Exploring the land market in the province of Noord-Holland using a spatial regression model

paper for the

44th congress of the European Regional Science Association, 2004

Jasper Dekkers[1], Piet Rietveld[1], Adri van den Brink[2], Henk Scholten[1]

[1] Faculty of Economics and Business Administration

Department of Spatial Economics, Vrije Universiteit Amsterdam, the Netherlands

email corresponding author: jdekkers@feweb.vu.nl

[2] Department of Land Use Planning, Wageningen University & Research Centre

Abstract

This paper focuses on rural land prices. Different actors and factors influence land prices. Buurman (2003) has analysed, categorised, and used them to explain spatial differences in transaction prices of parcels using a GIS-based linear regression model. The model distinguishes parcel and transaction characteristics and uses principles of hedonic price and bid-rent theory to explain differences in land prices. Some theoretical aspects regarding the model are discussed.

The regression model, estimated on a land transaction dataset covering the province of Noord-Brabant in the southern part of the Netherlands, is re-applied on a dataset covering the province of Noord-Holland. Insight is gained into actors and factors playing a role on the rural land market in this province. It seems that rural land that is included in building plans or located very close to areas for which building plans exist has a land price far higher than average. In most of these transactions, the city council is the buyer. Compared to other buyers, they pay the highest price for land in Noord-Holland.

Keywords: land market, hedonic price theory, regression analysis, Noord-Holland

1. INTRODUCTION

At first, the province of Noord-Holland might seem to be a strange choice to apply an exploratory regression model to because when looking at the land market, this province is full of exceptions. The province contains much agricultural nature areas, which has a strange price setting. Also, there is much horticulture and flower bulb land, which is relatively very expensive. Then there is the national airport, Schiphol that is assumed to have a large impact on land use and prices of its surrounding areas.
It is this extremity in land uses and prices which will challenge the regression model. Therefore, it will be perfect to test the robustness of the model.

Paragraph two elaborates on the theory behind the regression model as used by Buurman (2003), especially hedonic pricing theory and bid-rent theory. Paragraph three describes the regression model. Paragraph four contains an analysis of the Noord-Holland case study: the dataset is analysed on spatial patterns and regression results are discussed. Finally, paragraph five contains some conclusions and a discussion, followed by recommendations.

2. LAND PRICE THEORY AND HEDONIC PRICING[1]

The location of a parcel is an important explanatory variable for parcel prices.
The first economic land-market theories explained rural land prices as the residual value, being profits (i.e. total crop value) minus costs of production factors (labour, capital). According to this theory, differences in parcel prices can for example be explained by a difference in soil quality (Ricardo, 1817) because a higher crop value per hectare increases profit and thus creates a higher land value per hectare.
The importance of land in economic theories has changed during the centuries. The classical theories of the 17th and 18th century included land as a very important production factor. As one of the first, Von Thünen (1826) includes location as an explanatory variable by taking transport costs into account. The Neo-classical theories of the 19th century however did not specifically consider land (Randall and Castle, 1985).

[1] For a more extensive discussion of land price theory and hedonic pricing, see Buurman (2003).

Modern economic theories are more diverse. Although land is not often mentioned in general economic theories, some branches of economy have developed theory on land as a production factor, as a consumption good or – more indirectly – distance as a cost factor. During the 1950s and 60s, based on the theoretical work of Von Thünen, Isard (1956) and Alonso (1964) developed the bid-rent theory, specifically in order to explain urban land prices. Their theory also has implications for rural land prices, although the analysis of rural land price still owes more to Von Thünen's theory.
Location is but one characteristic of a parcel. Each parcel characteristic can be assigned a value. However, since these characteristics are embedded in a parcel, they only have an implicit value. A way has been developed to compute the implicit value of these non-tradable characteristics: the hedonic pricing method.

Hedonic pricing theory

The Hedonic Pricing Method determines the *implicit* value of non-tradable characteristics of goods by analysing the *observed* value of tradable goods that incorporate all or part of those non-tradable characteristics. Let A be a certain tradable good, for instance a parcel. The value ($V(A)$) of this good can be described as a function of its (non-tradable) characteristics:

$$V(A) = f(c_1, c_2, \ldots, c_n) \quad (1)$$

Let good B be another parcel with the same characteristics as parcel A except for characteristic c_1. Then, the value of good B can be written as:

$$V(B) = f(c_2, c_3, \ldots, c_n) \quad (2)$$

It is clear that the implicit market value of the first characteristic $V(c_1)$ is the difference between the values of the two parcels:

$$V(c_1) = V(B) - V(A) \quad (3)$$

The main strengths of the HPM are that values can be estimated based on actual choices and that (reliable) land transaction data and spatial data is available. Some limitations are that the method assumes perfect competition and fully informed actors, an obvious simplification of reality where a.o. zoning restrictions create artificial market segments, hindering perfect competition. Also, not all actors have all information available, causing some value affecting characteristics to stay unperceived.

Market clearing conditions to consider when applying hedonic pricing theory are (Rosen, 1974, p.35):

- Bundles of characteristics are equally valued by buyers and sellers, equalising the observed price with the hedonic price;
- Both buyers and sellers base their location and quantity decisions on maximising behaviour, and
- Equilibrium prices are determined so that buyers and sellers are perfectly matched.

For a more in-depth summary of the hedonic pricing technique, we refer to Griliches (1971) and Gordon (1973).

3. THE SPATIAL REGRESSION MODEL

Based on hedonic pricing theory and bid-rent theory, Buurman has developed a spatial explanatory model (figure 1). The purpose of this model is to explain (spatial) differences in transaction prices of rural land parcels. The model disregards transactions with one or more parcels with immobile property, because of the fact that the dataset

