The influence of economies of scale on agricultural land prices in the Netherlands

Cover figure: Agricultural 66-regions in the Netherlands, sorted by code.

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Abstract

Agricultural land price is influenced by many different factors. Earlier research in several countries showed a wide range of factors influencing land price. These factors include characteristics of the transaction, the region in which the transaction took place and the distance-to a potential influencing factor. The objective of this study is to identify the influence of economies of scale on land prices in the Netherlands using regional and individual transaction characteristics. The timeframe of the used database (2010-2011) in this study is considered useful since the agricultural land market is less influenced by zoning change and speculation during a recession. In contrast to earlier research in the Netherlands this study showed a connection between the economic size of a selling or buying company and the agricultural land price. Furthermore the region where the transaction took place, the population density and the distance from the buying farmer and the sellers parcel showed significant results.

Key Words: Agricultural Land Price, Economies of Scale, Transactional Characteristics, Regional Characteristics, the Netherlands.

Preface

This thesis is about agricultural land prices, an interesting topic in my opinion. I am glad that I had the chance to work on this topic since it is an underexposed theme in 'Spatial Planning', in which I did my Bachelor. I have always been interested in the more realistic side of planning and I believe that a decent economic background is necessary to judge the viability of new plans. My study advisor was aware of this and advised me to do a study in land prices. A study in land price, became a study in agricultural land prices, which turned out to be a great way to learn about the different influences various (environmental) factors have on land prices. The understanding I got from land prices will benefit me for a long time. I already encountered the first benefit, as I will do further research on this topic in my own field of 'Spatial Planning' from now on.

With this preface I would like to thank some people who made it possible for me to do this research. First of all I would like to thank Wim Heijman, my supervisor, because he connected me to the Agricultural Economics Research Institute (LEI) in The Hague. In The Hague Jan Luijt was my supervisor, and whenever I was stuck or could not explain some of my results, he could clarify things for me so I could continue the research, thank you for that Jan. Additionally I would like to thank Tom Kuhlman and Arnoud Schouten for helping me gather the right data and use the right queries to filter the data, whenever I got stuck. Back in Wageningen there was Esther Boere, she critically commented on the content and writing of my report and I would like to thank her for that.

Last but not least I would like to thank my roommates on the Wilhelminaweg. Although I was not home that often, they were still interested in my research. Therefore I felt comfortable whenever I went home and this kept me motivated to go on. Thank you guys!

R.A. Dijkhof
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1. Introduction

Agriculture is the most common form of land use in the Netherlands. However the area of agricultural land use is declining. Trends show that this decline goes hand in hand with a decreasing number of farms (Berkhout et al., 2008). Production on the other hand is still increasing, which implies further intensification of agriculture (Silvis et al., 2013). In the Netherlands the government uses strict zoning plans that assigns land to specific functions, the amount of suitable land per function is therefore limited. However, due to the increase in population and decline in average size of households, the demand for the land-use function housing was continuously present (Cotteleer et al., 2008). In the Netherlands the largest supplier of land to meet this increased demand is the agricultural sector. Agricultural land then fulfils other functions such as housing, infrastructure and nature. In recent years, the demand for these other functions decreased. The decreasing demand for housing is mainly due to the economic crisis (Aalbers, 2009). Other land use functions like infrastructure and nature development also decreased in demand because of budget cuts of the Dutch government (Bredenoord et al., 2011; de Boer et al., 2012).

Land use change assigned by the government leads to more speculation and an increased price of land especially around cities (Buurman, 2001). Investors speculate on a municipal decision to happen in which case another destination is assigned to a piece of agricultural land they own, causing their land to gain value (Luijt et al., 2003). These kind of investments are possible because of the structure of the land market: buying land is possible, but it may not be used for all purposes (Segeren et al., 2005). In recent years the amount of speculative investments dropped due to the decreased demand for housing. These developments reduce the competition with agricultural land use. The price of farmlands has fluctuated considerable over the recent decades, with an increasing trend. But this increase came to a standstill (DLG, 2012).

The price of land has remained fairly constant over recent years, which enables us to investigate the land price. Earlier studies have tried to determine how the land price is established, finding different factors that contribute to price formation (Cavailhès et al., 2003; Chicoine, 1981; Cotteleer et al., 2008; Drescher et al., 2001; Dunford et al., 1985; Pyykkönen, 2006; Sklenicka et al., 2013). The price now seems to be less subject to pressure from other functions, so it is a good moment to test how agriculture land price is composed.

Statistics show that intensification and expansion are trends of all times (Groen et al., 2003), therefore they should be included in a study investigating influences on the agricultural land price. In addition, we will add the influences of regional differences. The objective of this study is to identify the influence of economies of scale on land prices in the Netherlands using regional and individual transaction characteristics. Therefore we use an empirical model which uses eight independent variables. Four variables try to explain the land price through regional characteristics and four other variables try to explain the land price through transactional characteristics, of which most are directly or indirectly associated with economies of scale.

Since the early fifties farmers started to buy land to benefit from economies of scale. The added value expresses by lower costs per unit, resulting in more profit. Nowadays economies of scale are the most important motive to buy land (Kuhlman et al., 2010). A study in 2008 on dairy farms in the Netherlands showed that the costs per kg milk for a typical small farm are €0.56, while for a typical big farm it is €0.39. The cost per unit are 44% higher for the smaller farm (Meulen, 2010).

The economic value of land consists of several complex factors. The soil-quality, distance to the market and production are among these factors (Blaug, 1987). Lower transportation costs and higher soil fertility cause higher profits and therefore a higher land price. These are agricultural factors influencing the agricultural land price, but there are also non-agricultural factors influencing the agricultural land price.

More recent studies showed a range of non-agricultural variables to be influencing land value. Distance to infrastructure and nearest town (Chicoine, 1981), Standard Gross Margin (Cavailhès et al., 2003), farm density and regional unemployment (Pyykkönen, 2006), distance to capital and population count (Sklenicka et al., 2013), parcel size (Drescher et al., 2001), family connections and designated nature development (Cotteleer et al., 2008), but also buyers characteristics (Dunford et al., 1985) are just some of them. These studies took place in France, Finland, the Czech Republic, Minnesota (USA) and the Netherlands. It might be that the difference in study area or time had an influence on the outcome because some variables are significant in one study but not in another.

