Regional Differences on the Dutch Rural Land Market

Influence of Agricultural Zones on Land Prices.

The Netherlands 2000 - 2010

Msc. Thesis AEP
BSc R.G. Kroes
Supervisor:
Prof.dr. WJM Heijman

September 2013

Regional Differences on the Dutch Rural Land Market;

Influence of Agricultural Zones on Land Prices.

BSc R.G. Kroes

890101479020

Regional Economics

Agricultural Economics and Rural Policy Group

September, 2013

Major Thesis AEP

AEP-81336, 36 ECTS

Wageningen UR

Hollandseweg 1

6706 KN Wageningen

The Netherlands

Landbouw Economisch Instituut (LEI)

Alexanderveld 5

2585 DB The Hague

The Netherlands

Supervisors:

Prof.dr. WJM Heijman (WUR)

dr. JW Kuhlman (LEI)

dr.ir. HJ Silvis (LEI)

ir. HJ Agricola (Alterra)

Examiners:

Prof.dr. WJM Heijman

Abstract
The Dutch agricultural sector is developing in different directions within the Netherlands. Farmers are intensifying, specializing or expanding their farm activity in specific agricultural zones. The objective of this paper is to show that the location of parcel in a specific agricultural zone has a significant influence on the rural land price. To ensure a consistent relationship over time, the analysis is done for 2000 and 2010. The adapted hedonic pricing method is used to analyse the rural transactions and a set of variables, which consist out of land characteristics, regional indicators and the different agricultural zones. The results show that agricultural zones and the regional indicators influence the land price significantly.

Keywords
Hedonic pricing method, land market, Agricultural Zones

Highlights:

- Development of the agricultural sector in a region influences the rural land price.
- Main relations found in the analysis are comparable for 2000 and 2010.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

I would like to thank all the different people who helped me during my thesis. Their help made that I understood the background of the land market and the methods I used in this analysis.

I would like to thank Wim Heijman for the supervision during my thesis and also for introducing GIS to me during my BSc. thesis. Without this introduction I would not have chosen to follow the courses in GIS which helped me a lot during this analysis.

Next I like to thank the LEI for providing the opportunity to do my research and providing me access to the necessary data for this analysis. Also I would like to thank the supervisors from the LEI. Tom Kuhlman for introducing me at the office in The Hague and for his help with the data and methodology. Huib Silvis for involving me in a project of the LEI, in which I could contribute and learn a lot about the current state of the land market, and for the feedback on my report.

I would like to thank Herman Agricola for sharing his work on the agricultural zones map, so that I could use this in my research, and for participating in the discussion on my work.

Next I would like to thank Ron van Lammeren for introducing me in the topic of the land market and the possibilities for combining the knowledge of GIS in economic analysis.

I would like to thank Sytze de Bruin, Jeroen Klomp, Martha Bakker, Esther Boere and Vincent Linderhof for the help and advice they give me during my thesis when I asked specific questions related to the research.

1. Introduction

The agricultural sector is developing under the pressure of the world market, urban areas and national competition within the Netherlands. Farmland decreased by 7% and the number of farms decreased with 30% in the period from 2000 until 2010. The fastest decline of holdings is in the sector of mixed agriculture, this relates to the trend of specialization. The difference between the decrease of the number of farms and the land used for agriculture indicates an increase of average farm size. Silvis et al. (2013) show an increase of large and small farms based on hectares per farm. This last fact is based on the decreasing farm activity of the older land-based farmers, who slowly decrease their farm activity by selling parts of their land. The increase of the large farms relates to the expanding activity of the land-based agriculture sector (Silvis et al. 2013). Developments in the agricultural sector affect the rural land market. Not every region will be suited for the development of, for example, large-scale agriculture. Soil type, urban pressure and the strength of the agricultural sector in a region will influence the opportunity to develop the farm activity in a certain direction. These regional differences will influence the local land market. The developments towards specializing and expanding farms will influence the land price on the rural land market. Wascher et al. (2010) defined the agricultural zones map, which indicates different regions in which specific type of agricultural sectors are developing. In this research we investigate whether the developments of the agricultural sector within a specific zone influence the land price. The development of the sector are expected to be consistent in a time period of 10 years , to test this relation the analysis is done for the years 2000 and 2010. In which we introduce the indicator for the development of the agricultural sector, based on the agricultural zones map, as variable in the model. The analysis is done by making use of the hedonic pricing method. The results provide a picture of the current developments and interactions on the rural land market which helps to understand future developments. By comparing the results of the two years the consistency of the results can be observed. The spatial component is an important element in the analysis of the land market. The methods developed by Geographical Information Science are used in the economic analysis to integrate dataset and evaluate spatial relationships in the rural land market. The possibility of joining large quantities of data and the strength of visualizing the data and results can be used to spot regional patterns in the data.

2. THEORY[1]

The land market depends on a lot of interactions within space. The first law of Geography is essential in the analysis of the land market as Tobler (1979) stated; “Everything is related to everything else, but near things are more related than distant things.” Land is not a homogeneous good and even when all characteristics are equal for two parcels of land, the specific location of a parcel and the relation to the surroundings can make a difference in price. Recent research on the land market is focussed on understanding these local and regional dependencies. The hedonic pricing method, introduced by Rosen (1974), is used for this kind of analysis. The method is used to determine the shadow prices of the different elements of a product based on the product prices. A regression model is used to analyse the relationship between a sold product and the specific characteristics of that product. The method is adapted for the housing and land market. In these markets the characteristics of the transaction are also used in the analysis, which is not in Rosen’s original method. Recently Buurman (2003), Cotteleer et al. (2008) and Dekkers et al. (2010b)used the method to analyse the land price on the rural Dutch land market.

Market imperfections

The hedonic pricing method assumes perfect competition on the land market. In reality government intervention and local markets cause violation of this assumption. The influence of these factors should be understood and used when choosing variables for the analysis and by the interpretation of the results.

The government influences the land market by restricting the market through spatial planning and regulations. Anyone can enter the land market and buy a piece of land, but the use of land is restricted (Segeren et al. 2005). Not only the type of land use is restricted, but also the specific use is guided by for example environmental laws and production quota. The spatial planning schemes of the government have another effect on the market. By indicating in which area specific kinds of land use are allowed, the market becomes segmented. Every segment is a different market in which price of land is determined by the potential profitability (Luijt et al. 2002). The price of land in the urban area, for residential use, is a multiple of the price in the rural area where the land is used for agriculture. With fixed spatial plans these markets could operate separately from each other, but spatial plans are changing over time and this aspect leads to interactions between the different segments. The possibility of a future change of land use from agriculture to residential use entices speculators into the market, resulting in higher prices for rural land in the urban fringe areas (e.g., (Adams et al. 1968) ; (Chicoine 1981)). Dekkers et al. (2010a) showed that the spatial planning constraint leads

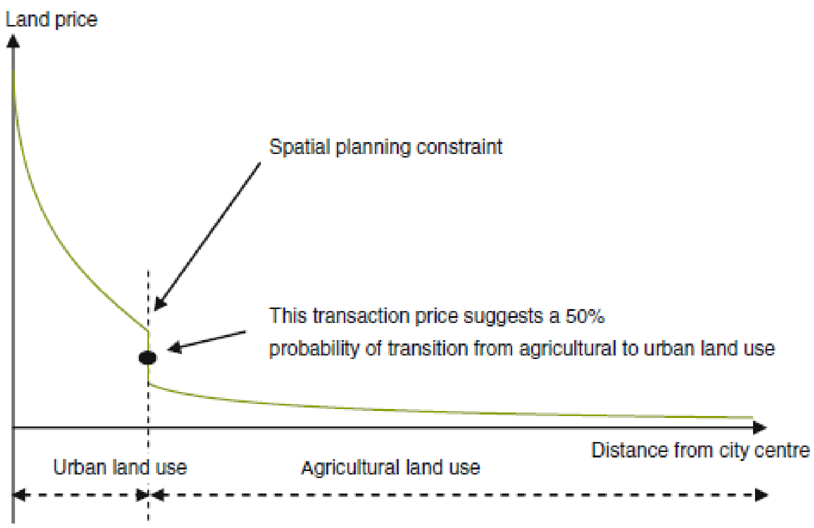


Figure 1; *Relation between land price, land use and distance from city centre with spatial planning constraints (Dekkers 2010)*

[1] Description classical theories land market, see appendix one.

to a grey area between the urban and rural area as showed in figure 1. This is currently used for agriculture but could be transformed to urban area; the chance of a change in function is referred to as the *transition probability* (Dekkers et al. 2010a). Luijt et al. (2002) referred to this area as the *option value* of land.

The segmented land market reduces the total number of buyers and sellers on the market. Based on the large number of farmers, the rural land market could still be competitive. Only the fixed location of land influences the number of potential buyers and sellers of a specific parcel. The distance between a farmer and a parcel affects the price a farmer is willing to pay for a piece of land. Increasing distance between farmer and the parcel leads to an increase of costs because, transportation to the parcel is more costly and time consuming for the farmer (Bakker et al. 2013). Cotteleer et al. (2008) showed that 90% of the farmers buy their land within a 6.7km range of their own farm. This figure shows that farmers value land further away less than land close by. This fact decreases the number of potential buyers of land. The number of sellers and buyers in a region is in this case based on the valuation of distance by different farmers and the amount of farmers in the region. The negative relation between distance and willingness to pay and the fixed location of land and farms create local land markets. The price on the local market deviates from the price that would be determined in a competitive market, based on the variation between the number potential buyers and sellers in a region (Cotteleer et al. 2008). Local markets do not provide an equilibrium price for land, but leave an excess surplus over which buyers and sellers can bargain. In case of relative large supply the relation between the total number of buyers and sellers in a region influence the bargaining power of both groups. More supply of land will have a negative impact on the bargaining power of the sellers and vice versa.