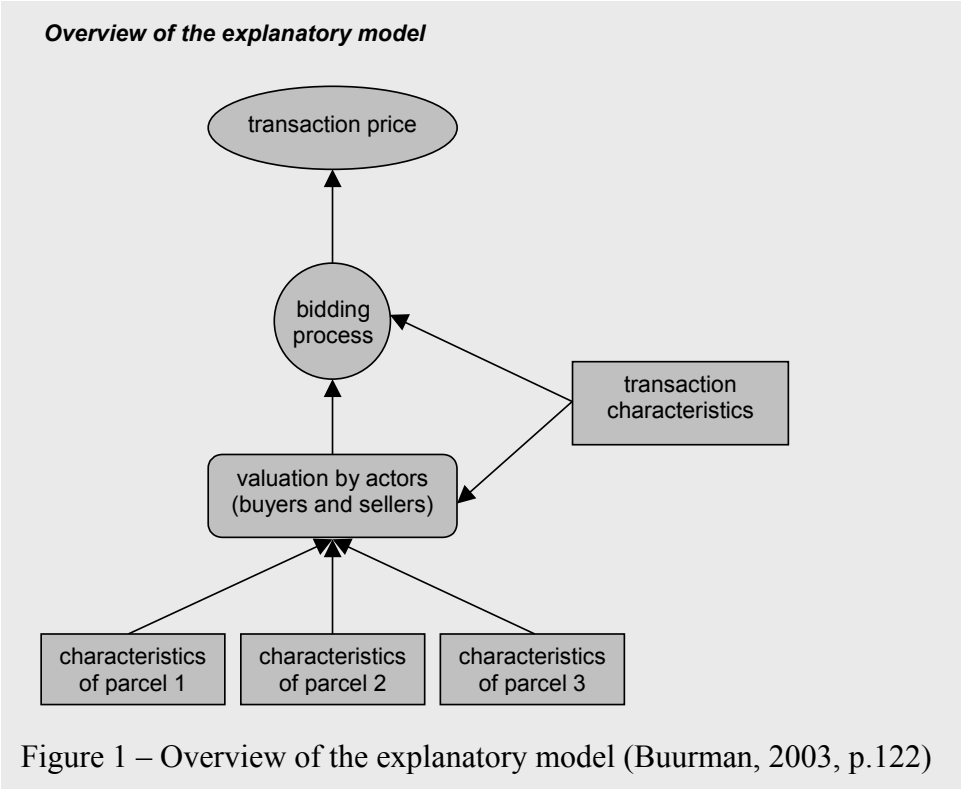


Figure 1 – Overview of the explanatory model (Buurman, 2003, p.122)

cannot tell us which part of the transaction price is caused by the immobile property and which part is caused by the parcel(s).

Buurman uses the Infogroma-database of the Government Service for Land and Water Management (DLG, part of the Ministry of Agriculture, Nature and Food Quality) to fill his model. This database contains all transactions of parcels outside urban areas and covers the Netherlands. In fact this dataset is a subset of the Dutch cadastral database. All transfers of ownership rights are being registered in this database. This immediately reveals one of the shortcomings of the database: it does not register options on parcels. This means that options cannot be included in the analysis.

The data acquired represents all actors and factors that are most likely (according to previous theoretical and empirical research; see Buurman, 2003) to affect transaction prices of land. Among others, the data contains:

- selling prices of bundles of parcels and locations of these parcels;
- parcel characteristics;
- neighbourhood characteristics;
- accessibility characteristics;
- environmental characteristics, and
- transaction characteristics, for example type of seller and buyer.

Using this data, a logarithmic regression function has been estimated that relates the transaction values to the parcel and transaction characteristics (figure 2). Translating the impact of parcel characteristics on the transaction value has been done by weighing the impact using parcel size. The resulting function measures the portion of the transaction

$$
\begin{aligned}
LnPrice = {} & \beta_0 \\
& + \beta_1 \cdot LnSize \\
& + \beta_2 \cdot Q2\_98 + \beta_3 \cdot Q3\_98 + \beta_4 \cdot Q4\_98 \\
& + \beta_5 \cdot Q1\_99 + \beta_6 \cdot Q2\_99 + \beta_7 \cdot Q3\_99 + \beta_8 \cdot Q4\_99 \\
& + \beta_9 \cdot Q1\_00 + \beta_{10} \cdot Q2\_00 + \beta_{11} \cdot Q3\_00 + \beta_{12} \cdot Q4\_00 \\
& + \beta_{13} \cdot Q1\_01 + \beta_{14} \cdot Q2\_01 \\
& + \beta_{15} \cdot Relative + \beta_{16} \cdot NatGovt + \beta_{17} \cdot Municipalities + \beta_{18} \cdot Farmer \\
& + \beta_{19} \cdot Rent \\
& + \beta_{20} \cdot Quality + \beta_{21} \cdot DistUrban + \beta_{22} \cdot DistRandstad \\
& + \beta_{23} \cdot NewMapBuitup + \beta_{24} \cdot NewMapOther + \beta_{25} \cdot NewMapInfra \\
& + \beta_{26} \cdot GC2\&3 + \beta_{27} \cdot GC4\&5 + \beta_{28} \cdot GC6 \\
& + \beta_{29} \cdot Forest + \beta_{30} \cdot Nature + \beta_{31} \cdot Builtup \\
& + \varepsilon
\end{aligned}
$$

Time dummies

Transaction characteristics

Parcel characteristics

Figure 2 – Regression model for Noord-Brabant (Buurman, 2003, p.126)

price that is attributable to each characteristic.

For the exact derivation of this function from the hedonic pricing function we refer to Buurman (2003). Since time also influences land prices, time is also included in the model in the form of quarterly dummies. The following table contains an overview of the variables Buurman has used in his model.

Overview and definition of the variables in the regression model

Variable name	*Description*
LnPrice	The natural logarithm of the transaction price in euros.
Constant	The constant ($ß_0$).
LnSize	The natural logarithm of the size of the transaction in square metres.
Q2_98 … Q2_01	Quarterly dummies covering the period from the second quarter of 1998 until the second quarter of 2001.
Relative	Dummy variable: takes the value 1 if buyer and seller are relatives.
NatGovt	Dummy variable: takes the value 1 if buyer is the national government.
Municipalities	Dummy variable: takes the value 1 if buyer is a municipality.
Farmer	Dummy variable: takes the value 1 if buyer's main occupation is in the agricultural sector.
Rent	Dummy variable: takes the value 1 if the land is rented out when traded.
Quality	A two-digit number between 0 and 1 that gives an indication of the quality of the soil in the transaction, based on the ground water level and the soil type. The value 0.00 means unsuitable for agriculture, 1.00 is land of top quality.
DistUrban	The average distance from the centre of gravity of the parcels in the transaction to the nearest built-up area in kilometres.
DistRandstad	The average distance from the centre of gravity of the parcels in the transaction to the Randstad area, calculated as the distance to the nearest of the four highway bridges over the northern bordering river in kilometres.
NewMapBuiltup	Weighted dummy variable: indicates how much of the transaction is located within 100 metres of a built-up area for housing or business, indicated in the New Map of the Netherlands.
NewMapOther	Weighted dummy variable: indicates how much of the transaction is located within 100 metres of any other built-up area indicated in the New Map of the Netherlands.
NewMapInfra	Weighted dummy variable: indicates how much of the transaction is located within 50 metres of infrastructure indicated in the New Map of the Netherlands.
GC2&3, GC4&5, GC6	Weighted dummy variables: indicate if a parcel is located near a built-up area of growth class 2 or 3, or 4 or 5, or in any of the urban regions (GC6).
Forest, Nature, Builtup	Weighted dummy variables which indicate which part of the transaction is located in areas where the dominant land use is forest, nature or built-up.