Although it is possible that the variables are different for each country it is more likely that time has influence on the outcome of these variables. Over time different prices and quantities of land were sold, causing a land market cycle. The land market cycle is a model described by Søgaard, this model shows that a "shock to the market will generate a cyclical pattern of prices and quantities" (Søgaard, 1993). So the land price and the traded quantity of land fluctuates over time, this is also happening in the Netherlands (Woltjer et al., 2008). During economic growth the residential area expands more than during a recession, therefore we can assume that farmers have less competition from non-farmers when looking for agricultural land during a recession (Luijt et al., 2003). Compared to other sectors agriculture is less vulnerable to recessions, therefore we expect that during a recession the agricultural land price will be influenced less by other sectors (Luijt et al., 2009). This theory is empowered by studies showing that the type of buyer (for example: real estate developers, government or farmers) has an enormous amount of influence on the agricultural land price (Buurman, 2001).

Earlier research used transaction characteristics (such as parcel size and buyers age), regional characteristics (such as unemployment rate and farm density) and distance-to characteristics (such as distance to highway or city). Transactional characteristics data can be gathered through the cadastre and regional characteristics data can be gathered through the national statistics office. The distance-to characteristics data are more complex to investigate. Via distances measured between the location of the relevant parcel and the location of the nearest specific factor a relationship between the factor and the price can be found. This is also known as the hedonic pricing model (Rosen, 1974). The advantage is that it gives a good indication of the influence of each specific factor on the land price. The disadvantage is that it is a complex and time-consuming method.

Although the variety of potential variables is enormous we try to keep it simple. The availability of a recent transaction database in recession is an advantage. The access to transactional and regional characteristics and the possibility to use characteristics of buyers and sellers should therefore give us the possibility to identify important factors relating to land price.

2. Theoretical model

We divided the Netherlands based on an existing division in 14 agricultural regions which were selected because they had corresponding agricultural characteristics. These 14 regions can be subdivided into 66 regions. For each land transaction it is known where in the 14 and 66 region it takes place. We have identified several regional characteristics which we expect to influence the agricultural land price. Moreover, the location of each specific farm can be found using data from Statistics Netherland (CBS). We can assume that some regions will have positive and negative characteristics influencing the price for the area (Folland et al., 1991). We will use a dummy for each region. Afterwards we will also take other regional characteristics into account. The model we will use looks like this:

$$Y = \beta_0 + \beta_j x_j + e$$

Where Y is the land price per hectare, β_0 is the intercept.

β_j represents the coefficient for x_j and x_j represents the variable.

e represents a mutually independent normally distributed random variable to correct the observational

We use the following regional characteristics: the region itself, the percentage of agricultural land bought by governments for nature development in 2009 and 2010, the dominant soil type and the population density for each of the 66 regions. Within a region the numbers connected to the transactions are therefore the same. Except for regional characteristics there are also different characteristics on transaction level. We choose to take the following characteristics at the transaction level into account: the NGE[1] of the buyer, the NGE of the seller, the size of the parcel and the distance between the buyer's house plot and the parcel for sale. The driving forces behind the first three characteristics are economies of scale. The characteristics should partly explain the value of the land. The dependent variable in this research is the price of land per hectare. The conceptual model is shown in Figure 1.

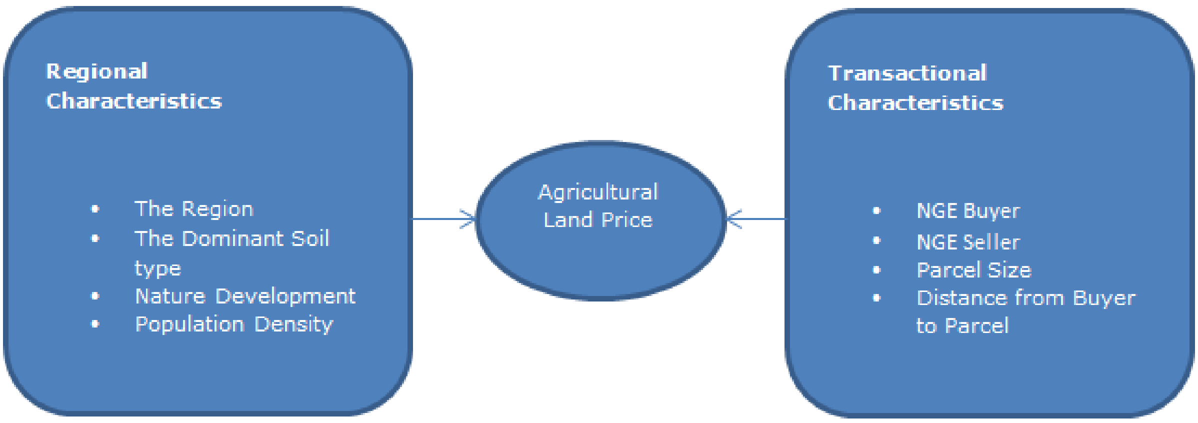

Figure 1 the conceptual model

[1] NGE – stands for Dutch size unit (standard gross margin divided by set factor)

Earlier research already showed a significant relation between the land price and some of the variables we selected (Table 1). The plot size was a significant explanatory variable in the Finish and American research while it did not show significant effects in the Netherlands and the Czech Republic. The effect of NGE's was also measured by earlier Dutch research, but it only showed significance for buyers in urban areas (Cotteleer et al., 2008). A significant effect was also visible for plots located inside Nature Development Areas. For population density both Finnish and Czech research showed significance while for Distance there was a significant effect measured in the Netherlands and the Czech Republic (Pyykkönen, 2006) (Drescher et al., 2001) (Sklenicka et al., 2013).

Table 1: Literature

Variable		**Finnish**	**Minnesota (USA)**	**Netherlands**
	Model	Hedonic	Hedonic + Regional	Hedonic
	Author	Pyykkönen	Drescher	Cotteleer[2]
	Year	2006	2001	2008
	Adjusted R^2	0.391	0.46	0.353 (for Rural model)
Y	Price per hectare			
X1	Parcel Size	(-)***	(-)***	X
X2	NGE buyer			
X3	NGE seller			X
X4	Regional dummy			
X5	Soil dummy			X
X6	Nature Development			(-)(**)
X7	Population Density	(+)***	(+)***	
X8	Distance to Parcel			X

***** = Significant at the 1% level**
**** = Significant at the 5% level**
*** = Significant at the 10%**
(+)/(-) = the direction of the significant influence
X = Taken into account by study but not significant
Null = Not taken into account by study

[2] The study distinguished three types of transactions; for this table the rural-model output was used.

