seller is a personal enterprise, 0 otherwise)	2	0.0561	0.2302	0.0000	1.0000
Land quality indicators					
Parcel size (ha)	3	3.3312	2.8863	0.1265	26.6949
Parcel shape (Minimum perimeter/actual perimeter =(4*square root(parcel size))/perimeter	3	0.0056	0.0027	0.0014	0.0282
Indicators about rights and restrictions					
Land is rented (=1, otherwise 0)	1	0.0434	0.2038	0.0000	1.0000
Current land use indicators					
Distance to nearest living area (km)	4	1.2815	0.8803	0.0026	0.7923
Distance to nearest industrial park (km)	4	1.9792	1.1917	0.0284	8.8318
Distance to nearest airport (km)	4	15.4055	7.8156	0.2182	44.0462
Distance to nearest recreational zone (km)	4	1.1882	0.7037	0.0402	6.0521
Distance to nearest nature (km)	4	0.6758	0.7459	0.0072	7.4252
Distance to nearest wet nature (km)	4	3.6358	2.8374	0.0711	2.0212
Distance to nearest glasshouse horticulture (km)	4	7.2994	7.1165	0.0206	43.0578
Distance to nearest salt water (km)	5	70.7615	40.0439	0.1581	149.7852
Distance to nearest fresh water (km)	5	1.0733	0.7811	0.0230	4.5256
Distance to nearest highways (km)	9	6.6572	5.1065	0.0577	28.8492
Zoning indicators					
Smallest distance to Ecological Main Structure (EHS) (this zone also partly consists of current land used for nature purposes) (km)	8	1.0316	1.2985	0.0016	9.0354
Future roads and railroads (1 if parcel is located within the indicated area, 0 otherwise)	7	0.0011	0.0325	0.0000	1.0000
Future fresh water (extra space for rivers, 1 if parcel is located within the indicated area, 0 otherwise)	8	0.0656	0.2477	0.0000	1.0000
Future living area (1 if parcel is located within the indicated area, 0 otherwise)	7	0.0127	0.1120	0.0000	1.0000
Future working area (1 if parcel is located within the	7	0.0053	0.0726	0.0000	1.0000

indicated area, 0 otherwise)					
Neighborhood characteristics					
Population Density (number of 100 inhabitants / square km)	6	3.1559	3.2433	0.6000	44.6500
Average disposable yearly income within the municipality (in €10.000)	6	1.2237	0.0805	1.0500	1.6200
Other variables					
Reilly index	4,6	0.0099	0.0763	0.0008	2.3473
Buyer and seller are family (=1, otherwise = 0)	1	0.1185	0.3234	0.0000	1.0000

*For the description of the database see appendix 1. The number in this column refers to appendix 1.

Empirical results

The ordinary least-squares (OLS) regression results of the hedonic pricing function are reported in table 3. This model assumes no spatial lag or error dependence. Furthermore, market and bargaining power are only allowed for in case there is no family relationship between the buyer and seller. A number of aspects of the estimates are worth noting. First, about 47% of the variation in the sales prices of agricultural land can be explained by the model. Second, all significant coefficients have the expected signs.

Table 3. OLS results of the hedonic pricing function of the agricultural land market

Dependent variable: Price per ha (€10000)	*Coefficient*	*t-statistic*	*Marginal effect*
N if seller and buyer are not family, 0 otherwise	-3.1639**	-2.61	
$Kids^{buy}$ if seller and buyer are not family, 0 otherwise	0.5506	0.64	
$Kids^{sell}$ if seller and buyer are not family, 0 otherwise	0.3605	0.92	
Sex^{buy} if seller and buyer are not family, 0 otherwise	-0.9344*	-1.88	
Sex^{sell} if seller and buyer are not family, 0 otherwise	0.2765	0.56	
Age^{buy} if seller and buyer are not family, 0 otherwise	-0.0235**	-2.03	