Table 1 – Variables used in the regression model (Buurman, 2003, p.128)

For the case study presented in this paper, the model of Buurman is adapted slightly. First of all the research of Buurman (2003) uses the Infogroma land transaction-database that contains all transactions in the rural areas of Noord-Brabant during the period 1998 until the first half of 2001. The case study described in this paper covers the province of Noord-Holland and a longer period: 1998 until end of 2002. Therefore, the series of quarterly time dummies is extended. Also the province of Noord-Holland does not have a spatial growth classes policy like Noord-Brabant has. The Red Contour policy (in dutch 'Rode Contourenbeleid') is the best provincial planning proxy for new

urban areas in Noord-Holland. Next to that, the Provincial Ecological Main Structure plans (PEHS) are also included in the model because these are the areas in which the government as an actor is actively buying land in order to construct nature areas. In its altered form, the model for Noord-Holland looks like this:

$$
\begin{aligned}
LnPrice = {} & \beta_0 \\
& + \beta_1 \cdot LnSize \\
& + \beta_2 \cdot Q2\_98 + \beta_3 \cdot Q3\_98 + \beta_4 \cdot Q4\_98 \\
& + \beta_5 \cdot Q1\_99 + \beta_6 \cdot Q2\_99 + \beta_7 \cdot Q3\_99 + \beta_8 \cdot Q4\_99 \\
& + \beta_9 \cdot Q1\_00 + \beta_{10} \cdot Q2\_00 + \beta_{11} \cdot Q3\_00 + \beta_{12} \cdot Q4\_00 \\
& + \beta_{13} \cdot Q1\_01 + \beta_{14} \cdot Q2\_01 + \beta_{15} \cdot Q3\_01 + \beta_{16} \cdot Q4\_01 \\
& + \beta_{17} \cdot Q1\_02 + \beta_{18} \cdot Q2\_02 + \beta_{19} \cdot Q3\_02 + \beta_{20} \cdot Q4\_02 \\
& + \beta_{15} \cdot Relative + \beta_{16} \cdot NatGovt + \beta_{17} \cdot Municipalities + \beta_{18} \cdot Farmer \\
& + \beta_{19} \cdot Rent \\
& + \beta_{20} \cdot Quality + \beta_{21} \cdot DistUrban + \beta_{22} \cdot DistRandstad \\
& + \beta_{23} \cdot NewMapBuiltup + \beta_{24} \cdot NewMapOther + \beta_{25} \cdot NewMapInfra \\
& + \beta_{29} \cdot EcoMainStruct + \beta_{30} \cdot RedContour \\
& + \beta_{31} \cdot Forest + \beta_{31} \cdot Nature + \beta_{32} \cdot Builtup \\
& + \varepsilon
\end{aligned}
$$

Time dummies

Transaction characteristics

Parcel characteristics

Figure 3 – Regression model for Noord-Holland, including provincial policy

To some extent, certain variables are correlated with each other. For instance NewMapBuiltup and RedContour (correlation of .38) partially cover the same areas, being the areas outside but near existing cities. Also, BuyerMun is correlated with both NewMapBuiltup (.31) and RedContour (.34), probably because the municipality buys a lot of her land for urban development. However, the correlation matrix did not reveal any serious case of multicollinearity in the model.

4. CASE-STUDY NOORD-HOLLAND

The study area

The surface of the province of Noord-Holland covers 4,059 square kilometres, of which 2,657 square kilometres of land surface. This is 7,8% of the land surface of the Netherlands. Noord-Holland obviously is smaller than Noord-Brabant, which covers 4,929 square kilometres of land surface, 14,6% of the Netherlands (year: 2000). In 2000, 2,5 million people were living in Noord-

Figure 4 – Noord-Holland

Holland, which makes it the second province of the Netherlands with regard to the number of inhabitants, just ahead of Noord-Brabant (2,4 million people), (CBS-Statline, 2004).

Approximately 19% of the Gross Domestic Product (GDP) is being generated in Noord-Holland. In Noord-Brabant this percentage is approximately 15% (CBS-Statline, 2000). Table 2 shows that the Commercial services sector is relatively important in Noord-Holland and that the Industry and the sector 'Agriculture, forestry and fishery' are relatively less important.

Production structure of Noord-Holland compared with Noord-Brabant and the Netherlands (CBS, 2000)

	Percentage Gross added value, 1999		
	Noord-Holland	Noord-Brabant	Netherlands
Agriculture, forestry and fisheries	1.6	2.4	2.8
Industry	17.0	33.5	25.5
Commercial services	59.3	44.4	49.0
Government and healthcare	22.2	19.7	22.8
Total	*100.0*	*100.0*	*100.0*

Table 2 – Production structure of Noord-Holland

The dataset

Table 3 gives an overview of the number of transactions and parcels analysed in the aforementioned studies.

Number of transactions and parcels in the dataset

Transactions (T) and Parcels (P)	*Noord-Holland* 1998 - 2002		*Noord-Brabant* 1998 - June 2001	
	T	P	T	P
Total in dataset	3662	10015	10481	21124
Valid x,y co-ordinate	3564	9709	10047	20211
Transaction value and surface correct	2507	4608	8440	15135
Of which:				
with immobile property	*732*	*1644*	*2341*	*5641*
without immobile property	*1775*	*2964*	*6099*	*9494*

Table 3 – Number of transactions and parcels in Noord-Holland

One transaction can contain several parcels. All transactions and parcels have been checked subsequently on valid x,y co-ordinates, transaction price and surface. 2964 parcels in 1775 transactions remain for analysis.

Land mobility in Noord-Holland seems to be much lower, but in Noord-Holland on average more parcels per transaction are traded (2.73) than in Noord-Brabant (2.02). Put aside the fact that the land surface of Noord-Brabant is roughly twice as large and a large part of the difference in land mobility is explained: in Noord-Holland 3.77 parcels per square kilometre have been traded, in Noord-Brabant this is 4.29 parcels per square kilometre.