3. Data and Methods

3.1 Source and Content Database

The Dutch cadastre supplies data on each transaction, including the function of the transaction, to the 'Government Services for Land and Water Management' (DLG). The DLG adds personal and transactional data to the transaction. In the context of the 'agricultural research service' (DLO) all the farms are obliged to fill in a yearly survey, the 'Farm Structure Survey'. This data is coupled to DLG's data by the 'Agricultural Economics Research Institute'(LEI[3])(Luijt, 2002). This coupled data forms the basic database for this research.

The content of this database is diverse. Information consists of an identification code with the year and month in which the transaction took place, regional codes to indicate where the buyer or seller lives, the size of the parcel(s) included in the transaction, the purchase price (also per hectare), company profiling, age, sex, names and more. In another file the parcels are separated from their transactions. This file provides the coordinates were this particular parcel is located.

3.2 Data Selection

In 2009 and 2010 there are 30,000 transactions registered by the Dutch cadastre. Within these transactions a total of 90,000 parcels are traded. The choice for two years instead of one is made to enlarge the database, which is necessary because a lot of these transactions are not relevant for this study. Also the land prices were pretty stable during this period. When this study was carried out, the data of 2011 was also available. However the years 2009 and 2010 were specifically chosen because of matching measurement units. Until 2010 NGE's were used in the database, afterwards SO's. NGE's are the Dutch measurement standard to measure the standard gross margin of a farm. SO's were introduced as the new EU-wide standard measurement unit. This was the only differences in the database, but because SO cannot be converted to NGE and to increase the database we chose to use the years 2009 and 2010.

3.3 Sample Selection

In this research we only want to include the transactions between two farmers. This, in order to avoid the speculation aspect that largely influences land price. To be sure that all transactions are from one farmer to another, there are several data-selection criteria developed. One of them is developed by the Dutch cadastre, another one by the DLG. Because the basic database for this research is composed by the LEI, which combined the information of the DLG and the DLO, it is easier to use the DLG criteria. The cadastre criteria are not identifiable anymore, while the DLG criteria are still used in the database. Most important criteria are that a transaction is bigger than half a hectare, that there are no buildings included and that the prices are over €1,000 and under €500,000 per hectare. For this research we also added another criteria, namely that both the seller and the buyer need to have a BRS-number. This number indicates that a farmer filled in the yearly obligatory 'Farm Structure Survey', so if this number is missing the farm is not recognized as a farmer by the LEI. This can be the case if we are dealing with hobby farmers or when agriculture is a minor activity, in that case their transactions is deleted from the database. Landscape foundations and municipalities with BRS-numbers are deleted, also transactions with non-existent coordinates are removed.

[3] Landbouw Economisch Instituut (LEI)

4. Empirical Model

4.1 Variables

4.1.1 Buyer

Every potential buyer has different characteristics. In this research we looked at the different characteristics for each buyer. Different buyers have different backgrounds, grow different products and keep different livestock. However, they compete for the same piece of land. Therefore the marginal revenue per additional hectare of land differ between potential buyers. When a farmer does not have extra fixed costs to cultivate the extra piece of land, for example because he or she would not need new machinery, then a bigger farm is most likely able to pay more than a smaller farm. The bigger farm will have more advantage of the economies of scale. The marginal revenue per hectare of land are already higher and after the transaction this will only increase (Jan Luijt et al., 2011). The variable to measure the economic capacity is the NGE of the buyer. Another reason to choose NGE is because they indicate how large a farm is. Larger farms have a higher profitability and are also more likely to have invested more money in their farm. Therefore they have a better long-term perspective ((Meulen, Bont, en Ketens, et al.; Meulen, Bont, Horne, et al., 2010).

4.1.2 Seller

Buyers and sellers each have their own characteristics. There can be different reasons for a farmer to sell his land. For example, the farmer wants to retire and has no family members that want to take over or it could be that it is tough to keep his company profitable. A seller should want to get the best price possible for his land, but the volume of the turnover also plays a role. The theories behind scale advantages do not only apply for the largest farms, they apply for all sizes of farms. A medium sized farm will have a higher land rent for the same crop compared to a smaller farm, because we assume the amount of fixed costs between farms are almost equal. Both the small farm and the medium farm need the same kind of machinery. A certain bid per hectare could therefore exceed the land rent of the small farm while not reaching the land rent of the medium sized farm. Also smaller farms are less likely to have invested money recently, therefore they have a worse long-term perspective (Meulen, Bont, en Ketens, et al.; Meulen, Bont, Horne, et al., 2010).Therefore, we expect that a bigger seller will be able to receive a higher price per hectare than a smaller seller. The variable for this characteristic is the NGE of the seller.

4.1.3 Size

The size of the parcel in a transaction is likely to influence the price per hectare. The price consists of more than just the price for the land, there are also additional costs per transaction (Lence, 2001). These costs need to be made to transfer the land from one rightful owner to another, the so called transaction costs. Because these costs are made for the transaction regardless its size, you would expect that the average costs per hectare decreases when the size of the parcel in a certain transaction is larger (Wunderlich, 1989).

4.1.4 Region

Every agricultural region has different kind of characteristics that may influence the land price. The regional dummies correct for regional differences in land price. The explanatory difference between the 14 and 66 agricultural region will be interesting. We expect that the 66 agricultural regions will add extra explanatory variance compared to the 14 agricultural regions, because of the smaller deviation in agricultural regions (Folland, 1991).

4.1.5 Dominant Soil Type in the region

By using a soil map of the Netherlands a dominant soil type per region is determined[4]. A dummy is used to indicate the dominant soil type per region. These soil types can be clay, sand, peat or mixed soils. It would make sense that different types of soils are preferable, because they relate to different productivity of land. Because these 66 regions are based upon the type of agriculture that takes place, we expect to see a connection between the dominant soil type and the land price (Miranowski et al., 1984).