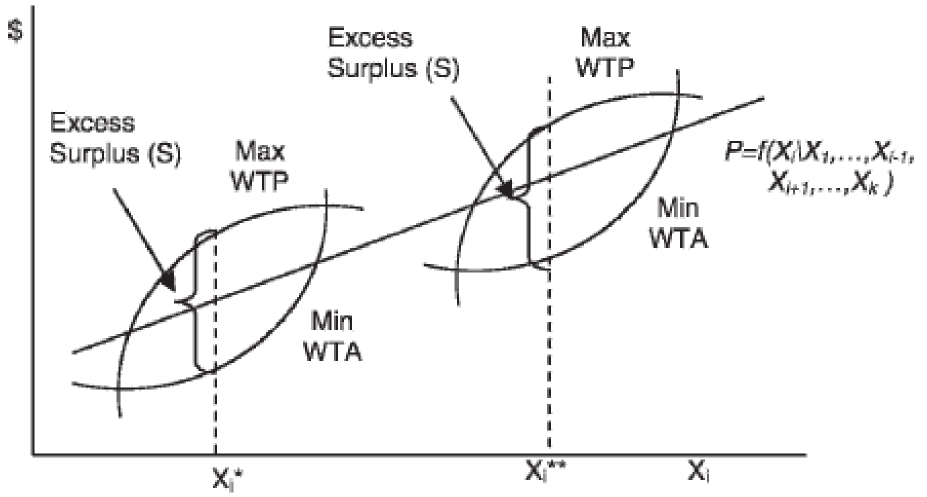


Figure 2; *Regression model with excess surplus (Cotteleer et al. 2008)*

Determinants of land value

Dekkers et al. (2010b) defined three groups of variables that explain part of the variation in land prices; the parcel, the actor and the spatial characteristics. These variables, together with the regional differences, explain part of the variation in rural land prices.

The parcel characteristics are the variables that could influence the productivity of the land. Soil type, and parcel size are important variables in this category. Cotteleer et al. (2008) and Buurman (2003) used the soil type as indication for the soil quality, which would affect the land price based on the theory of Ricardo. Both studies did not find a strong effect of inserting soil type in the analysis. The size of the transaction is another variable that affects the land prices. The transaction costs per hectare are lower if the transaction is larger. On the other hand productivity could be increased when the parcels are larger, which makes it easier to work on

with large materials (Buurman, 2003). The land use of the parcel is also included in this group, difference in land use results in a price difference (Cotteleer et al. 2008).
The actor characteristics are the personal characteristics of buyer and seller of land. Cotteleer (2008) used a lot of personal characteristics in relation to the local market characteristics, age, number of possible successors and ESU per farm could for example influence the bargaining power of the individual farmer. The actor characteristics did not have a strong significant influence on the land price based on the research of Cotteleer et al. (2008). Significant elements were leasing contracts and compulsory sale. These observations are in this research excluded from the dataset.
The spatial characteristics are based on the location of a parcel and the relation to other spatial elements. For example the influence of the urban area on the land prices (Chicoine 1981), but also the distance to nature areas, horticulture and highways influence the price of a parcel(Dekkers et al. 2010b; Cotteleer et al. 2008). Luijt et al. (2003) and Cotteleer et al. (2008) used the gravity model of Reilly as indicator for urban pressure. This method was introduced as a model to express urban pressure by Shi et al. (1997). The Reilly index did not show significant results in the recent study of Cotteleer et al. (2008). Buurman (2003) and Dekkers et al. (2010b) used distance to an urban area to express the urban pressure. In all of these studies the urban pressure is assumed constant for every urban area. Recent developments show that this is not the case, the population in some urban areas is declining (Kuhlman et al. 2012). In these regions the neighbourhood of the urban area will not result in urban pressure on the rural land market, which could results in a lower land price in these regions.

3. MODEL

A regression model is used to determine the impact of different parameters on the rural land market. Buurman (2003) defined the following description of the hedonic pricing method in relation to the land market; *"Thus in the case of land, the price of a parcel can be determined by valuing the attributes of a parcel. This happens implicitly when actors bid for a specific parcel: they base their bids on the valuation of the different amenities and properties of a parcel (…) Hence, realised land prices are the result of the buyers' valuation of the characteristics of parcels."*

A problem is the spatial dependency of the data, which means that nearby observations are correlated. There are two types of spatial dependencies, spatial autocorrelation and spatial heteroskedasticity, which results in biased and inconsistent regression results if the problem is ignored (Anselin 1988, 2003). Spatial autocorrelation is the correlation of a variable with its neighbours, based on a lag dependence of the explanatory variables. If this is the case it would lead to spurious regression results and could result in wrong conclusions (Dekkers, et al. 2010, Anselin, 1988). Spatial heterogeneity is another problem in a spatial dataset. This refers to the problem that the effect of a variable is not consistent over space. This could happen if regional variables are not included in the model. This would lead to heteroskedasticity in the error term (Anselin, 1988).

Osland (2010) set up a statistical test procedure to test the spatial dependency of the hedonic pricing method. The steps are presented in appendix three. The first step is testing the regression results based on the global Moran's I test (Moran 1948). If this test states that there is spatial dependency in the data the Lagrange Multiplier test for spatial dependency can be used to determine a relevant spatial regression model (Osland 2010). Three type of models could be used to handle to problem of spatial dependency; the spatial error model, the spatial lag model and a combination of the two. The spatial error model is used if there is a problem of spatial heteroskedasticity. The spatial lag model is used to for the problem of spatial autocorrelation. If both problems arise in the data analysis a combination of the two models can be used (Osland, 2010). The different type of spatial econometric models are described in appendix four.

After a positive test of spatial dependency it is useful to use an cluster and outlier analysis(Anselin 1995). This method is based on the local Moran's I, which tests whether a variable of point x is significant different from the average and whether it is different from his own neighbours based on the weighting matrix. This results in an output in which five types of groups are distinguished; results which are not significantly different from their neighbours and the average, a cluster of high values, a cluster of low values, a high values in a region with low values and a low values in a region with high values (Mitchell 2005). This method is used to test the error term of the regression model, it provides the opportunity to see where the spatial clusters are situated in the dataset. This information can be used to add additional variables if these could be linked to the spatial distribution of the error term.

In this research we focus on the regional differences on the land market, in particular on the influence of the regional differentiated development of the agricultural sector. Variables included in our analysis have a strong emphasis on the spatial characteristics of the land market. The actor characteristics are not included in this research, because in recent literature these variables did not show strong significant effects (Cotteleer et al. 2008). Table 1 provides an analysis of the variables used in the analysis. The variables that could be spatial dependent are tested by using the Moran's I test, if the result is significant it means that there are spatial effects in that variable.

The dependent variable used in this research is the transaction price per hectare. From the Moran's I p-value it is clear that this variable is spatial dependent. This is an indication that there could be a problem of spatial dependency in the analysis if the exploratory variables will not capture the spatial dependency in the dependent variable. To test the influence of developments in the agricultural sector, every transaction is linked to one specific agricultural zone based on the central point of the transaction. Second we use regional dummies to capture the regional variance in markets. These regional indicators capture part of the variation in land price based on regional differences. The agricultural areas division of the Netherlands in 14 regions is used to capture part of the variance. This division is based on the similarity of the agricultural structure in different regions in the Netherlands. During the analysis the variation within these regions will be investigated by the outlier/cluster analysis. If there are large differences within the region we could choose to add an additional regional indicator on a lower scale.

Other variables included in the analysis are based on the parcel and spatial characteristics of the transaction. For the transactions characteristics we include the size of the transaction in hectares and the land use. For the spatial characteristics; urban pressure, growth of urban area and distance to different spatial element are included. The urban pressure is included in the model as the local population density, defined as the sum of the population within a 6.7km range from the parcel. The range of 6.7 km is based on the local market of the regions which could influence the price on the land market. A new variable in this research is the growth of the urban area. This variable is inserted as the growth percentage based on the difference between the local population density of the years 2000 and 2010. Three relations to spatial elements will be included in the research, based on literature we included the distance to the closest nature area, horticulture area and highway. For these variables the distance to the closest spatial element will be calculated form the centre point of the parcel(s).

Table 1; Analysis of variables used in research.