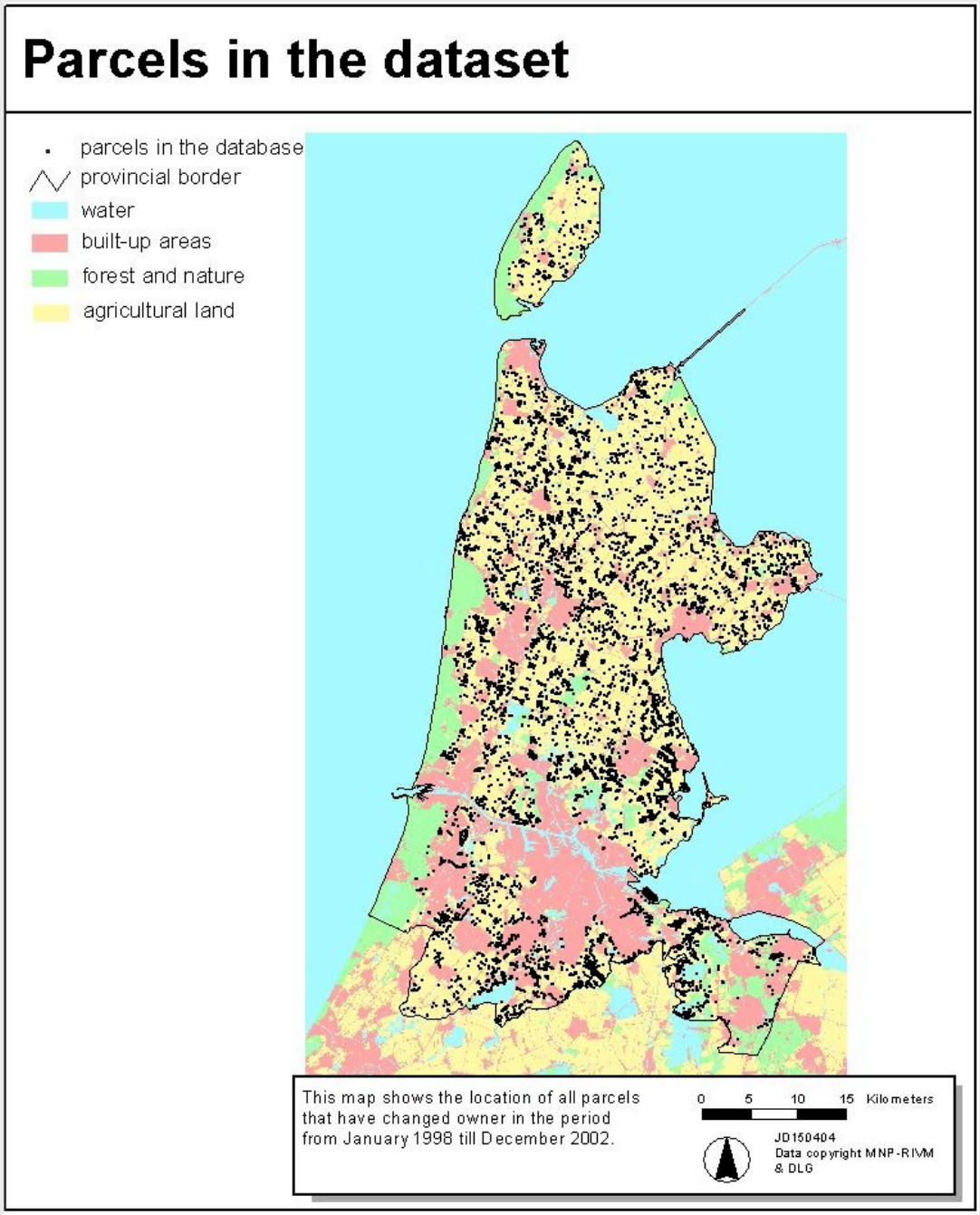


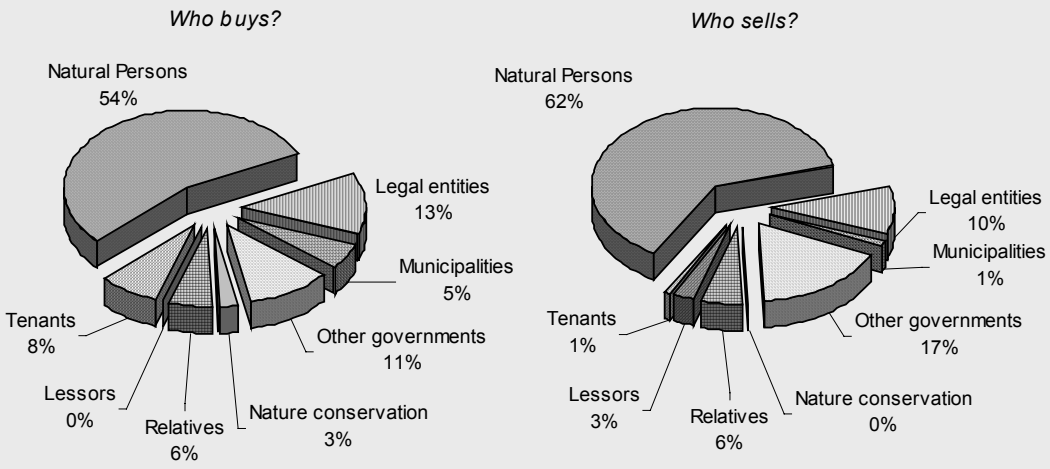
Figure 5 – All parcels in the dataset

Figure 5 shows the locations of all parcels in the dataset. As can be seen, there are some concentrations of dots. One example is the land reclamation project IJburg, a newly built quarter at the east shore of Amsterdam. This project is one transaction of 83 parcels, sold by the national government and bought by the municipality of Amsterdam.[2]

Exploratory data analysis

Most of the land in the province of Noord-Holland is bought and sold by natural persons (54 resp. 62%). The second largest seller is other governments. Most of the land they sell to natural persons, the rest is sold to other governments.

Amount of land (in percentage of total area) sold and bought by actors



If we zoom in on the land transactions by the government, we see that the municipalities and DLG are the largest buyers of land and the national government is by far the largest seller of land (67%). This can very well be a result of the national political strategy of selling land in order to decrease the national budget deficit. The national government owns a lot of military ground that can partly explain this large quantity of sold land. Next to that, the government bureau Domeinen has agricultural land in tenancy to farmers. During the past years, large quantities of this land were sold to the tenants. In 2001, the national government decided to (temporarily) stop the selling of this land.

[2] This transaction is not included in the regression analysis however, because of an unreliable transaction prize.