Age^{sell} if seller and buyer are not family, 0 otherwise	-0.0231**	-2.08	
Inc^{buy} if seller and buyer are not family, 0 otherwise	-0.0008**	-2.60	
Inc^{sell} if seller and buyer are not family, 0 otherwise	0.0003	0.37	
$Personal^{buy}$ if seller and buyer are not family, 0 otherwise	2.5965**	5.98	
$Personal^{sell}$ if seller and buyer are not family, 0 otherwise	2.8671**	5.00	
Parcel size	0.1349**	2.51	
Parcel shape	84.4751	1.51	
Land is rented (=1, 0 otherwise)	-2.0375**	-3.59	
1 / distance to nearest living area (km)	0.0205**	2.21	-0.0125
1 / distance to nearest industrial park (km)	0.0834	1.15	-0.0213
1 / distance to nearest airport (km)	0.0797	0.16	-0.0003
1 / distance to nearest recreational area (km)	0.1697**	2.93	-0.1202
1 / distance to nearest wet nature (km)	-2.0582*	-1.73	0.1557
1 / distance to nearest glasshouse horticulture (km)	0.1590**	4.77	-0.0030
1 / distance to nearest salt water (km)	0.2949	0.85	-0.0001
1 / distance to nearest fresh water (km)	-0.0636*	-1.81	0.0552
1 / distance to nearest highway (km)	-0.0255	-0.26	0.0006
1 / dist. to nearest nature or Ecological Main Structure (EHS) (km)	-0.0041	-0.82	0.0185
Future roads and railroads	-1.8016	-0.51	
Future fresh water	0.1598	0.33	
Future living area	0.0010	0.00	
Future working area	4.9695**	3.07	
Reilly index	31.7077**	19.78	
Population density	0.1636**	4.24	
Average income within the municipality	3.4476**	2.23	
Buyer and seller are family (=1, 0 otherwise)	-3.7828**	-3.39	
Constant	0.2949	0.13	
R-squared	0.4726		
Adjusted R-squared	0.4541		
Number of observations	945		

**significant at 95% reliability level. *significant at 90% reliability level.

The parameter for market power is statistically significant at the 95% confidence level and has the expected negative sign. We expected a negative sign because *N* increases when the relative number of sellers increases compared to the relative number of buyers. In case there are more sellers relative to the number of buyers, sellers have relatively less bargaining power and sales prices decrease. So, local market power is an important element in explaining land prices[5].

With respect to bargaining power, six out of ten parameters of variables accounting for bargaining power are significantly differently from zero. So, besides market power effects there is also evidence for bargaining power effects on agricultural land prices. However, we find no evidence for symmetry as assumed by Harding et al. (2003) for those coefficients that are statistically significant. For example, if we consider the age of the oldest farm operator, we expect age to be positively correlated with bargaining power and therefore a negative sign for buying farmers and a positive sign for age of selling farmers. However, for the latter we obtained a significant negative sign, violating symmetry. The negative sign can be explained from the fact that some older potential sellers like to sell their land because of retirement, so they might bargain less over prices and accept a lower price for their land. For the bargaining power variables that deal with the size of the farms we also don't find symmetry. Farm size of buyers in terms of NGE (Inc^{Buy}) has a negative impact on the price per ha, as expected, but number of NGE's is not significant for sellers. For the second size indicator, $Personal^j$, both parameters for buyers and sellers are significant and positive, clearly violating symmetry in bargaining. Personal enterprises are usually associated with smaller farms. If the buyer is a

[5] We also defined three other proxy variables for market power and used them in estimation instead of the above specification. Two of these alternative measures approximated the number of potential buyers by summing up predicted probabilities of buying land obtained from a probit model. The three alternative proxies gave rather similar estimation results as those obtained with the above specification.

personal enterprise, indeed a higher land price is paid. However, the parameter for sellers is also positive. What may play a role here is the number of hectares and parcels sold. In case the seller is not a personal enterprise, it can be expected to be a large farm, which may sell more land and more parcels, which is negative for the bargaining power of the seller, resulting in the positive sign for personal enterprise. For gender, we might expect symmetric bargaining power, but there is not much variation in this variable, because most farm operators are men, explaining why gender of sellers is not significant and why gender of buyers is only significant at the 90% level. Furthermore, the variables $kids^j$ are correlated with the age of the farm operator, so this explains why these variables are not significant.

An important significant variable in the model is the Reilly index, which is an indicator of the urbanization of an area. Parcels located within highly urbanized areas are priced much higher. Also variables like population density and average income in the municipality are indicators of the urbanization. Both variables have significant parameters and have a positive influence on prices.

Furthermore, some land use indicators are included in the model in the form of distances to the nearest area with a certain type of land use. Since we expect the effect of these variables to diminish when distance increases, we included 1/distance instead of distance itself. Because of this transformation, we also provide the marginal effects around the means of changes in distance itself in table 3. For example, if the distance between a parcel and its nearest living area would increase with 1 km, this would mean a price reduction of €125,- per ha. on average. Also prices increase by €1202,- on average when the land is 1 km closer to a recreational area. For farmers close to recreational areas it is easier to start up additional non-agricultural activities on their land. Furthermore, wet nature close by has a negative impact on prices, due to the high water level in those areas, glasshouse horticulture has a positive impact, due to a zoning effect, because glasshouse horticulture is not allowed everywhere in the Netherlands. Last, fresh water located nearby has a negative impact, probably due to higher water levels and higher chances of flooding in these areas. If the transacted plot is within an area that is denoted as a future working area, it increases the price by about €50000.