	2000				2010			
Variable	**Mean**	**Min.**	**Max.**	**Moran's I**	**Mean**	**Min.**	**Max.**	**Moran's I**
Transaction price per ha in €	37083	6292	84594	0.60 (0.00)	46598	14595	117500	0.60 (0.00)
Size transaction ha	4.29	0.25	54.91	0.28 (0.00)	5.16	0.25	69.12	0.22 (0.00)
Population 2000/2010	47222	855	446875	0.76 (0.00)	47874	750	397120	0.78 (0.00)
Population growth 2000-2010	2.72%	-7.97%	34.46%	0.68 (0.00)	2.67%	-7.97%	34.46%	0.64 (0.00)
Distance to spatial element in m								
Nature	5036	0	19839		4799	0	20972	
Horticulture	2197	0	20524		2184	1	22466	
Highway	5050	39	27579		5284	43	27943	
Dummy variables								
		Number of observations				**Number of observations**		
Land use	Grass land	1445			Grass land	935		
	Arable land	1098			Arable land	1156		
Agricultural competitiveness	Urban-high	306			Urban-high	218		
	Urban-low	525			Urban-low	467		
	Rural-high	1126			Rural-high	872		
	Rural-low	569			Rural-low	519		
Agricultural area	Bouwhoek en Hogeland	96	Westelijk Holland	112	Bouwhoek en Hogeland	81	Westelijk Holland	99
	Veenkolonien en Oldambt	226	Waterland en Droogmakerijen	32	Veenkolonien en Oldambt	179	Waterland en Droogmakerijen	18
	Noordelijk Weidegebied	484	Hollands/Utrechts weidegebied	128	Noordelijk Weidegebied	316	Hollands/Utrechts weidegebied	81
	IJsselmeerpolders	37	Zuidwestelijk akkerbouwgebied	135	IJsselmeerpolders	60	Zuidwestelijk akkerbouwgebied	140
	Oostelijk Veehouderijgebied	429	Zuidwest-Brabant	122	Oostelijk Veehouderijgebied	389	Zuidwest-Brabant	56
	Centraal Veehouderijgebied	166	Zuid-Limburg	33	Centraal Veehouderijgebied	126	Zuid-Limburg	67
	Rivierengebied	76	Zuidelijk veehouderijgebied	466	Rivierengebied	76	Zuidelijk veehouderijgebied	403

4. DATA DESCRIPTION

The main data source used is the combination of the InfoGroMa database of the Government Service for Land and Water Management of the Netherlands (DLG) and the Agricultural Census of the Central Bureau of Statistics. The former database contains all the rural land transactions registered by the Dutch Cadastre and Public Registers Agency (Kadaster). In appendix two is a table presented in which all data sources are stated.

The agricultural zones map is not used before in relation to the analysis of prices on the rural land market. The map is used to differentiate regions within the Netherlands which are preferable for a specific type of development of the agricultural sector. Wascher et al. (2010) define regional agricultural zones based on the interaction between urbanisation and the agricultural competitiveness. The urbanisation map is based on two variables; economic density and accessibility to urban services. In which the last is determined by the distance to a city centre in which the defined urban services are provided. These variables are scaled and related to each other in a one to one relation. The two maps are combined and scaled in three groups; peri-urban, rural and deep rural (Van Eupen et al. 2012). The agricultural competitiveness is based on three underlying variables; the average farm size (ESU/farm), the average intensity (ESU/hectare) and the population per agricultural hectare, all per municipality. These variables are based on the local market pressure as described by Vereijken and Agricola (2004). They stated that there is interaction between the population pressure at one side and the strength of the holdings in that region on the other side. The pressure of the farms is based on two facets; the competitiveness of the region based on the average ESU per hectare and the competitiveness of the farms within that region based on the average ESU per farm in that region. The variables are related with a weighting value. The average ESU per farm is weighted with a factor three, the average ESU per hectare is weighted with a factor one and the population pressure is weighed with a factor two. The weighting factors are based on interpretation of the theory and expert judgement (Vereijken and Agricola 2004). The farm size is stated more important for the agricultural competiveness than the intensity per hectare. This is based on the fact that a couple of large holdings have more power on the land market than a large number of small farmers in a region. The underlying maps of the agricultural zones map are presented in appendix three.

Figure 1 shows the agricultural zones, which is a combination of the two described maps. As indicated in the legend, four types of agricultural zones are specified. The farmers in the region with high urban pressure and agricultural competitiveness are most likely to intensify their production with a focus on high yield crops. This region mainly expands in the direction of the horticulture sector and production for the world market. The region with high agricultural competitiveness and low urban pressure provides the best opportunity for large scale holdings. In the areas were the agricultural sector is less competitive the focus is more on multifunctional agriculture. In the regions with a high urban pressure the agricultural sector provide services that fits the urban environment and in the rural area the focus is on tourism and nature development (Wascher et al. 2010).

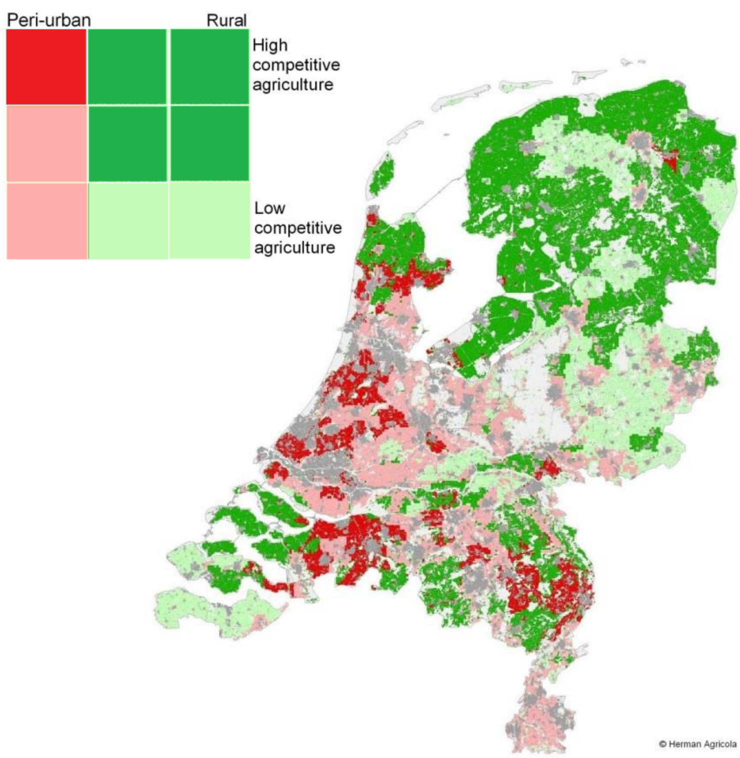


Figure 1; Agricultural zones for the Netherlands (Wascher et al. 2010)

5. EXPLORATORY ANALYSIS

To compare the rural land transactions, the selection criteria of Luijt et al. (2002) and Cotteleer at al. (2008) are used. Based on the selection criteria a number of transactions is selected and showed in Figure 2. This figure shows the spatial distribution of the transactions for both 2000 and 2010. The map clearly shows that the distribution of transactions is not randomly distributed. In the urban and nature areas no transactions are observed and in some agricultural areas clusters of transaction are observed. The non-random distribution affects the potential outcome of the analysis. The data sample shows the transactions in which the location of the buyer and seller, the location of the sold parcel(s) and all other characteristics are such that buyer and seller could come to an agreement over the price (Bakker et al. 2013). This shows that not all farmers get the opportunity to buy or sell a parcel of land, all aspects should be ideal for seller and buyer before a transaction takes place. Another aspect affecting the rural land market, as described in the theory, is the local market structure of the rural land market. Table 2 shows the six most frequently observed transaction prices per hectare. The large share of rounded prices suggests that farmers negotiate over the price, which will result in price variation.

Table 2; top six paid transaction prices in 2010

Price per hectare	% of total transactions
€50,000.00	4%
€ 40,000.00	4%
€ 35,000.00	3%
€ 45,000.00	3%
€ 30,000.00	2%
€ 60,000.00	2%

Table 3; Index land price per type of land use per year

	2000	2010
Arable land	91	100
Grass land	90	80
Horticulture	241	285
Dutch average	€ 40,965	€ 53,698

Before testing the regional differences and local characteristics by using a regression model the data for the years 2000 and 2010 is analysed. Figure 3 shows the regional differences in land prices for 2000 and 2010 based on the kriging method[2]. This map shows the regional differences within the Netherlands and suggests a significant regional effect in the analysis. The results of the kriging map should be interpreted with care, because in regions where a small number of transactions is observed the interpolation is vulnerable to the influence of an individual transactions (Kuhlman et al. 2010). The transactions in the horticulture sector are excluded from the data based on the large price difference. Table 3 clearly shows the difference between the land prices in the horticulture sector and the rest of the agricultural sector. The land used for the horticulture sector cannot be compared with the other types of land use. The regional differences are analysed based on a regional division in five regions of the Netherlands. The regional variance in land price development per land use type and the comparison of the price level per land use type compared to the Dutch average is given in Table 4. The results show the fast growth of land prices in the South of the Netherlands and the decrease of the value of grass land over the period from 2000 to 2010.In Table 5 the land price and the transaction size is linked to the agricultural zones for the years 2000 and 2010. The price differences and average transaction size support the idea that the agricultural zones classify a specific region in which a specific type of farming can be developed.

Figure 2; Distribution transactions 2000 and 2010

[2] Ordinary kriging based on the nearest 15 observations, weighting matrix based on the inverse distance method with Euclidean distance.

Table 4; Regional price development.

Regions	Price development for 2000 – 2010 (corrected for inflation)		Price level 2010 compared to Dutch average	
	Arable land	**Grass land**	**Arable land**	**Grass land**
North	18%	-9%	0.81	0.78
East	11%	-3%	1.04	1.13
West	-2%	-9%	0.90	0.99
South west	11%	-7%	1.02	1.18
South	33%	11%	1.13	1.32
NL	18%	-5%	1.00	1.00

Table 5; Index land prices compared to average per competitive category and average transaction size in hectare.

	Price index		Avg. size transaction (ha)	
	2000	**2010**	**2000**	**2010**
Urban-high	148	150	2.9	3.9
Rural-high	89	90	5.5	7.3
Urban-low	105	109	3.1	3.5
Rural-low	85	84	3.6	3.7

Especially the high prices in the urban highly competitive agricultural sector and the large transaction size in the rural highly competitive agricultural sector. Both relate to the assumption that farmers in the two different regions are relatively intensifying or expanding their farm activity.