Land transactions by the government in hectares

	Bought (ha)	*(% v. total)*	*Sold (ha)*	*(% v. total)*
DLG	491	32%	271	15%
National government	113	7%	1193	67%
Province	143	9%	54	3%
Municipality	515	33%	117	7%
Other public institutions	295	19%	146	8%
Total	*1,558*	*100%*	*1,781*	*100%*

Table 4 – Number of transactions and parcels in Noord-Holland

Municipalities pay on average by far the highest price per square metre with legal entities paying the second highest price. The high buying price for municipalities is peculiar: In Noord-Brabant, the buying price of municipalities and legal entities was roughly equal, while legal entities had the highest selling price. As Buurman (2003) also explains, municipalities and legal entities both buy land for developing houses. This explains the high price. For legal entities, land speculation and taking position in the land market can also explain the price level found. For municipalities in particular, the large difference in average price paid could in addition be caused by outliers. Examining the top10 highest prices per square meter transactions revealed that 6 out of 10 buyers were municipalities (see table 5). Two of these transactions were situated in an area east of Alkmaar, near city limits and in a planning area for new buildings (from the New Map of the Netherlands (see figure 7).

Average price paid per square metre

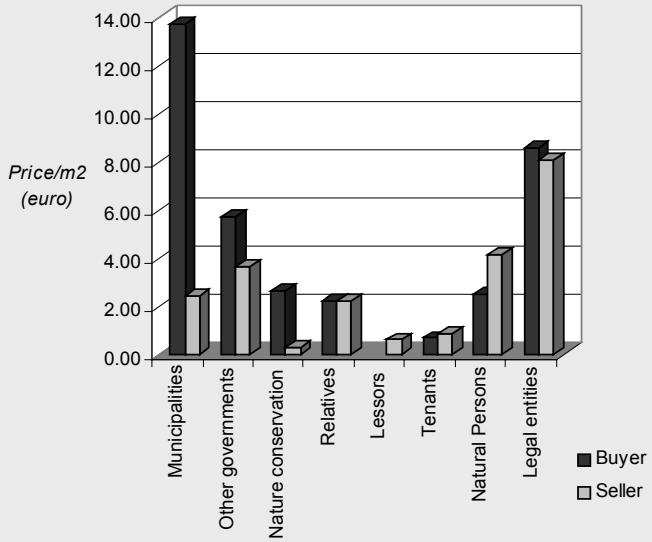


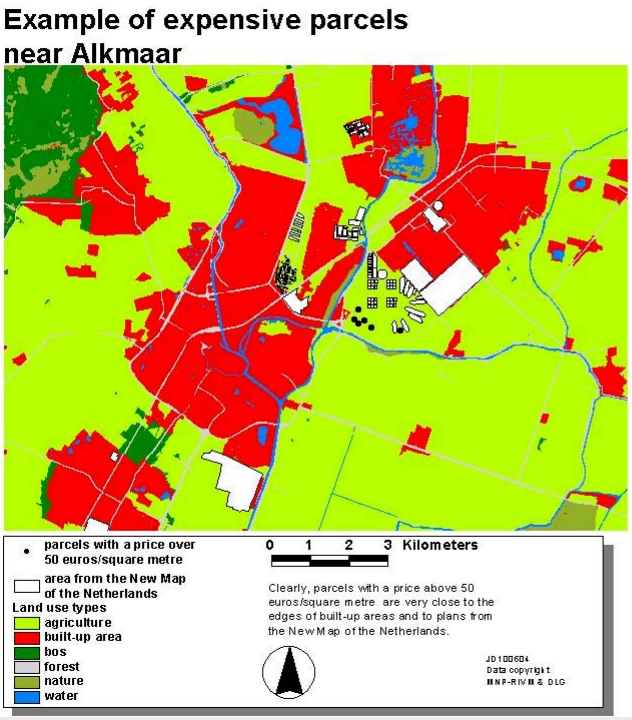
Figure 6 – Average price paid per square metre

Top10 land transactions in price per square meter

#	*p.p.sqm.*	*Buyer Municipality*	#	*p.p.sqm.*	*Buyer Municipality*
1	362.90	Yes	6	85.59	Yes
2	153.15	No	7	76.42	No
3	119.20	Yes	8	70.68	No
4	107.91	No	9	57.12	Yes
5	98.93	Yes	10	51.21	Yes

Table 5 – Top10 highest p.p.sqm. transactions in Noord-Holland

Figure 7 – Expensive parcels near Alkmaar



Average Change in price per square meter per month

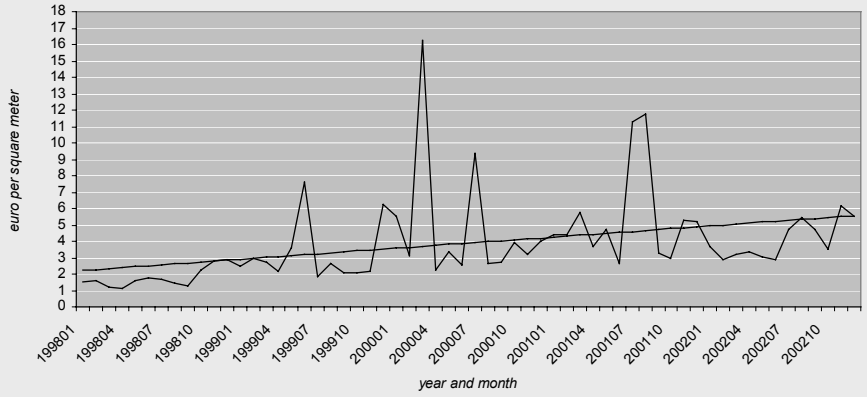


Figure 8 – Average change in p.p.sqm. per month

From table 5, observations 1 and 5 both are situated in the area east of Alkmaar and both transactions take place in march 2000. This also explains the peak in the average change in price per square meter per month in that quarter (see figure 8).
A further examination of any possible relationship between these transactions is recommendable.
An interpolation of land prices has been made using the inverse distance weights method with power 1 and 12 neighbours (see figure 9). Clearly the area east of Alkmaar