4.1.6 Percentage Nature Development in the region

This is the only variable which has a direct policy connection. The European and Dutch governments set up policies to connect different nature areas in Europe. In the Netherlands this nature development program is called the EHS. Governments buy agricultural land to redesign this as nature development areas. When the government plays such a role on the land market you can expect that this influences the price. There is an extra player and therefore more speculation on the land market. Moreover there is less land left for farmers who want to expand. The demand-supply market is therefore disturbed, making land more scarce and according to the Ricardian trade and payments theory scarce goods are more expensive (Becker, 1965). We expect that when in 2009 and 2010 a larger percentage of the total available agricultural area was bought by the government within a region, that the land price paid by farmers was also higher.

4.1.7 Population Density in the region

Despite that we only use transactions between farms, we expect that there still is some room for speculation. This is a potential extra value after a change of destination. This potential comes from the difference in land price depending on the function of the land; for agricultural use the average land price is about €50,000 per hectare, for residential land the value can be a tenfold. The speculation effect is mainly present close to growing villages, although that doesn't necessarily mean that land around shrinking villages is cheaper (Kuhlman et al., 2012). A farmer will be aware of this speculation effect and will get a lot more than the normal agricultural land price. Because this will often happen nearby growing villages and growing villages are often in more densely populated regions, we use the population density in a region as an explanatory variable. This extra demand will probably influence the land price (Spinney et al., 2011). Therefore we expect a higher land price in more densely populated regions. For the density we used a logarithmic scale, the figures in the appendix show more even spread data that way.[5]

4.1.8 Distance

Except for the location of the land it is also possible that the location of the buyer has an influence on the price of land. The closer the new piece of land is to your own, the less it will cost to cultivate the newly acquired land. In the Netherlands there is an old saying: 'Neighbours land is for sale just once.' It means that when a piece of land is for sale nearby it might be the only opportunity during your farming career. Studies show that 90% of all parcels are bought by farmers living within 6.7 Km (Cotteleer et al., 2008). When keeping in mind the scale advantages and intensifying agricultural

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[4] Map added in appendix, Figure 10
[5] See figure 2 and 3 in the appendix

trends, farmers are often willing to pay a price far above the land rent (Filatova et al., 2009). To calculate the distance we took the coordinates from the buyer his home plot and the bought parcel. By using the Pytachoras method we could calculate the straight line distance. This method makes it able to calculate the longest side of a triangle with a 90 degree angle, the other sides can be calculated by subtracting both coordinates. Although it could be seen as a hedonic pricing method, both locations are in fact characteristics of the buyer and seller. For the distance we used a logarithmic scale, the figures in the appendix show more even spread data that way[6].

4.2 Empirical Model

In order to determine factors influencing the price of land, the previous named characteristics are selected. These characteristics together try to explain the price of land. But different farmers will most likely value these characteristics differently. The characteristics of the land market are such that the hedonic pricing model is a good way to estimate the value of some of the characteristics. Earlier research on agricultural land pricing in the Netherlands and the USA also used the hedonic pricing method to determine non-agricultural values (Cotteleer et al., 2007) (Drescher et al., 2001). A close distance to a residential area might explain a higher land price. In this research we will use that principle. Only instead of a single distance per transaction we use regional averages, in the case the population density of the area. A region with a higher population density is more likely to have transactions relatively close to a city. The outcomes are tested for multicollinearity and heteroscedasticity (Bruin, 2011) (White, 1980). The following model will give us a chance to show if the land price is influenced by the independent variables we mentioned earlier:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + e$$

Where Y is the land price per hectare, β_0 is the intercept.

β_1 represents the coefficient for the NGE of the buyer, x_1 represents the NGE of the buyer.

β_2 represents the coefficient for the NGE of the seller, x_2 represents the NGE of the seller.

β_3 represents the coefficient for the size or the parcel, x_3 represents the size of the parcel.

β_4 represents the coefficient for the region dummy, x_4 represents the region.

β_5 represents the coefficient for the dominant soil dummy, x_5 represents the dominant soil.

β_6 represents the coefficient for the nature development, x_6 represents the nature development.

β_7 represents the coefficient for the population density, x_7 represents the population density.

β_8 represents the coefficient for the distance of purchase, x_8 represents the distance of purchase.

e represents a mutually independent normally distributed random variable to correct the observational error.

[6] See figure 4 and 5 in the appendix

4.3 Hypotheses

A short summary of the expected direction of the earlier mentioned variables.

x_1 = NGE of the buyer
H_a : There is no relation between x_1 and Y.
H_0 : There is a relation between x_1 and Y.

x_2 = NGE of the seller
H_a : There is no relation between x_2 and Y.
H_0 : There is a relation between x_2 and Y.

x_3 = Hectares of land
H_a : There is no relation between x_3 and Y.
H_0 : There is a relation between x_3 and Y.

x_4 = Region-dummy
H_a : There is not a relation between x_{4i} and Y.
H_0 : There is a relation between x_{4i} and Y.

x_5 = Soil-dummy
H_a : There is not a relation between x_{5i} and Y.
H_0 : There is a relation between x_{5i} and Y.

x_6 = Percentage National Ecological Network purchases by the Dutch state.
H_a : There is no relation between x_6 and Y.
H_0 : There is a relation between x_6 and Y.

x_7 = Density
H_a : There is no relation between x_7 and Y.
H_0 : There is a relation between x_7 and Y.

x_8 = Distance buyer and parcel
H_a : There is no relation between x_8 and Y.
H_0 : There is a relation between x_8 and Y.

4.4 Who is buying?

Table 2 shows the average transaction in the Netherlands over 2009 and 2010. The distance is with an average of over 4,000 meters higher than expected, but is easily influenced by several transactions far away. The most interesting outcome however is that the buyer's turnover is higher than the turnover of the sellers. On average the transaction covered a total of 5.5 hectare. This table therefore suggest that the economies of scale have a big influence on who buys and who sells. Since the amount of small farmers is decreasing and the amount of bigger farms is increasing. The maps in the appendix show the average values for each agricultural region for the land price, buyer's NGE, seller's NGE, population density, size of the transaction and percentage of Nature Development[7].