Based on the analysis of the regional differences and on the type of land use, it is clear that regional differences have explanatory power in the final analysis. Part of the variation in land price could probably be captured by regional variables in the analysis. A combination of the agricultural competitiveness map and the agricultural regions will therefore be used in the hedonic pricing method.

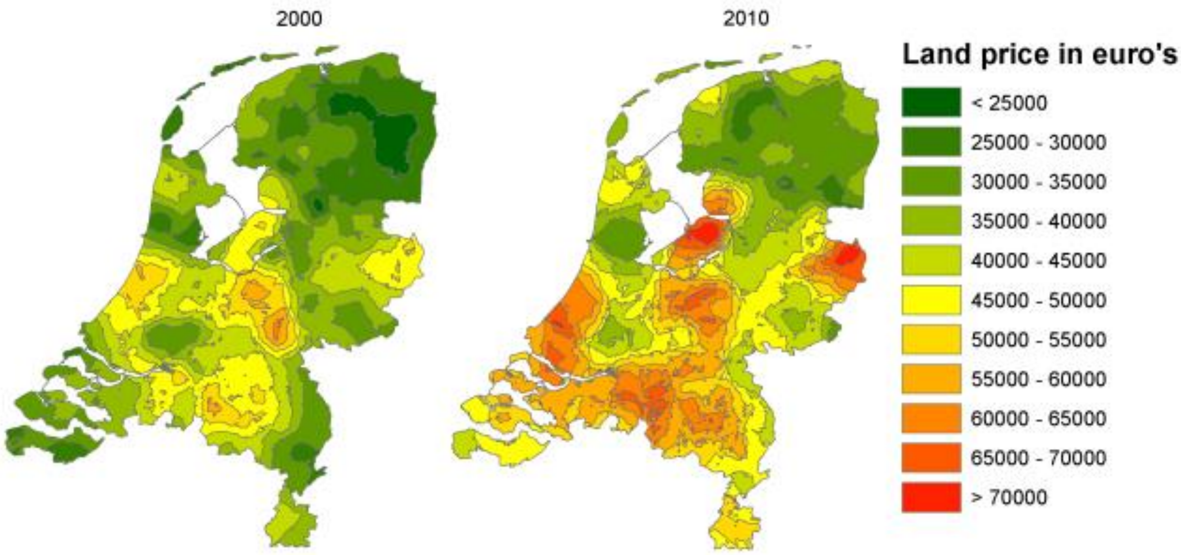


Figure 3; Overview land prices based on kriging method

The defined variables are first tested by using the ordinary least squares regression. The regression results are tested on spatial dependency and heteroskedasticity. A weighting matrix is created to value the spatial relationship in the data. We choose a weighting matrix which uses the values of the neighbours within a range of 6.7km around of the centre of the parcel. The importance of the neighbouring observations decreases with one divided by the distance between the two points. The choice for the 6.7km range is based on the distance within 90% of the farmers bought their land (Cotteleer et al. 2008). Both test statistics are significant, which means that there is spatial dependency and heteroskedasticity in the data. The results of the OLS analysis are in this case biased and inconsistent. A spatial regression model should be used to regress the independent variables on the dependent variable.

Table 6; Results Lagrange Multiplier test for spatial dependence

	2000			2010		
	score	P value		score	P value	
LMerr	385	0.00	***	231	0.00	***
LMlag	16	0.00	***	21	0.00	***
RLMerr	369	0.00	***	215	0.00	***
RLMlag	0.11	0.74		6	0.02	**
SARMA	385	0.00	***	237	0.00	***

Before preforming the Lagrange Multiplier test to specify the best spatial regression model it is useful to analyse the spatial structure of the residuals by a cluster and outlier analysis. The high significant Beusch-Pagan and Moran's I test statistic could be the result of spatial clusters in the model residuals. The results of the analysis are shown in Figure 4. It is clear that there are significant price differences within the region in a couple of agricultural areas. This is observed by the clusters of low and high values within one agricultural area. Based on the large impact of the regional dummy in the model, this will cause regional clustering of the residuals. To reduce the spatial dependence of the residuals, one of the clusters per agricultural area, high prices or low prices, is used in the OLS regression. The additional variables capture part of the variance in the residuals, which lead to a higher R^2 and lower Global Moran's I and the Beusch-Pagan test statistics.

The introduction of the additional regional variables decreased the spatial dependency of the residuals, but the dependency is still significant. The results of this analysis are stated in appendix eight. A spatial regression model is necessary in this case. The Lagrange Multiplier test for spatial dependency is used to determine which kind of spatial model is appropriate. In Table 6 the test results are stated. From the results it is clear that the spatial autocorrelation of the residuals is the most significant problem in the data. Based on these results the preferred spatial model is the spatial error model, which incorporates a spatial autoregressive parameter in the error term of the model. I did not choose for a spatial Durbin model, because most of the lagged variables will intuitively not add information to the analysis. Part of the variables are based on distance to an area, a lagged variable of these will weaken the effect of this relation. The population and growth ratio are already based on the surrounding at a 6.7km range. Including a lagged variable of these would mean that the population pressure of a large area would be included. Including a spatial lag variable for the dummies will only affects the border of the area, based on the range of the weighting matrix. That is the only place where the value of the dummy variables changes. This is not useful in this analysis. The results of the spatial error model are presented in Table 7. The spatial autoregressive parameter (lambda) included in the error model is highly significant, which means that the parameter explains part of the variance in the residuals based on the residuals of its neighbours.

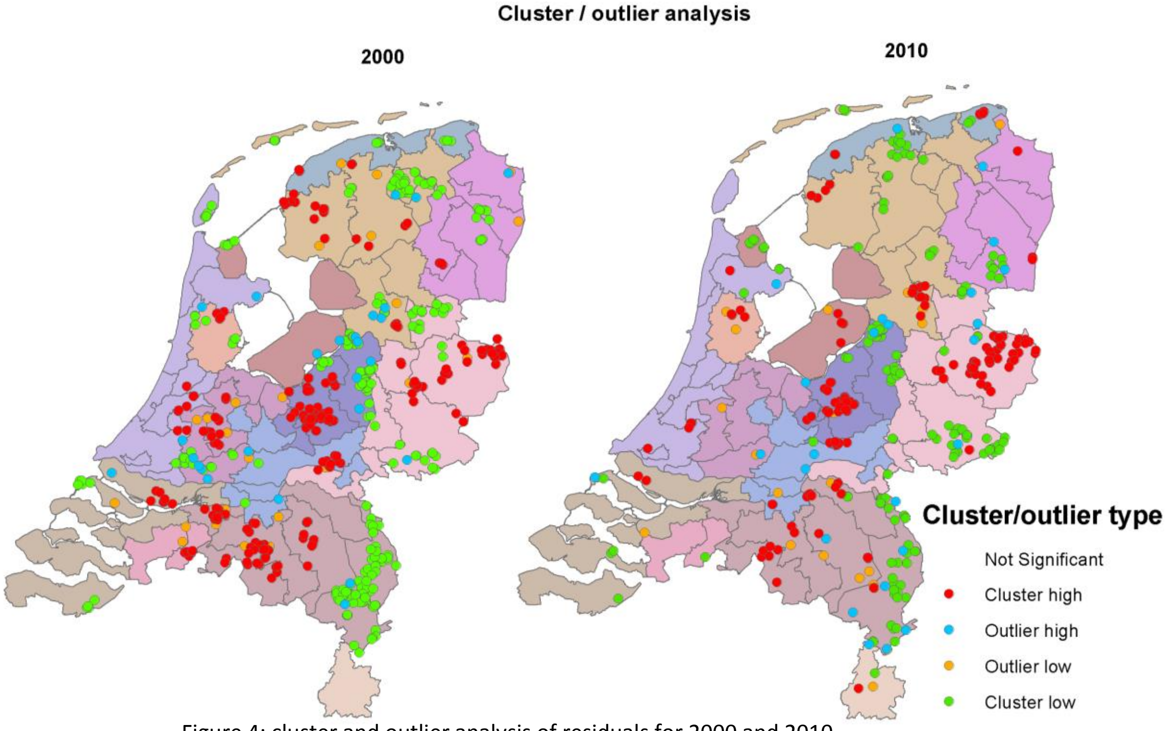


Figure 4; cluster and outlier analysis of residuals for 2000 and 2010

6. RESULTS

The results of the analysis, as presented in Table 7, clearly indicate a significant impact of the agricultural zones on the land price. Transactions in the urban region with high agricultural competitiveness are 8% higher in 2000 and 9% in 2010 than the prices in the region with a low urban pressure and low agricultural competitiveness. Also the other agricultural zones have a significant impact on the land price, in which the urban pressure is more important than the agricultural competitiveness.