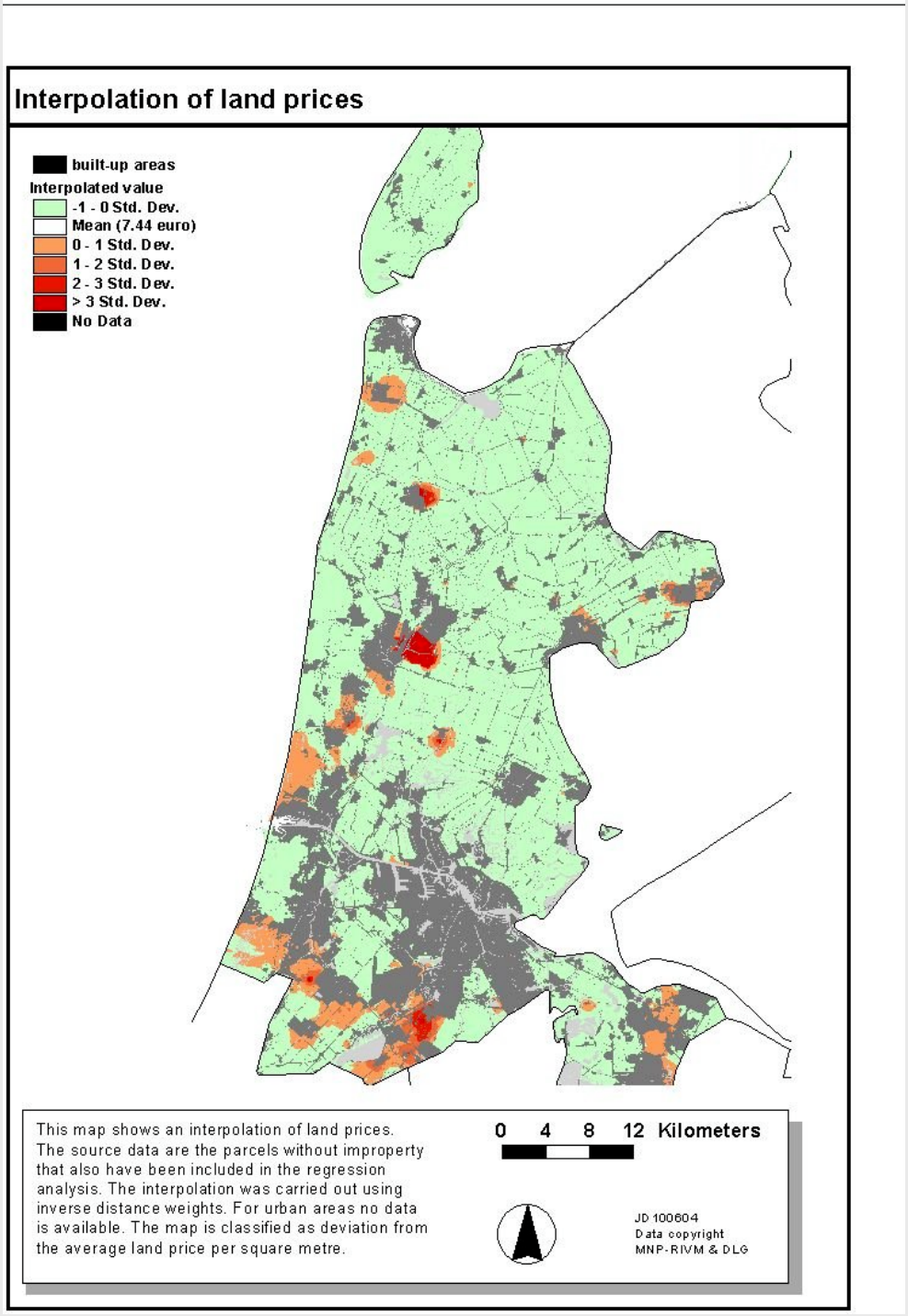


Figure 9 – Interpolation of land prices

is visible. Also an are south of Amstelveen jumps out. Zooming in revealed the following (see figure 10):

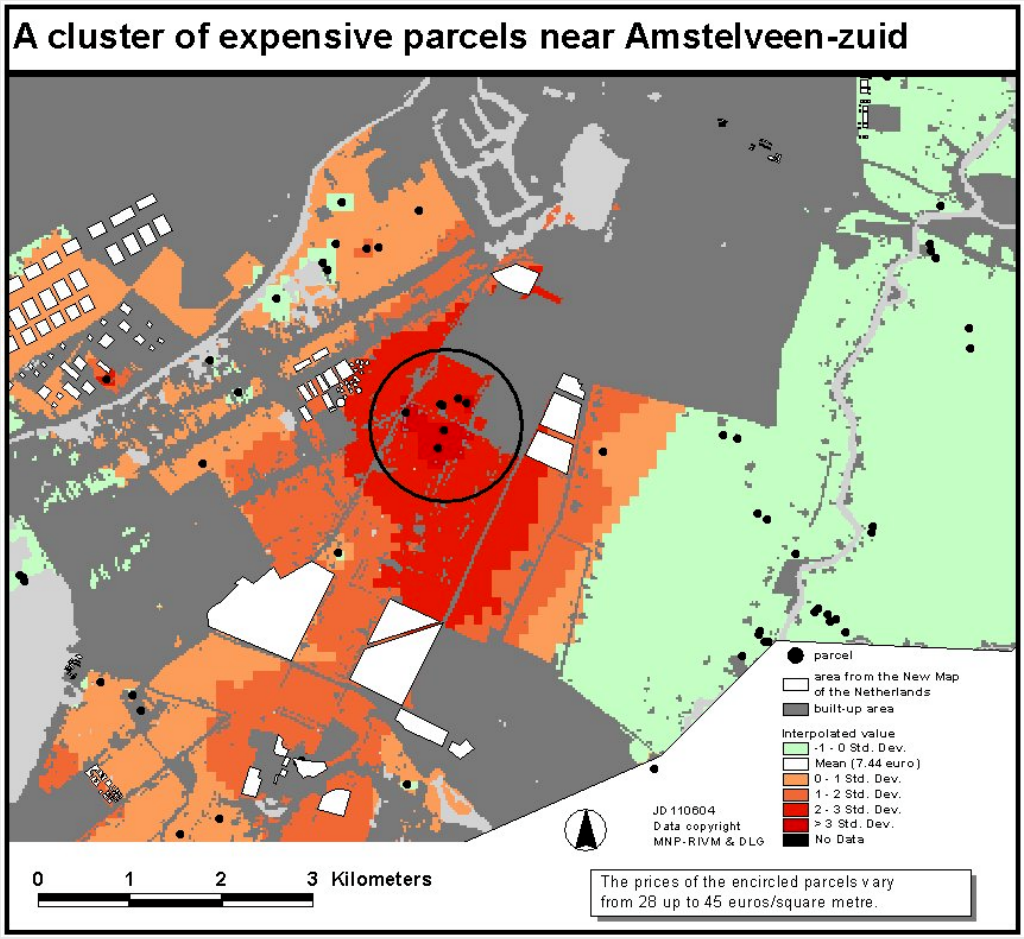


Figure 10 – Interpolation of land prices near Amstelveen

This is an area very near city limits for which building plans are probably going to be developed, which explains the high price. The mean land price in Noord-Holland is 7.44 euros/square metre. It would be interesting to visit the location in order to see if already any building activity is taking place.