[7] The maps are added in the appendix (figure 6, 7, 8, 9, 10 & 11)

Table 2: Discriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
y = Price per hectare (€)	3283	47441.15	30729.24	1457.726	480422.9
x1 = NGE buyer (NGE)	3283	128.0234	121.9386	1.65	1727.5
x2 = NGE seller (NGE)	1528	78.14254	146.0826	0.04	1880.27
x3 = Plot size (hectare)	3283	5.483558	7.587757	0.5	124.3192
x6 = Nature Development (% of areable land bought by the government)	3283	0.4581796	0.5072607	0	4.179269
x7 = Population Density (pop/km2)	3283	405.5561	321.8778	45.83389	2843.796
x8 = Distance (m)	3283	4172.772	14482.33	24.69818	205409.8

Variable	Obs	%
R Bouwhoek en Hogeland	3283	3.28967
R Veenkoloniën en Oldambt	3283	8.10235
R Noordelijke weidegebied	3283	17.27079
R Oostelijk veehouderijgebied	3283	21.4438
R Centraal veehouderijgebied	3283	4.93451
R IJsselmeerpolders	3283	2.7414
R Westelijk Holland	3283	3.71611
R Waterland en droogmakerijen	3283	1.2184
R Hollands/Utrechts weidegebied	3283	5.39141
R Rivierengebied	3283	3.83795
R Zuidwestelijk akkerbouwgebied	3283	6.79257
R Zuidwest Brabant	3283	1.73622
R Zuidelijk veehouderijgebied	3283	16.63113
R Zuid Limburg	3283	2.89369
S Clay	3283	15.96101
S Sand	3283	32.83582
S Sand-Clay-Peat	3283	16.53975
S Clay-Sand	3283	25.89095
S Peat-Clay	3283	4.93451
R= x4 = Region Dummy		
S= x5 = Soil Dummy		

5. Results

If we only look at the 14 agricultural areas as an explanation for the land price, eleven of the fourteen areas were statistically significant at the 0.05 level. The model had an f-test of 0.000 (F(13, 3269) = 51.6) and the adjusted R^2 shows us a .17 explanation.[8]

If we look at the same way to the smaller bordered 66 agricultural areas the 35 out of 66 areas were statistically significant at the 0.05 level. The model had an f-test of 0.000 (F(65, 3282) = 18.57) and the adjusted R^2 showed us a .26 explanation[9].

The more precise region classification explains the land prices better than a rougher regional classification of a transactions location. This was expected because it can explain more variation, it shows that the newer more detailed classification works. The more solid 66 region dummies could not be used in the final model, because the database is too small, but also because of multicollinearity and interpretation problems.

5.1 Outcome model overall.

The analysis shows us a model with four out of six significant (non-dummy) variables on the 5% level. Namely: NGE buyer, NGE seller, Population Density and Distance (Table 3).

Ten of the fourteen regions influenced the price significantly on the 0.05 level and two of the five soils did. The model had an f-test of 0.000 (F(23, 1504) = 32.02) and an R^2 of 0.30.

The model has been corrected for heteroscedasticity and the VIF-test showed that there was no multicollinearity.[10]

[8] See appendix table 8
[9] See appendix table 9
[10] See appendix table 7

Table 3: Robust Linear regression							
Linear regression				Number of obs		=	1528
				F(23, 1504)		=	32.02
				Prob > F		=	0
				R-squared		=	0.2981
				Root MSE		=	0.34276
			Robust				
log_ys	Coef.		Std. Err.	t	P>t	[95% Conf.	Interval]
x1 = NGE buyer	0.0294	***	0.0104155	2.82	0.005	0.0089336	0.0497946
x2 = NGE seller	0.0015	**	0.0007355	2	0.045	0.0000301	0.0029155
x3 = Plot size	0.0001		0.0018666	0.07	0.947	-0.0035362	0.0037867
R Bouwhoek en Hogeland	0.1709		0.1048651	1.63	0.103	-0.0348139	0.3765807
R Veenkoloniën en Oldambt	-0.1897	***	0.0718724	-2.64	0.008	-0.3306714	-0.0487097
R Noordelijke weidegebied	-0.1693	**	0.0694851	-2.44	0.015	-0.3056245	-0.0330287
R Oostelijk veehouderijgebied	0.1483	**	0.0726036	2.04	0.041	0.0059349	0.290765
R Centraal veehouderijgebied	0.1588	**	0.0792934	2	0.045	0.0032954	0.3143703
R IJsselmeerpolders	0.5102	***	0.1023823	4.98	0	0.309408	0.7110622
R Westelijk Holland	0.0091		0.0789911	0.12	0.908	-0.1458542	0.1640348
R Waterland en droogmakerijen	-0.3310	**	0.1539981	-2.15	0.032	-0.6330971	-0.0289496
R Hollands/Utrechts weidegebied	-0.0449		0.0847758	-0.53	0.597	-0.2111664	0.1214163
R Rivierengebied	0.2199	***	0.0832336	2.64	0.008	0.0566062	0.3831385
R Zuidwestelijk akkerbouwgebied	0.3207	***	0.0988594	3.24	0.001	0.1268255	0.5146594
R Zuidwest Brabant	0.2757	**	0.1089234	2.53	0.011	0.0620809	0.4893965
R Zuidelijk veehouderijgebied	0.3223	***	0.06728	4.79	0	0.1903215	0.4542666
S Clay	-0.0365		0.0509497	-0.72	0.473	-0.1364812	0.0633988
S Sand	-0.0292		0.0309257	-0.94	0.346	-0.0898189	0.0315052
S Clay-Sand	-0.1454	***	0.0398386	-3.65	0	-0.2235072	-0.067217
S Peat-Clay	-0.1764	**	0.0725937	-2.43	0.015	-0.3188197	-0.0340284
x6 = Nature Development	-0.0389		0.0273754	-1.42	0.156	-0.0925902	0.0148058
x7 = Population Density	0.1812	***	0.0275143	6.59	0	0.1272646	0.2352056
x8 = Distance	-0.0207	**	0.0085238	-2.43	0.015	-0.0374539	-0.0040143
_Cons	122.631	***	0.0834486	14.7	0	1.062.622	1.389.998
R = x4 = Region Dummy							
S = x5 = Soil Dummy							

***** = Significant at the 1% level**
**** = Significant at the 5% level**
*** = Significant at the 10%**

5.2 Results per Variable

5.2.1 Transactional Characteristics

As hypothesized the NGE of the buyer did significantly influence the land price (p = 0.000, Table 3). The elasticity was 0.040. The NGE of the seller did also significantly influence the land price (p = 0.000). The elasticity was 0.012. This means that when a buyer has a higher NGE they are willing to pay more per hectare. A seller with a higher NGE demands more per hectare. Both these outcomes were expected from the theory (Cavailhès et al., 2003; Jan Luijt et al., 2011), although it was not found significant in earlier research in the Netherlands (Cotteleer et al., 2008).