The growth variable is defined different for the two years. This variable is for both years based on the growth between 2000 and 2010. For 2000 this means that future growth is used and for 2010 the past growth is used. This has a different effect on the price per hectare. Using the observed development of the population, as in 2000, has a significant effect on the land price per hectare. An increase of 1 per cent point of the growth lead to an increase of 0.4% of the dependent variable. For 2010 the growth of the population has no significant effect on the land price. The transaction size has a small positive impact on the land price for both years, an increase of one hectare leads to a 0.3% increase of the land price per hectare. This relates to the idea that increasing transaction size lead to lower average transaction costs and scale advantages of large scale farming. The distance to horticulture has a negative impact on the land price in both years, closer to the horticulture sector means higher land prices. The price differences between the horticulture sector and the other agricultural sectors, as indicated in the exploratory analysis, are the basis for the negative coefficient of this variable. Arable or grass land close to the horticulture sector could be used for this sector. The other distances to spatial elements do not have a significant effect on the land price in the rural market. The urban pressure has a significant negative effect for both years. While the effect is highly significant, the coefficients of these variables are small; 10000 inhabitants more in a region. The indication of land use has also a significant effect on the land price. Grass land is compared to arable land, for both years grass land has a lower price than arable land. In 2000 grass land was 2% lower than arable land and in 2010 the price difference was 6%. Based on the regional dummies it is clear that there are significant price differences between the agricultural regions. Not only there are differences between the agricultural areas, but also within the agricultural areas there are significant price differences. This is clearly based on the significance of the included regions after the cluster analysis. For example the land price in Twente in 2010 is 26.1% higher than average land price in the area Oostelijke Veehouderijgebied, the area where Twente is part of. This means that the land price of Twente is almost equal to the land price of Flevoland, based on the sum of the impact factors.

Table 7; Regression results spatial error model

variable	2000 Coefficient		2000 Impact	2010 Coefficient		2010 Impact
constant	10.6753	***		10.9872	***	
Size	0.0029	***		0.0034	***	
Horticulture in km	-0.0111	**		-0.0078	**	
Highway in km	-0.0028	*		-0.0014		
Nature in km	0.0024			-0.0004		
Population in thousands	0.0008	***		0.0007	***	
Growth population in %	0.0042	***		0.0024		
Land use						
Grassland (0= Arable land)	-0.0218	***	-2.2%	-0.0623	***	-6.0%
Agricultural zone						
urban-high (0 = rural low)	0.0782	***	8.1%	0.0859	***	9.0%
urban low	0.0627	***	6.5%	0.0514	***	5.3%
rural high	0.0448	***	4.6%	0.0374	***	3.8%
Regional area						
Bouwhoek en Hogeland (0 = Flevoland)	-0.2692	***	-23.6%	-0.4486	***	-36.1%
Veenkolonien en Oldambt	-0.5769	***	-43.8%	-0.6370	***	-47.1%
Noordelijk Weidegebied	-0.3913	***	-32.4%	-0.5549	***	-42.6%
Oostelijk Veehouderijgebeid	-0.2101	***	-19.0%	-0.3223	***	-27.6%
Centraal veehouderijgebied	-0.0092		-0.9%	-0.0663		-6.4%
Westelijk Holland	-0.2355	***	-21.0%	-0.3879	***	-32.2%
Waterland en Droogmakerijen	-0.4426	***	-35.8%	-0.7994	***	-55.0%
Hollands/Utrechts weidegebied	-0.3038	***	-26.2%	-0.4041	***	-33.2%
Rivierengebeid	-0.0979		-9.3%	-0.1165	*	-11.0%
Zuidwestelijk akkerbouwgebied	-0.2880	***	-25.0%	-0.1877	***	-17.1%
Zuidwest-Brabant	-0.2088	***	-18.8%	-0.1318	*	-12.3%
Zuidelijk veehouderijgebied	-0.0632		-6.1%	-0.1386	***	-12.9%
Zuid-Limburg	-0.1427	*	-13.3%	-0.2702	***	-23.7%
Twente	0.1775	***	19.4%	0.2318	***	26.1%
Oostelijke Veluwe	-0.3159	***	-27.1%	-0.3787	***	-31.5%
Noord-Limburg	-0.3435	***	-29.1%	-0.1845	***	-16.8%
Wieringen en Wieringermeer	-0.3156	***	-27.1%	-0.3664	***	-30.7%
Groninger Zuidelijk Westerkwartier	-0.2347	***	-20.9%	-0.1559	*	-14.4%
Voorne-Putten en Hoeksche Waard	0.2025	**	22.4%	0.1045		11.0%
Veluwezoom en Betuwe	0.1258	*	13.4%	-0.1953	***	-17.7%
Land van Breda	0.0952	*	10.0%	-0.1320		-12.4%
Lambda	0.44		0.00	0.41		0.00

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

7. Conclusion & Discussion

The results of the regression analysis show a significant effect of the different agricultural zones, based on the agricultural competitiveness and urban pressure, on the rural land price. The price difference between the agricultural zones is an indication for the differentiated development of the agricultural sector within the Netherlands and the consequences for the rural land price. Specializing, intensifying and expanding farm activities are clustered in the regions which are most suited for this development.

The relatively low impact of all variables, besides the regional dummies, indicates that it is hard to capture all the interactions at the land market on national level. The high impact of the regional dummies indicates that regional specific relations cause a large share of the variation in the rural land price. A problem in the regression analysis was the heteroskedasticity in the regression results. Including the additional regional dummies solved part of the problem, but it does not explain why there are regional differences. Based on the differences in rural land prices per region and regional development it could be that the coefficients of the variables are not constant over space. Population pressure could, for example have a different effect on the land price in the North than in the West of the Netherlands. The local market structure will also influence the regional difference on the rural land market. The complex set of interaction influencing the rural land market is hard to capture in a regression model. The effect of the zoning plans, regional policy, market imperfections and regional characteristics makes it challenging to use the results to forecast future developments on the land market. It would be interesting to use the results of this analysis to zoom in on a specific region and use the relations as described in the literature and observed from the regression analysis in a model, which allows for more interaction between the different actors in the specific rural land market. An agent based model could be used to test the complex relations within a region, in which government interventions, local market characteristics and actor characteristics could be included together with the parcel and spatial characteristics used in this research.

The differentiated development of the agricultural sector in the Netherlands and the effect on the land market will be useful in further analysis of the land market. Differentiated development of the agricultural sector, regional differences and spatial dependency of land prices should not be ignored in research related to the land market, but should be studied. Understanding the relations on local markets would lead to a better understanding of the variation in rural land price on the national rural land market.

REFERENCES

Adams, F. G., G. Milgram, E. W. Green, and C. Mansfield. 1968. Undeveloped land prices during urbanization: A micro-empirical study over time. *The Review of Economics and Statistics* 50 (2): 248-258.

Alonso, W. 1964. Location and land use. Toward a general theory of land rent. *Location and land use. Toward a general theory of land rent.*

Anselin, L. 1988. Lagrange multiplier test diagnostics for spatial dependence and spatial heterogeneity. *Geographical analysis* 20 (1): 1-17.

Anselin, L. 1995. Local indicators of spatial association, LISA. *Geographical analysis* 27 (2): 93-115.

Anselin, L. 2003. Spatial externalities, spatial multipliers, and spatial econometrics. *International Regional Science Review* 26 (2): 153-166.

Bakker, M. M., G. B. M. Heuvelink, B. Brookhuis, and T. Kuhlman. 2013. Assessing the effect of distance between farm and parcel on the price prepared to pay in a rural land market. In preperation.

Chicoine, D. L. 1981. Farmland values at the urban fringe: An analysis of sale prices. *Land Economics* 57 (3): 353-362.

Cotteleer, G., C. Gardebroek, and J. Luijt. 2008. Market power in a GIS-based hedonic price model of local farmland markets. *Land Economics* 84 (4): 573-592.

Dekkers, J. E. C., P. Rietveld, H. J. Scholten, and A. v. d. Brink. 2010a. "Analizing rural-urban land use transition in the Netherlands." In *Externalities, land use and urban expansion.*: VU.

———. 2010b. "Explaining the value of rural land." In *Externalities, land use and urban expansion.*: VU.

Heijman, W. J. M., and R. A. Schipper. 2010. *Space and economics: An introduction to regional economics*: Wageningen Academic Publishers.

Isard, W. 1956. Location and space-economy.

Krugman, P. R. 1991. *Geography and trade*: MIT press.

Kuhlman, J. W., J. Luijt, J. v. Dijk, A. D. Schouten, and M. J. Voskuilen. 2010. Grondprijzenkaarten 1998-2008. edited by LEI. Wageningen.

Kuhlman, T., H. Agricola, A. d. Blaeij, J. d. Hoop, R. Michels, B. Smit, and T. Vogelzang. 2012. Landbouw en recreatie in krimpregio's. edited by LEI.

Livanis, G., C. B. Moss, V. E. Breneman, and R. F. Nehring. 2006. Urban sprawl and farmland prices. *American Journal of Agricultural Economics* 88 (4): 915-929.

Luijt, J., C. Hamsvoort, F. Brouwer, and J. Straaten. 2002. The pivotal role of the agricultural land market in the Netherlands. *Nature and agriculture in the European Union: new perspectives on policies that shape the European countryside*: 162-181.

Mitchell, A. 2005. The ESRI guide to GIS analysis, Volume 2: Spatial Measurements and Statistics. Redlands. CA: ESRI Press.

Moran, P. A. 1948. The interpretation of statistical maps. *Journal of the Royal Statistical Society. Series B (Methodological)* 10 (2): 243-251.

Osland, L. 2010. An application of spatial econometrics in relation to hedonic house price modeling. *Journal of Real Estate Research* 32 (3): 289-320.

Ricardo, D. 1817. *Principles of Political Economy and Taxation*. London: J. Murray.

Rosen, S. 1974. Hedonic prices and implicit markets: product differentiation in pure competition. *The journal of political economy*: 34-55.