As mentioned before, the model is estimated using OLS, whereas usually there is spatial lag and error dependence in hedonic pricing models. Table 4 shows test results of several statistics that test for spatial lag and error dependence. These tests show that there is no evidence for any of these types of dependence in our model at a 95% reliability level. What we do observe is that at a 90% reliability level none of the tests with pre-specified weighting matrices is significant. Only the Kelejian and Robinson-statistic, which doesn't depend upon a pre-specified weighting matrix suggests spatial autocorrelation at the 90% confidence level if parcels are located within 1 km of each other. For larger distances, this KR test statistic also suggests absence of spatial error dependence. We conclude from these tests that it is correct to use an OLS model to estimate the hedonic price function for agricultural land in the Netherlands since spatial lag dependence and spatial error dependence are absent in this model specification.

Table 4: Test statistics spatial lag and spatial error dependence

	$W = 1 / d$	*$W = 1 / d^2$*	*Wij = 1 if distance < 1 km, 0 otherwise*	*Spatio temporal lower triangular matrix based on 1 / d*
Test for spatial lag dependence				
SARMA	2.0805	2.2452	2.1600	0.7687
Prob SARMA	0.3534	0.3254	0.3396	0.6809
Tests for spatial error dependence				
Moran I	-0.0115	-0.0407	-0.0410	-0.0079

Prob Moran I	0.9908	0.9676	0.9673	0.9937
LM err	1.5165	1.6212	1.5895	0.7616
Prob LM err	0.2181	0.2029	0.2074	0.3828

	Max 1 km	*Max 5 km*	*Max 10 km*	*Max 20 km*
KR	26.1983*	20.9119	17.5310	0.8589
Prob KR	0.0513	0.1819	0.3521	1.0000

**significant at 95% reliability level. *significant at 90% reliability level.

Conclusions and recommendations

In this paper we find evidence for market power in local agricultural land markets. This means that there is no perfect competition in the agricultural land market and prices deviate from competitive market prices due to the existence of excess surpluses. Also we find evidence for bargaining power. This means that sellers and buyers bargain over the excess surplus and that the final transaction price resulting from the negotiations depends on the characteristics of the buyer and seller involved in bargaining. This has important consequences for subsequent work that uses hedonic pricing techniques to model real estate prices. Ignoring local market power and bargaining effects may lead to omitted variable bias on estimated shadow prices in hedonic pricing models.

Besides market power and bargaining, agricultural land prices are also largely dependent upon the degree of urbanization in the surrounding areas. For a densely populated country like the Netherlands this could of course be expected. Although all land considered in this paper is used for agricultural purposes, speculation seems to play an important role in determining prices for agricultural land.

Further research is needed to determine whether or not the conclusion of no error-dependence is justified. To do this the model can be estimated using the GMM method suggested by Conley (1999) and Conley and Molinari (2005). This method does not require a pre specified weighting matrix. All test-measures that require a pre specification were insignificant. This might point to the fact that all four measures of the weighting matrix were not well specified.

The current model does not contain indicators for the quality of land. These are hard to determine, because the quality depends on a combination of factors, e.g. soil type and groundwater level. Whether these characteristics have positive or negative impact depends on the crops grown on these parcels. So, in order to include a land quality indicator we have to combine several characteristics in one quality measure. With respect to model specification, further research is also needed on the land use variables. At this moment all measures were specified in the nearest distance to certain kinds of land use. However, measures specified as percentage of a certain type of land use within a buffer zone around a parcel of 1 km might be a better measure.

Another issue that deserves our attention is which observations to include in the model and which ones not to include? Although both buyers and sellers in our model are farmers, it is strange that farmers are willing to pay amounts of over €100000,- for agricultural land. This may involve speculation. On the one hand the agricultural land market is related to other land markets and you will always find evidence of speculation in the prices. But we did exclude transactions with prices over €1000000,- because of this reason. So the question is which observations should we include and which ones not?

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Appendix 1

Table A1: Databases used in this research

Nr	*Name database*	*Data source*	*Year data*
1	Infogroma	Government Services for Land and Water Management (DLG)	2003
2	Landbouwtelling	Government Services for Regulations	2003
3	Parcel Registration (BRP)	Government Services for Regulations	2004
4	Land Use Statistics	Statistics Netherlands (CBS)	2000
5	Spatial land use mapping (LGN)-4	Wageningen UR - Alterra	1999-2000
6	District and Neighborhood Information	Statistics Netherlands (CBS)	2003
7	The New Map of The Netherlands (NKN)	Corporation of the New Map of The Netherlands	2002
8	Note about Spatial Allocation	Ministry of Housing, Spatial Planning and the Environment	2004
9	National Roadmap (NWB)	Ministry of Transport, Public Works and Water Management	2003