The size of the parcel traded in a transaction did not significantly influence the land price (p=0.947). The parcel size was found significant in four out of the five studies earlier mentioned. The only study where it was not significant also took place in the Netherlands. On one hand we expected a negative connection between the size and the price, according to the transaction-cost theory (Wunderlich, 1989), on the other hand the earlier mentioned advantages of economies of scale (Luijt et al., 2011) expects a higher price for every extra hectare. In this case they might collide. In the Czech study they found that the influence of parcel size is strongly negative within 100 meters from a built-up area, in contrast there was a positive influence after 100 meters (Sklenicka et al., 2013).

The distance between the buyer and the bought parcel is significant for the land price (p = 0.015). With an elasticity of -0.021. This means the further away a parcel is located from a potential buyer, the lower the price the buyer is willing to pay.

Table 4: Elasticities

Variables	Elasticity
x1 = NGE buyer	0.0399
x2 = NGE seller	0.0115
x7 = Population Density	0.1812
x8 = Distance	-0.0207
Dummies are not included	

5.2.2 Regional Characteristics

Table 3 shows the ten regions that significantly influence the land price. The influence of a region where a transaction takes place is large. Although the influence of population density, soil type and nature development are already taken into account there are probably a lot more influencing factors which differ per region. The regions with a positive coefficient are mainly in the west and south of the Netherlands, while regions with a negative coefficient are mainly in the north of the Netherlands.

Clay-Sand and Peat-Clay show a significant negative influence on the land price. A good interpretation of these results is not really possible. For the reason that the significant soil types are all consisting of the three different soil types that were derived from the soil map in the first place.

Nature development does not show a significant influence on the land price (p=0.155). Although earlier research showed that Nature Development and price were connected (Cotteleer et al., 2008). The reason is that in those cases it was known that a parcel was designated for Nature Development, and therefore had a lower price. In this case study we thought the other way around. Since farmers would be less interested in this land there would be more competition for the remaining land, but that hypothesis was not proven.

As hypothesized the population density shows a significant influence on the land price (p=0.000), with an elasticity of 0.181. This means that land prices in denser regions are higher.

6. Conclusion

6.1 Conclusion

Results show that the economic size of the buyer and the seller are significantly influencing the agricultural land price. This implies that the economies of scale play a dominant role in who is buying and who is selling land. The distance between the buyer and the parcel also turned out to be significantly influencing the agricultural land price. This is in contrast to the earlier research done in the Netherlands by Cotteleer, who did not found a connection between the buyers distance, nor the economic size, and the agricultural land price (Cotteleer et al., 2008).

The region where a transaction took place plays an important role, furthermore also the population density showed significant influence. Some regional averages attributed to the model quite good, but an average soil type is probably too vague.

6.2 Discussion

The economic size of the buyer and seller are significantly influencing the agricultural land price, this can be explained by the different value an extra hectare has for different sized farms. A bigger farm has lower costs per unit then a smaller farm, according to the theory of economies of scale. A force not taken in consideration in this research is a possible inhibitory effect in the case the farmer has debts, because of the expansion. Although our non-hedonic study found a slightly lower R^2 than other hedonic studies, it does not necessarily predict worse. With more observations a more precise estimation for the different regions can be made. This way it would increase the reliability of this research. So more data would be needed to be more precise on the regional differences. The economies of scale are proven. The small coefficient shows that the price is not very sensitive for these buyers and sellers' characteristics. Furthermore there is an imperfect market, because 90% of the transactions is done within a range of 6.7 kilometre from the buyer (Cotteleer et al., 2008). This means a lot of potential bids on land outside this 6.7 kilometre are refused for being too low, because the buyer subtracts the transportation costs (or his distance costs) in the price (Bakker et al., 2013). This means that the influence of distance between buyer and seller is probably even higher. This study did not found a connection between the parcel size and the agricultural land price, while other studies did. It could be that there is a connection, but in this research parcels close to the cities probably disturb this effect, as in the Czech Republic (Sklenicka et al., 2013).

7. References

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4. Appendix

7.1 Stata tables

Table 5: VIF-Test		
Variable	VIF	1/VIF
x4_4	15.43	0.064803
x4_3	12	0.083334
x4_13	11.99	0.083384
x4_9	6.78	0.14751
x4_2	6.4	0.156267
x4_11	6.14	0.162807
x4_1	5.44	0.183942
x5_4	5.02	0.199258
x5_1	4.81	0.207774
x4_6	4.76	0.210098
x4_5	4.36	0.229548
x4_10	4.33	0.230987
x5_2	4.21	0.237291
x4_7	3.56	0.280838
x5_5	3.16	0.316466
log_x7_s	2.8	0.356761
x4_12	2.43	0.411414
x4_8	2.04	0.489429
x6	1.62	0.618922
x3	1.26	0.790515
log_x8_s	1.12	0.892347
x1_s	1.09	0.913653
x2_s	1.05	0.94841
Mean VIF	4.86	