Segeren, A., B. Needham, and J. Groen. 2005. De markt doorgrond. edited by Ruimtelijk Planbureau. http://www.rivm.nl/bibliotheek/digitaaldepot/1_De_markt_doorgrond.pdf.

Shi, Y. J., T. T. Phipps, and D. Colyer. 1997. Agricultural land values under urbanizing influences. *Land Economics*: 90-100.

Silvis, H., H. Agricola, M. J. Voskuilen, and R. G. Kroes. 2013. Landbouwontwikkeling en grondmarkt in Nederland. edited by LEI.

Tobler, W. 1979. Cellular geography. *Philosophy in geography* 9: 379-386.

Van Eupen, M., M. Metzger, M. Pérez-Soba, P. Verburg, A. van Doorn, and R. Bunce. 2012. A rural typology for strategic European policies. *Land Use Policy* 29 (3): 473-482.

Vereijken, P. H., and H. J. Agricola. 2004. Transitie naar niet-agrarisch gebruik van het buitengebeid: hoe kunnen gemeenten en provincies erop inspelen?

Von Thünen, J. H. 1826. Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalokonomie. *Fischer, Jena* 182 (1).

Wascher, D. M., J. Roos-Klein Lankhorst, H. J. Agricola, and A. d. Jong. 2010. SUSMETRO : Impact Assessment Tools for Food Planning in Metropolitan Regions : IA tools and serious gaming in support of sustainability targets for food planning, nature conservation and recreation. edited by Alterra. Wageningen.

Weber, A. 1929. Uber den Standort der Industrien (Alfred Weber's Theory of the location of industries). *University of Chicago*.

APPENDIX I; CLASSICAL LAND RENT THEORIES

Classic economic theory generally distinguish three types of production factors; capital goods, labour and land (Isard 1956). Ricardo (1817) was the first who stated that land is not a homogeneous good, according to Ricardo the quality of land determine the land rent and is one of the elements that can lead to a comparative advantage of one place in comparison to another place. Von Thünen (1826) was the first to describe the relationship between land and other spatial attributes, this paper is considered to be the start of regional economics (Heijman and Schipper 2010; Von Thünen 1826; Dekkers et al. 2010b). Von Thünen stated that transportation costs to the market (urban area) determined the price of land and the use intensity of a particular parcel. When distance to the urban area increases the price of land and use intensity decreases. Close to the market, the land is used for rural activities that create the highest land rents. The basic idea of Von Thünen is still used for analysing the interactions on the land market (Livanis et al. 2006).

The theories of Ricardo and Von Thünen are based on an agricultural society. During the industrial revolution the location theory of Von Thünen didn't explain all the actions of location choices by firms. Weber (1929) developed a theory based on the changing economic structure. Weber indicated that labour costs and agglomeration effects are important variables that define the location of a firm together with the transportation costs. The agglomeration effect describes the benefits of spatial concentrating of firms. Later on this effect is called *external economies of scale* in the new economic geography (Heijman and Schipper 2010). The theory of Von Thünen is used by Isard (1956) to explain the broader economic structure, by stating that land will be used by the activity that has the highest yield. This theory is used by (Alonso 1964) to develop the bid-rent theory (Isard 1956).

For a long time regional economics was neglected by the general economic theories, the work of Isard and Alonso led to more attention for the field of regional economics and led to the development of new fields of economics. Urban economics and transportation economics are based on the work of Isard and Alonso (Isard 1956). The developments in the field of regional economics, by Krugman and others, finally led to a theory that linked the general and regional economics; 'the new economic geography' (Krugman 1991). In this theory the growth pole theory and economic growth theory are linked, which led to the recognition of spatial concentrated growth. Focussing on the specific regional conditions will lead to better regional policy and understanding of regional differences in economic growth (Heijman and Schipper, 2010).

APPENDIX II; OVERVIEW DATA SOURCES USED IN RESEARCH

Data sources used in research

Name database	Variable	Data source	Year
	Parcel/transaction characteristics		
InfoGroMa		DLG/ Kadaster	2000-2010
	location parcels (X,Y coordinates) Transaction price in euro per ha Transaction size in ha		
Agricultural Census		Central Agency Statistics (CBS)	2000-2010
	Land use sold parcel		
	Spatial characteristics		
Urban Area in the Netherlands		Central Agency Statistics	2008
	Local population density Distance to growing urban area		
Agricultural Zones		Wageningen UR – Alterra	2010
	Indication type of agricultural zone		
Agricultural areas (5-14-66)		Wageningen UR – Alterra	2013
	Indication agricultural region		
National Road Map		Rijkswaterstaat	2011
	Distance to highway		
Natura 2000		Rijskoverheid (data.overheid.nl)	2010
	Distance to nature areas		
Land use map (LGN6)		Wageningen UR – Alterra	2007-2008
	Distance to horticulture areas		

APPENDIX III; BASIC TEST PROCEDURES SPATIAL HEDONIC PRICING METHOD

Stage	Test*	H_0	H_1	Procedures
1	Moran's I test	No spatial effects in the residuals.	Special effects of some unspecified kind.	If H_0 is rejected, preform the LM tests.
2	LM-error test	No spatial autocorrelation (λ=0), given the assumption that (ρ=0).	Spatial autocorrelation ($\lambda \neq 0$).	If H_0 is rejected, estimate a spatial error model.
	LM-lag test	No spatial autocorrelation (λ=0), given the assumption that (ρ=0).	Spatial autocorrelation ($\rho \neq 0$).	If H_0 is rejected, estimate a spatial lag model.
				If both null hypotheses of the LM-tests are rejected, preform the robust tests. Alternatively or additionally, continue as described below the robust tests.
3	Robust LM-error test	No spatial autocorrelation (λ=0), correcting for the presences of local spatial lag dependence.	Spatial autocorrelation ($\lambda \neq 0$).	If H_0 is rejected, estimate a spatial error model.
	Robust LM-lag test	No spatial autocorrelation (ρ=0), correcting for the presences of local spatial lag dependence.	Spatial autocorrelation ($\rho \neq 0$).	If H_0 is rejected, estimate a spatial lag model.
				If both null hypotheses of the RLM-tests are rejected, study which test statistic is the largest. If this is the RLM-error statistic, estimate a spatial error model. If the RLM-lag statistic is the largest, estimate a spatial lag model. If the results vary, preform common factor hypothesis tests.
4	Common Factor Hypothesis tests	$B_1 = -\rho\beta_0$	$B_1 \neq -\rho\beta_0$	Estimate a spatial Durbin model and a spatial error model. Preform common factor hypothesis tests formulated as a likelihood ratio test. If H_0 is rejected this is evidence in favor of the spatial error model.

*For all the tests used here one must decide on the definition of the spatial connectivity and weights styles. The most common weight style in econometrics is the row-standardized style. P and λ in stage 1 – 3 refer to the parameters in model spatial lag and error model. The LM-tests are asymptotically distributed as χ^2.
Osland (2010)

APPENDIX IV: SPATIAL ECONOMETRIC MODELS

The problem of spatial autocorrelation can be handled with two models. These models are comparable to the Weighted Least Squares models used in time series analysis. The first model is the spatial error model (Anselin, 2003; Osland, 2010);

$$Y = \alpha + \beta X + \varepsilon$$

Where ε is;

$$\varepsilon = \lambda W \varepsilon + \mu$$

And $\mu \sim \mathrm{N}(0, \sigma^2)$

In which W is the spatial weight matrix and λ is a spatial autoregressive parameter. This parameter is calculated during the regression, if this parameter is zero there is no spatial dependency in the error term (Osland, 2010).

This model is used when there is spatial dependency in the error term. This problem occurs when there are regional differences which are not captured in a model. The spatial model is used to increase the efficiency of the parameter estimates (Osland, 2010).

The second model is the spatial lag model (Anselin, 2003; Osland, 2010);

$$Y = \rho W Y + \beta X + \varepsilon$$

Where ε is;

$$\varepsilon \sim \mathrm{N}(0, \sigma^2)$$

In which ρ is the spatial autoregressive parameter. Solved for Y the formula becomes;

$$Y = (I - \rho W)^{-1} \beta X + (I - \rho W)^{-1} \varepsilon$$

The spatial lag model is used when there is spatial dependence in the error term based on the spatial dependency of the dependant variable. This means that a higher price for an observation leads to higher prices of the neighbours based on the adjacency effect. Prices of neighbouring observations will influence each other (Osland, 2010). In the housing market this would mean that for example the maintenance of one house in a region will have a positive effect on the prices of neighbouring houses.

APPENDIX V; AGRICULTURAL COMPETITIVENESS MAP

The agricultural competitiveness map is based on two main forces; urban-rural structure and agricultural structure. The urban-rural structure is defined by Van Eupen et al. (2012) based on the economic density (GDP) and the accessibility (accessibility of services), figure 1.