Results of regression analysis

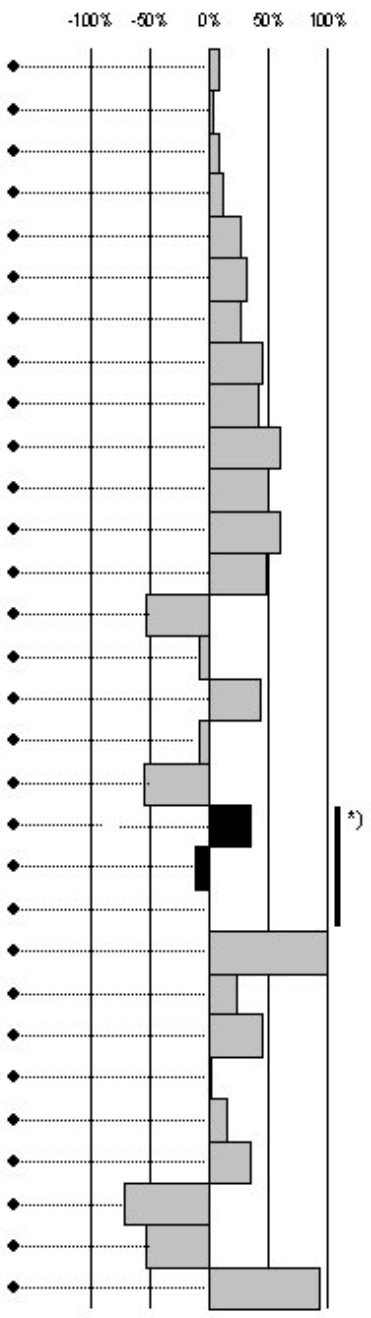
Figures 11a and 11b on the next pages contain an overview of the regression results of the case studies Noord-Brabant (Buurman, 2003) and Noord-Holland. Were Buurman (2003) obtained an adjusted R^2 of 73%, the model of Noord-Holland performs remarkably well also with an adjusted R^2 of 69%. Also, the signs of all variables are the same in both models, although the impact differs. In Noord-Holland, land prices have risen more and faster than in Noord-Brabant. A remarkable difference is the impact of the variables NewMapBuiltup and Builtup in both models. This difference is probably

caused by the variable RedContour in the model of Noord-Holland, which has a large impact on land prices and covers partly the same area as the two other aforementioned variables. Removing the variable RedContour from the model causes the significance of NewMapBuiltup to improve, while it's impact triples from 20% to 66%. Also the

The results of the estimation in Noord-Brabant

Variable	Coefficient		Std. Error	Impact
Constant	1.631	***	(0.116)	
LnSize	0.949	***	(0.009)	
Q2_98	0.076		(0.047)	8%
Q3_98	0.034		(0.054)	3%
Q4_98	0.081	*	(0.047)	8%
Q1_99	0.110	**	(0.046)	12%
Q2_99	0.229	***	(0.044)	26%
Q3_99	0.263	***	(0.047)	30%
Q4_99	0.242	***	(0.042)	27%
Q1_00	0.370	***	(0.043)	45%
Q2_00	0.345	***	(0.045)	41%
Q3_00	0.464	***	(0.049)	59%
Q4_00	0.403	***	(0.042)	50%
Q1_01	0.475	***	(0.046)	61%
Q2_01	0.387	***	(0.046)	47%
Relative	-0.742	***	(0.033)	-52%
NatGovt	-0.089	**	(0.046)	-8%
Municipality	0.356	***	(0.040)	43%
Farmer	-0.099	***	(0.019)	-9%
Rent	-0.784	***	(0.042)	-54%
Quality	0.298	***	(0.070)	35%
DistUrban	-0.117	***	(0.011)	-11%
DistRandstad	-0.004	***	(0.001)	0%
NewMapBuiltup	0.689	***	(0.049)	99%
NewMapOther	0.217	***	(0.055)	24%
NewMapInfra	0.368	***	(0.098)	44%
GC2&3	0.015		(0.018)	2%
GC4&5	0.135	**	(0.064)	14%
GC6	0.294	***	(0.032)	34%
Forest	-1.244	***	(0.032)	-71%
Nature	-0.757	***	(0.097)	-53%
Builtup	0.660	***	(0.053)	94%
Adjusted R^2	73%			
No. of obs.	6099			

*Note: *** significant at 1%, ** significant at 5%, * significant at 10%*



*) *Note that these three variables are measured in a different unit and their impact percentages are not comparable to those of other variables.*

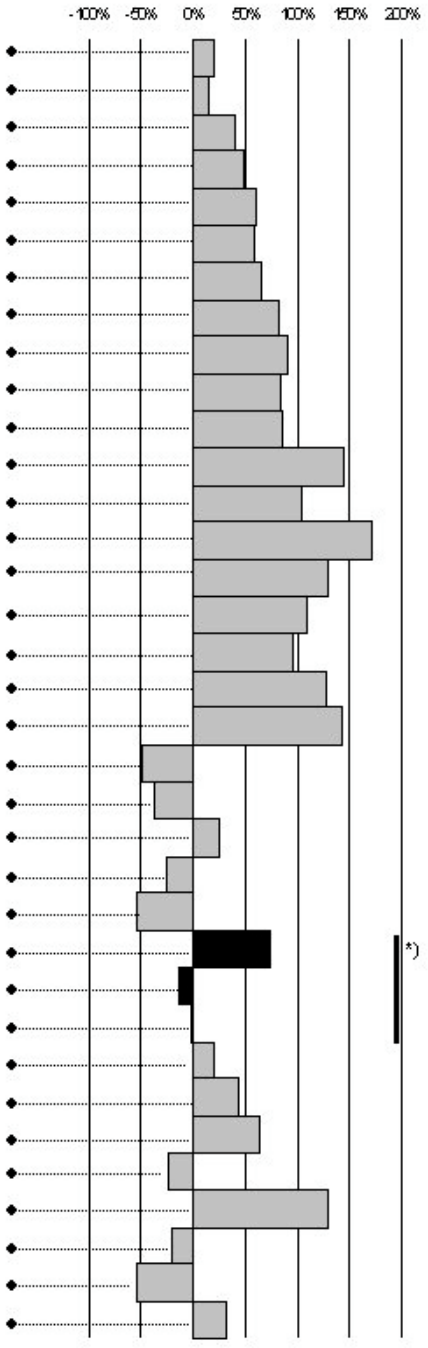
Figure 11a – Regression results in Noord-Brabant

impact of Builtup doubles from 31% to 62%. The adjusted R^2 drops to 66%. Some more thought should be given on how to exactly specify these variables in the model in order to minimise correlation and to optimise the model.