Table 6: The 14 Regions							
Source	SS	df	MS	Number of obs	=	3283	
				F(13, 3269)	=	51.6	
Model	118.277	13	9.098231	Prob > F	=	0	
Residual	576.4034	3269	0.176324	R-squared	=	0.1703	
				Adj R-squared	=	0.167	
Total	694.6804	3282	0.211664	Root MSE	=	0.41991	
log_ys	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]	
x4_1	0.401807	0.0777221	5.17	0	0.249418	0.554196	
x4_2	0.105654	0.0712108	1.48	0.138	-0.03397	0.245276	
x4_3	0.132595	0.0686956	1.93	0.054	-0.0021	0.267285	
x4_4	0.419049	0.0682537	6.14	0	0.285225	0.552873	
x4_5	0.564146	0.0741385	7.61	0	0.418783	0.709508	
x4_6	0.778652	0.0797951	9.76	0	0.622199	0.935106	
x4_7	0.508971	0.0765074	6.65	0	0.358964	0.658979	
x4_8	(dropped)						
x4_9	0.38718	0.0735138	5.27	0	0.243042	0.531318	
x4_10	0.564232	0.076207	7.4	0	0.414814	0.713651	
x4_11	0.532002	0.0721027	7.38	0	0.390631	0.673373	
x4_12	0.604553	0.0866112	6.98	0	0.434735	0.774371	
x4_13	0.583378	0.0687826	8.48	0	0.448517	0.718239	
x4_14	0.517062	0.0791464	6.53	0	0.361881	0.672244	
_cons	1.039515	0.0663935	15.66	0	0.909338	1.169692	

Table 7: The 66 Regions						
Source	SS	df	MS	Number of obs	=	3283
				F(65, 3217)	=	18.57
Model	189.519	65	2.915676	Prob > F	=	0
Residual	505.1615	3217	0.157029	R-squared	=	0.2728
				Adj R-squared	=	0.2581
Total	694.6804	3282	0.211664	Root MSE	=	0.39627
log_ys	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
x9_1	0.043198	0.1338924	0.32	0.747	-0.21932	0.305721
x9_2	-0.22358	0.0952188	-2.35	0.019	-0.41028	-0.03689
x9_3	-0.33857	0.0832062	-4.07	0	-0.50171	-0.17543
x9_4	-0.29973	0.0813304	-3.69	0	-0.4592	-0.14027
x9_5	-0.53376	0.1009688	-5.29	0	-0.73173	-0.33579
x9_6	0.053333	0.1091627	0.49	0.625	-0.1607	0.267368
x9_7	-0.02617	0.0752663	-0.35	0.728	-0.17374	0.121409
x9_8	-0.17551	0.0699864	-2.51	0.012	-0.31273	-0.03829
x9_9	-0.2741	0.0683002	-4.01	0	-0.40802	-0.14018
x9_10	-0.94826	0.1338924	-7.08	0	-1.21078	-0.68573
x9_11	-0.41811	0.1188293	-3.52	0	-0.6511	-0.18512
x9_12	-0.24453	0.0756175	-3.23	0.001	-0.3928	-0.09627
x9_13	-0.35089	0.0774309	-4.53	0	-0.5027	-0.19907
x9_14	-0.37318	0.0876254	-4.26	0	-0.54499	-0.20138
x9_15	-0.33051	0.0735948	-4.49	0	-0.47481	-0.18622
x9_16	-0.22456	0.0690903	-3.25	0.001	-0.36002	-0.08909
x9_17	-0.10276	0.0752663	-1.37	0.172	-0.25034	0.044814
x9_18	0.223599	0.0666106	3.36	0.001	0.092995	0.354202
x9_19	0.009586	0.0738699	0.13	0.897	-0.13525	0.154423
x9_20	0.363634	0.0888586	4.09	0	0.189409	0.537859
x9_21	0.534153	0.0882279	6.05	0	0.361165	0.707142
x9_22	-0.11591	0.0791769	-1.46	0.143	-0.27115	0.039332
x9_23	-0.09749	0.1091627	-0.89	0.372	-0.31152	0.116547
x9_24	0.046904	0.0809924	0.58	0.563	-0.1119	0.205706
x9_25	0.739242	0.2366321	3.12	0.002	0.275277	1.203206
x9_26	-0.00667	0.0836234	-0.08	0.936	-0.17063	0.157293
x9_27	0.349782	0.1023678	3.42	0.001	0.149069	0.550494
x9_28	0.282987	0.0738699	3.83	0	0.13815	0.427824
x9_29	-0.06664	0.0659059	-1.01	0.312	-0.19586	0.062582
x9_30	0.106511	0.1112459	0.96	0.338	-0.11161	0.324632
x9_31	-0.01989	0.0789055	-0.25	0.801	-0.1746	0.13482
x9_32	0.157357	0.2866465	0.55	0.583	-0.40467	0.719386
x9_33	0.090726	0.1293737	0.7	0.483	-0.16294	0.344389

x9_34	0.520334	0.1188293	4.38	0	0.287345	0.753323
x9_35	-0.01977	0.1188293	-0.17	0.868	-0.25276	0.21322
x9_36	0.733086	0.2071449	3.54	0	0.326937	1.139235
x9_37	0.489164	0.2866465	1.71	0.088	-0.07286	1.051192
x9_38	-0.18678	0.0962289	-1.94	0.052	-0.37545	0.001898
x9_40	-0.40692	0.0870491	-4.67	0	-0.5776	-0.23624
x9_41	0.547016	0.2071449	2.64	0.008	0.140866	0.953165
x9_42	0.195942	0.2071449	0.95	0.344	-0.21021	0.602092
x9_43	0.159262	0.0859687	1.85	0.064	-0.0093	0.327821
x9_44	0.241503	0.2866465	0.84	0.4	-0.32053	0.803531
x9_45	0.194731	0.1038725	1.87	0.061	-0.00893	0.398394
x9_46	0.182559	0.1160436	1.57	0.116	-0.04497	0.410086
x9_47	-0.07956	0.1726942	-0.46	0.645	-0.41816	0.259043
x9_48	-0.05683	0.0859687	-0.66	0.509	-0.22539	0.111724
x9_49	-0.05467	0.0797447	-0.69	0.493	-0.21102	0.101688
x9_50	0.369732	0.1872367	1.97	0.048	0.002617	0.736847
x9_51	0.684176	0.1293737	5.29	0	0.430513	0.937839
x9_52	0.126434	0.0962289	1.31	0.189	-0.06224	0.31511
x9_53	0.119614	0.0849745	1.41	0.159	-0.047	0.286224
x9_54	-0.05331	0.0803487	-0.66	0.507	-0.21085	0.104228
x9_55	0.332087	0.0962289	3.45	0.001	0.143411	0.520764
x9_56	0.356866	0.0933663	3.82	0	0.173802	0.539929
x9_57	0.601198	0.2366321	2.54	0.011	0.137233	1.065163
x9_58	0.231513	0.0917076	2.52	0.012	0.051702	0.411324
x9_59	0.111565	0.0909413	1.23	0.22	-0.06674	0.289874
x9_60	0.32486	0.1023678	3.17	0.002	0.124147	0.525573
x9_61	0.371986	0.0803487	4.63	0	0.214446	0.529526
x9_62	0.245928	0.076991	3.19	0.001	0.094972	0.396884
x9_63	0.237355	0.0765735	3.1	0.002	0.087217	0.387493
x9_64	0.276106	0.0688644	4.01	0	0.141083	0.411129
x9_65	-0.05217	0.0674473	-0.77	0.439	-0.18441	0.080076
x9_66	0.11014	0.0728338	1.51	0.131	-0.03267	0.252946
_cons	1.446437	0.0604304	23.94	0	1.327951	1.564923