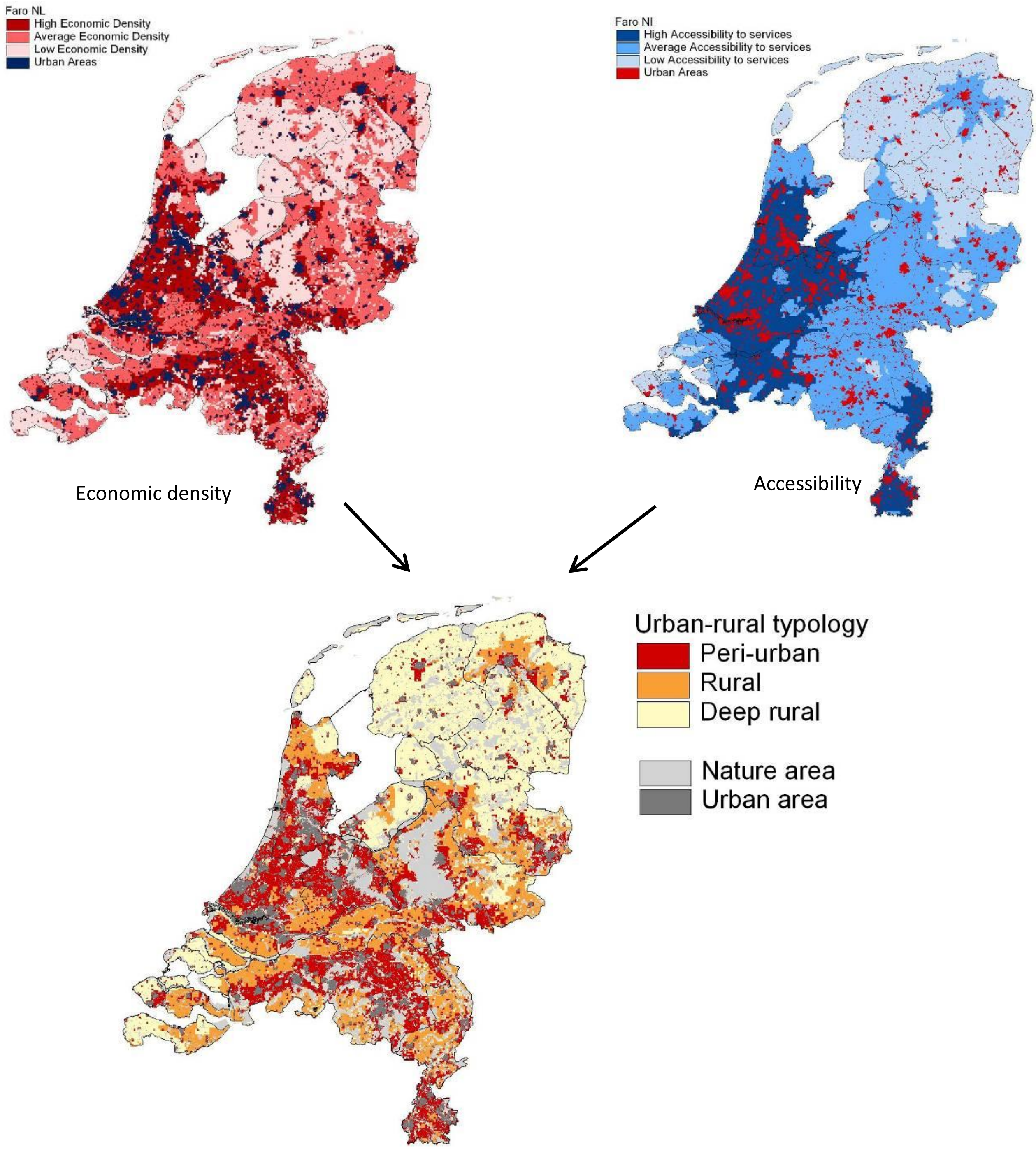


Figure 1; Urban-rural structure

The agricultural structure is defined based on three forces that are competing for land in the rural area; population pressure in rural area (population/rural ha/municipality), intensity land use (NGE/ha) and scale of the farm (NGE/farm). In figure 2 the forces on the land market are indicated. The agricultural structure is defined based on the interaction between the three forces. When in a region the urban pressure is low and the NGE per hectare and per farm is high the agricultural structure will be strong and vice versa. In reality the zone plans of the government is also an important force in the land market.

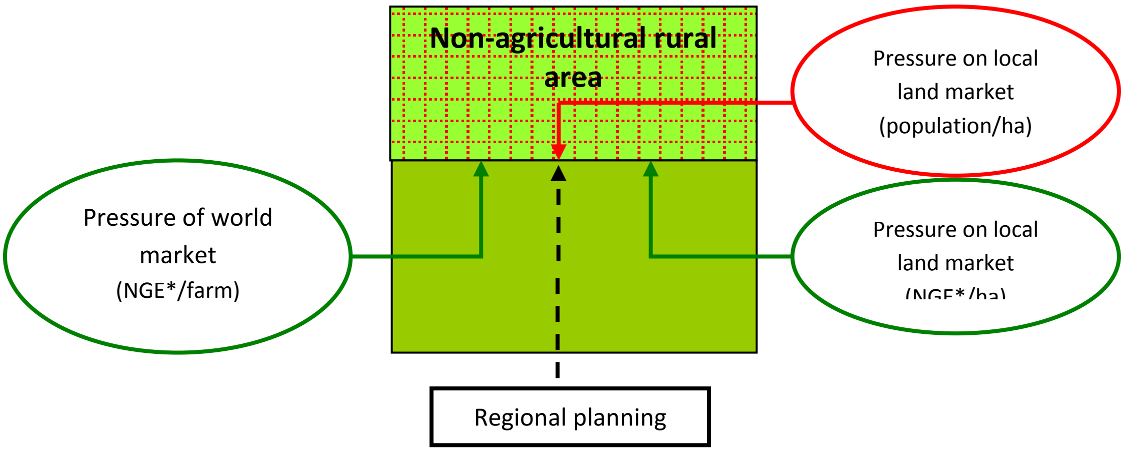


Figure 2. Forces on rural land market (Vereijken & Agricola, 2004)

Change of land use is only possible with approval of the government. This variable is not fixed however and is therefore not included.

In figure 3 the variables used in this analysis are stated and the integrated map is shown.

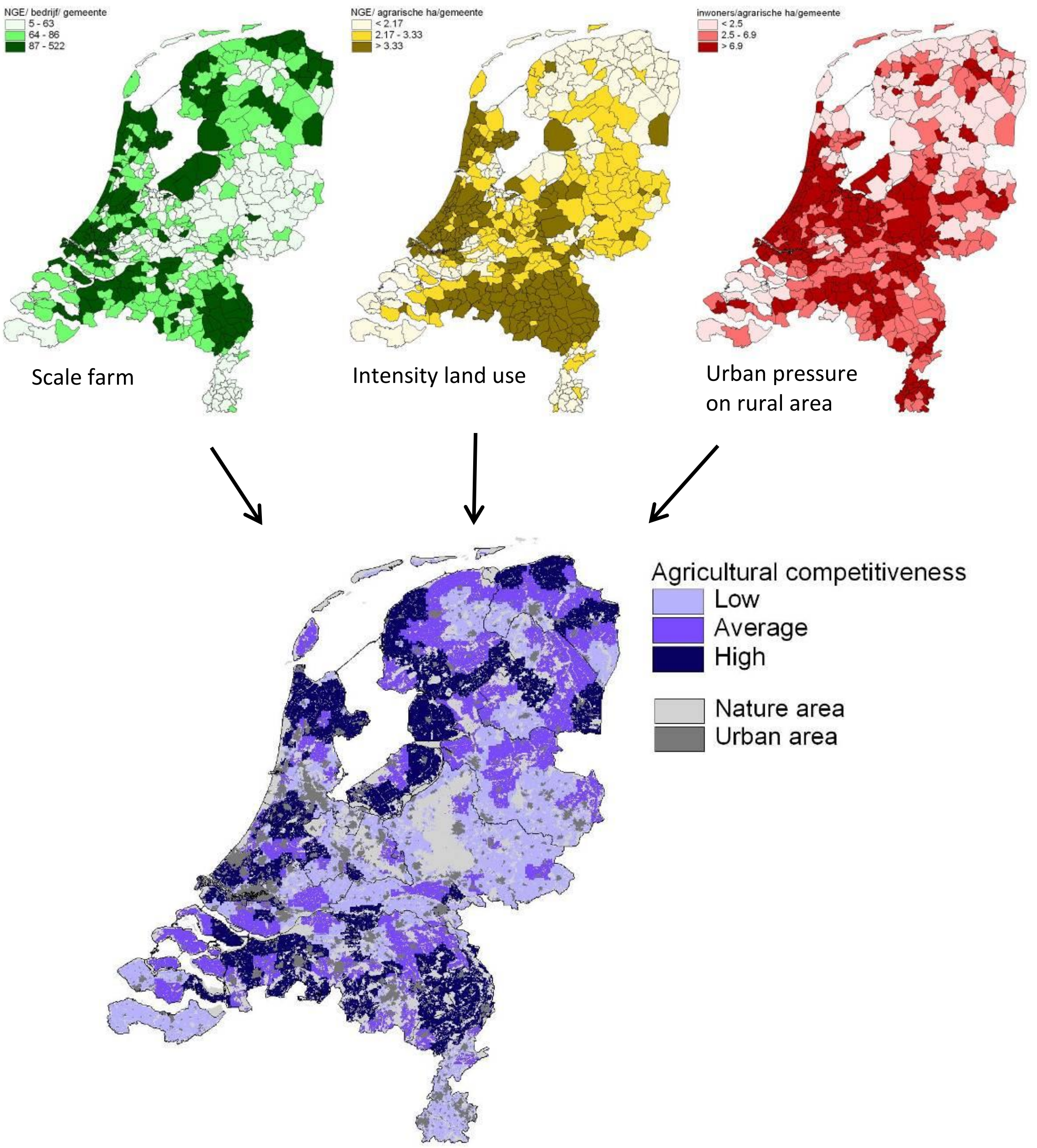


Figure 3; Agricultural competitiveness (Vereijken and Agricola 2004)

The two map; urban-rural structure and agricultural structure are finally combined to create the agricultural competitiveness map. To integrate the maps, the classification as showed in figure 1 and 3 is used. This results in a nine classes, as shown in figure 4, which are clustered in four groups. These groups represent different type of agricultural areas, as described in the article.