The results of the estimation in Noord-Holland

Variable	Coefficient		Std. Error	Impact
Constant	0.710	***	(0.218)	
LnSize	0.950	***	(0.018)	
Q2_98	0.186		(0.138)	20%
Q3_98	0.136		(0.145)	15%
Q4_98	0.337	***	(0.126)	40%
Q1_99	0.400	***	(0.129)	49%
Q2_99	0.474	***	(0.133)	61%
Q3_99	0.462	***	(0.133)	59%
Q4_99	0.498	***	(0.126)	65%
Q1_00	0.599	***	(0.127)	82%
Q2_00	0.649	***	(0.130)	91%
Q3_00	0.612	***	(0.138)	84%
Q4_00	0.621	***	(0.123)	86%
Q1_01	0.891	***	(0.138)	144%
Q2_01	0.714	***	(0.133)	104%
Q3_01	0.998	***	(0.141)	171%
Q4_01	0.829	***	(0.129)	129%
Q1_02	0.740	***	(0.136)	110%
Q2_02	0.672	***	(0.139)	96%
Q3_02	0.825	***	(0.140)	128%
Q4_02	0.886	***	(0.130)	143%
Relative	-0.680	***	(0.076)	-49%
NatGovt	-0.479	***	(0.164)	-38%
Municipality	0.234	***	(0.082)	26%
Farmer	-0.299	***	(0.042)	-26%
Rent	-0.778	***	(0.059)	-54%
Quality	0.548	***	(0.084)	73%
DistUrban	-0.164	***	(0.080)	-15%
DistRandstad	-0.007	***	(0.001)	-1%
NewMapBuiltup	0.185	**	(0.097)	20%
NewMapOther	0.357	***	(0.084)	43%
NewMapInfra	0.488	***	(0.141)	63%
EcoMainStruct	-0.264	***	(0.044)	-23%
RedContour	0.833	***	(0.069)	130%
Forest	-0.233		(0.257)	-21%
Nature	-0.780	***	(0.176)	-54%
Builtup	0.267	***	(0.117)	31%
Adjusted R^2	69%			
No. of obs.	1775			

*Note: *** significant at 1%, ** significant at 5%, * significant at 10%*



*) *Note that these three variables are measured in a different unit and their impact percentages are not comparable to those of other variables.*

Figure 11b – Regression results in Noord-Holland

5. CONCLUSIONS AND DISCUSSION

Conclusions and Discussion

The conclusion from this first exploratory analysis is that the spatial regression model Buurman (2003) has developed seems to be quite robust: using another dataset, the model performs well, with similar signs for all variables and again a high explanatory power considering the high adjusted R^2. The correlation matrix did not reveal any serious case of multicollinearity in the model. One point of discussion regarding the outcomes is that for Noord-Holland an analysis of possible presence of spatial autocorrelation remains to be carried out.

Regarding the price per square meter, there are some outliers that are worth investigating, in particular parcels bought by municipalities. The average price paid by municipalities is extraordinary high and six out of ten of the transactions with the highest prices per square meter have a municipality as a buyer.

The model for Noord-Holland can be estimated in various ways. The way it is specified now contains three variables (Builtup, NewBuiltup and RedContour) that pratially cover the same areas. It is recommendable to think about how to alter model specifications or the composition of these three variables in order to improve the model.

Also, in some cases in which land prices are hard to explain or interesting patterns are visible, it could prove to be useful to do some field work. For instance the areas east of Alkmaar and south of Amstelveen could be visited in order to gain extra information regarding the involved parcels.

Finally, it is clear that this first analysis has yielded quite positive results with regard to the model specification, but with regard to actors and factors playing a role on the Noord-Holland land market, this paper has only given some global insight. A more thorough analysis needs to be performed. This can very well be combined with the further work on the model itself in combination with field work and literature research regarding provincial policies during the last two decennia.

Recommendations regarding the model

Rosen (1974, p.40) argues that the spatial explanatory regression model inhabits "[…] natural tendencies toward market segmentation, in the sense that consumers with similar value functions purchase products [i.e. parcels, red.] with similar specifications [i.e. characteristics, red.]. This is a well-known result of spatial equilibrium models."

Buurman claims his model is a hedonic model, based on bid-rent theory. According to Rosen (1974, p.34) "Econometrically, implicit prices are estimated by the first-step regression analysis (product price regressed on characteristics) […].". Following Rosen's reasoning to the letter, the model of Buurman cannot be called hedonic, because the product price is not only regressed on product (i.e. parcel) characteristics, but also on characteristics of the transactions themselves. At best, the model is only partially hedonic, although this term is perhaps not very usable.

It is possible to adapt the model of Buurman in order to become truly hedonic. The most promising way to do so seems to be to take the buyer characteristics and use them to create separate market segments. These market segments are in themselves homogenous, thus satisfying criteria of Rosen (1974) for hedonic analysis.

When used in explanatory setting, one can simply divide the observations from the dataset by looking at the type of buyer. When used in exploratory setting, perhaps the best way to divide the observations is to estimate the chance that a parcel will be bought by a certain type of buyer. The buyer with the highest chance gets the observation in his market. The Agricultural Economics Research Institute (LEI) (Luijt, 2001; Luijt, Kuhlman & Pilkes, 2003) is developing a model where a two separate price equations - for 'red' and for 'green' buyers – are estimated. Observations are divided over these two separate submarkets using a stochastic equation, which estimates the buyer odds. The model of Buurman can perhaps be improved using a similar approach.

Acknowledgements

The authors would like to thank the National Institute for Public Health and the Environment (RIVM) for funding this research. Further, the author's gratitude goes out to the Government Service for Land and Water Management of the Netherlands (DLG), a department of the Netherlands Ministry for Agriculture, Nature Management and Fisheries (LNV), for supplying the land transaction data and support thereby, especially Ruud Troost. Finally, the author thanks Gerard Kooman, Edwin Bleijinga, Rik Heskes en Ton van Bart of the Province of Noord-Holland for the interesting discussions about processes at hand on the land market in their province.

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