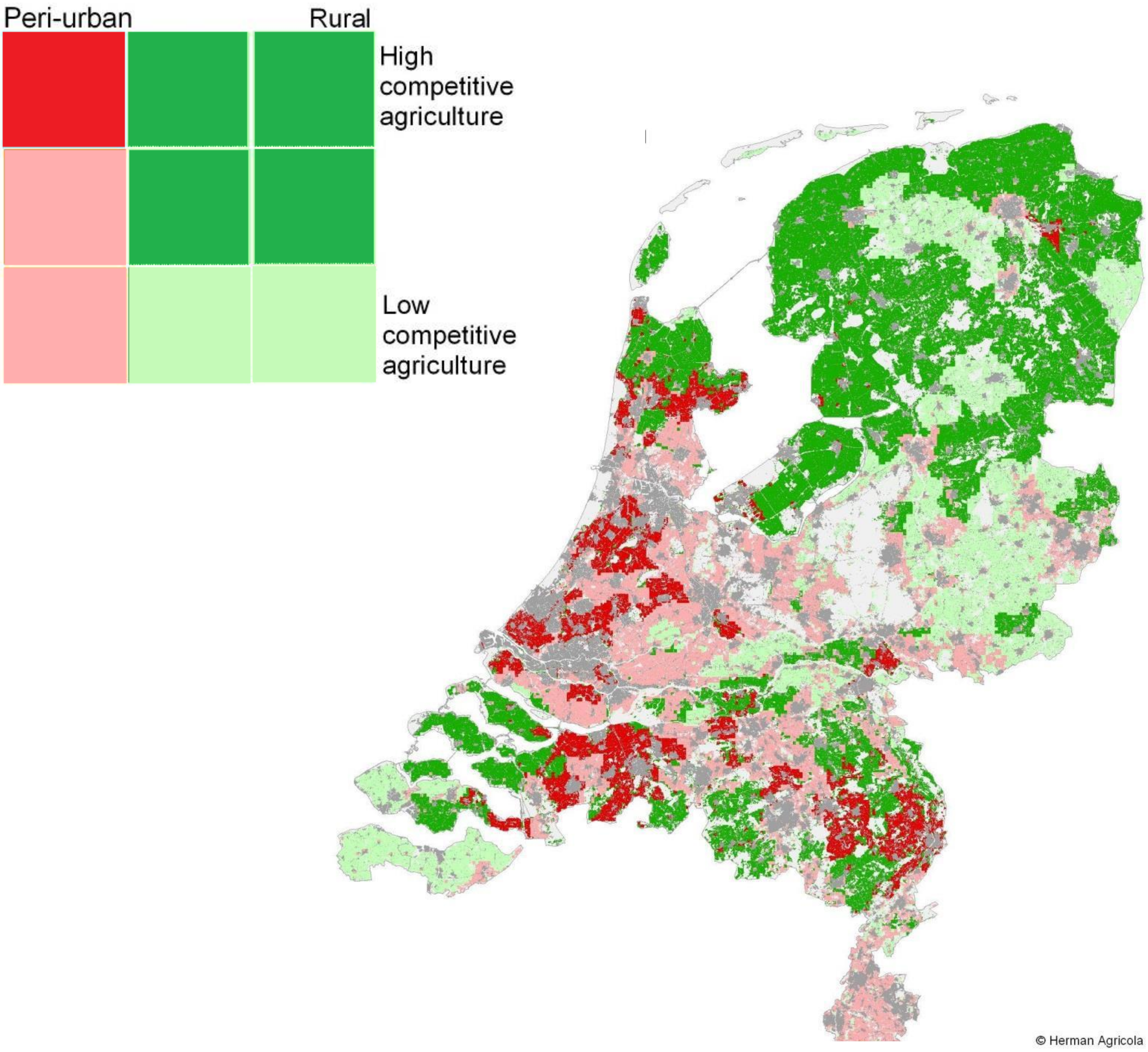
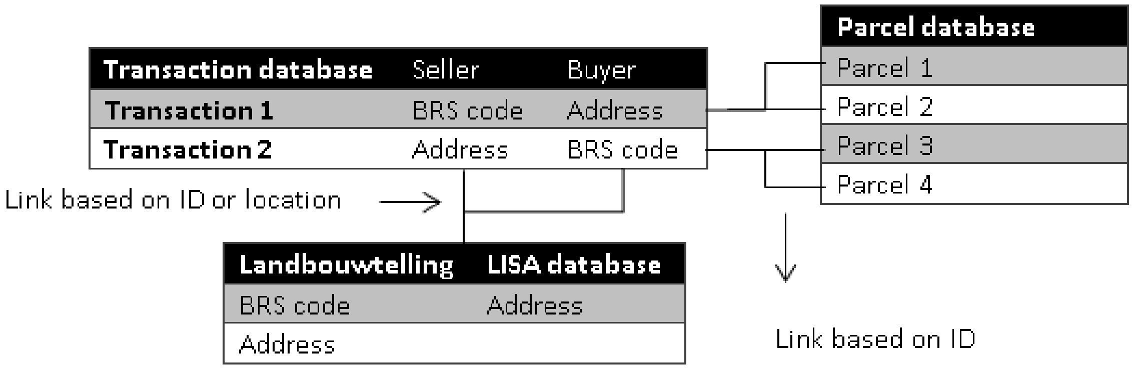


Figure 4; Agricultural zones for the Netherlands (Wascher et al. 2010).

APPENDIX VI; STRUCTURE INFOGROMA DATABASE



Overview relations between databases within InfoGroMa

Appendix VII; Selection agricultural transactions

2000

"TAPENR" >= '200001' AND "TAPENR" <= '200012' AND "KOOPSHa" >0 AND "KOOPSOM_BE" = 'J' AND "VV_AGR" = 'J' AND ("VV_CAT" = '13' OR "VV_CAT" = '14') AND "VK_AGR" = 'J' AND ("VK_CAT" = '13' OR "VK_CAT" = '14') AND "RECHT" = '1' AND ("GEBR" = '1' OR "GEBR" = '2') AND "OPSTAL" = 'N' AND "AAND_ACC" = 'J' AND "OPP_HA_" >=0.25 XCOORD > 3 AND YCOORD>3

2010

"opp_ha" >0.25 AND "KoopsomPerHa" >0 AND "Koopsom_Betr" = 'J' AND "VV_Agr" = 'J' AND("VV_Cat" = 13 OR "VV_Cat" = 14) AND "VK_Agr" = 'J' AND("VK_Cat" = 13 OR "VK_Cat" = 14) AND "Recht" = 1 AND "Opstal" = 'N' AND "onteig" = 'N' AND ("Gbr" = 1 OR "Gbr" = 2) XCOORD > 3 AND YCOORD>3

APPENDIX VIII; OLS REGRESSION RESULTS

Results OLS regression

	2000			2010		
variable	Coefficient		Impact	Coefficient		Impact
constant	10.4859	***	-	10.8749	***	-
Size	0.0025	***	-	0.0040	***	-
Nature in km	0.0414	***	-	0.0032		-
Horticulture in km	-0.0494		-	-0.0488		-
Highway in km	-0.0414		-	- 0.0056		-
Population in thousands	0.0010	***	-	0.0014	***	-
Growth %	0.0085	***	-	0.0046	***	-
Land use (0 = arable land and 1 = grassland)	0.0042		0.4%	-0.0640	***	-6.2%
high-high	0.1392	***	14.9%	0.1148	***	12.2%
high low	0.0903	***	9.4%	0.0816	***	8.5%
low high	0.1066	***	11.3%	0.0804	***	8.4%
Bouwhoek en Hogeland	-0.1648	***	-15.2%	-0.3499	***	-29.5%
Veenkolonien en Oldambt	-0.4792	***	-38.1%	-0.5601	***	-42.9%
Noordelijk Weidegebied	-0.3372	***	-28.6%	-0.4779	***	-38.0%
Oostelijk Veehouderijgebeid	-0.0500		-4.9%	-0.2085	***	-18.8%
Centraal veehouderijgebied	-0.0643		-6.2%	-0.1596	***	-14.8%
Westelijk Holland	-0.1807	***	-16.5%	-0.3844	***	-31.9%
Waterland en Droogmakerijen	-0.4479	***	-36.1%	-0.7292	***	-51.8%
Hollands/Utrechts weidegebied	-0.2474	***	-21.9%	-0.4200	***	-34.3%
Rivierengebeid	0.0434		4.4%	-0.1722	***	-15.8%
Zuidwestelijk akkerbouwgebied	-0.1698	***	-15.6%	-0.1266	***	-11.9%
Zuidwest-Brabant	-0.0935	**	-8.9%	-0.1710	***	-15.7%
Zuidelijk veehouderijgebied	-0.0699	*	-6.8%	-0.1702	***	-15.7%
Zuid-Limburg	-0.0462		-4.5%	-0.2875	***	-25.0%
Adj. R2	0.38			0.44		
Nb. of obs.	2543			2091		
Test spatial dependency			p-value			p-value
Moran's I	0.34	-	0.000	0.30	-	0.000
Test for heteroskedasticity						
Breusch-Pagan	127.2		0.000	9.29		0.002

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