7.2 Stata Scatterplots

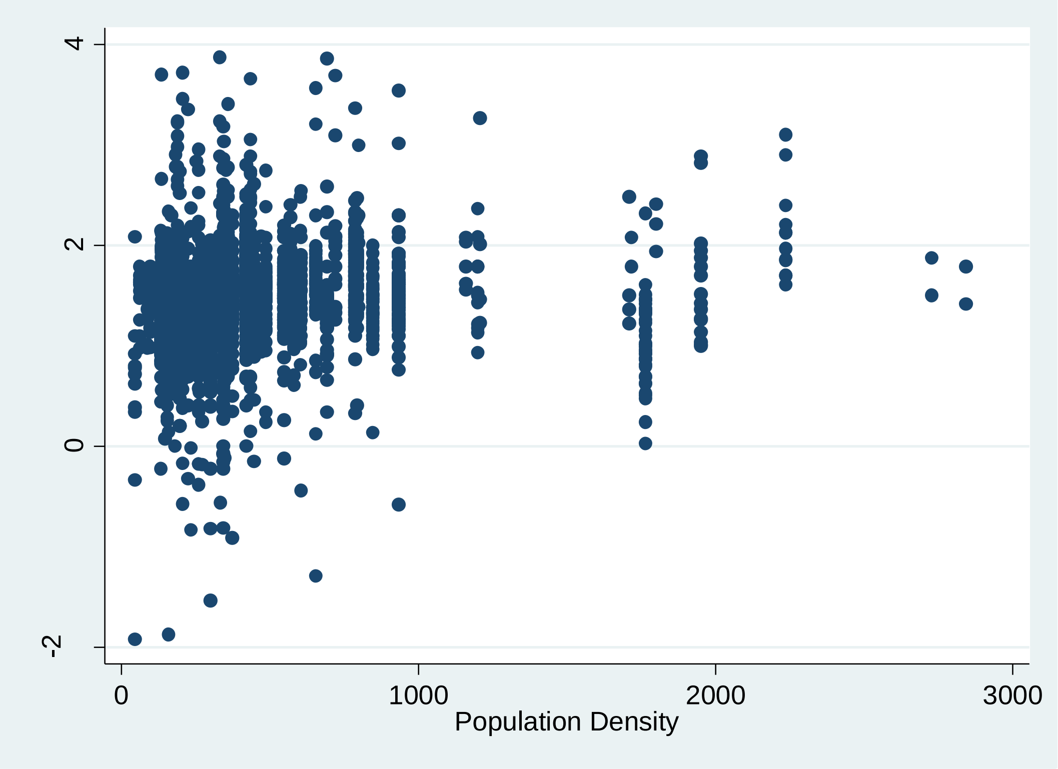

Figure 2 Scatterplot Log_Price and Population Density

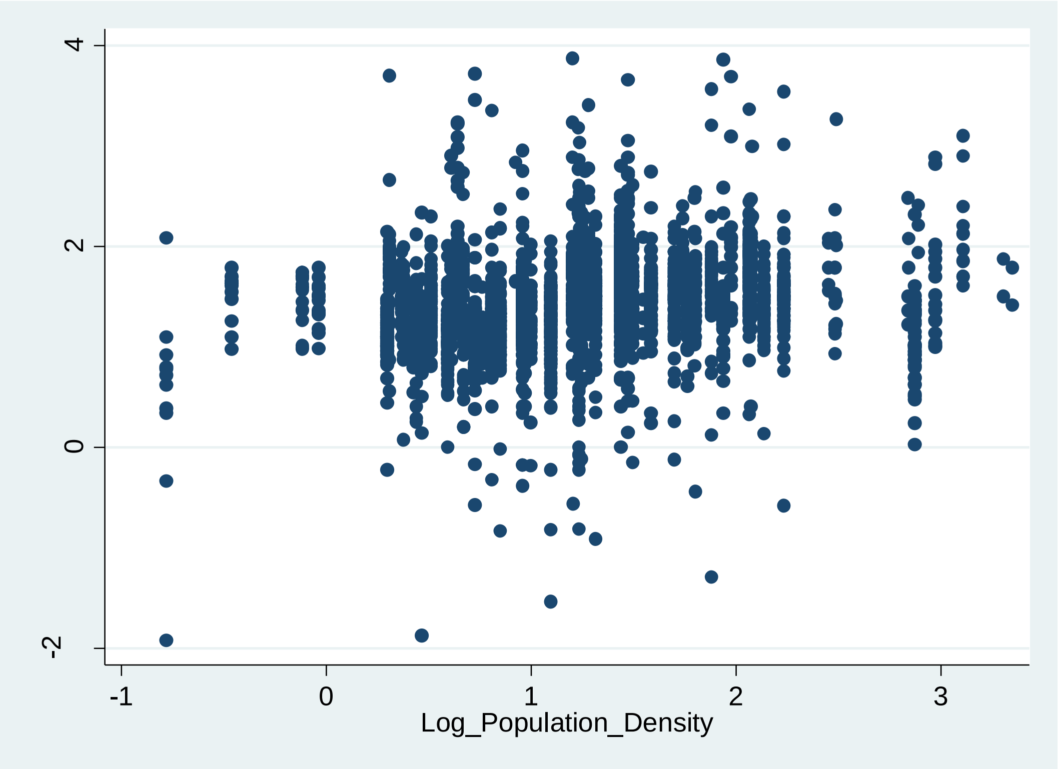

Figure 3 Scatterplot Log_Price and Population Log_Density

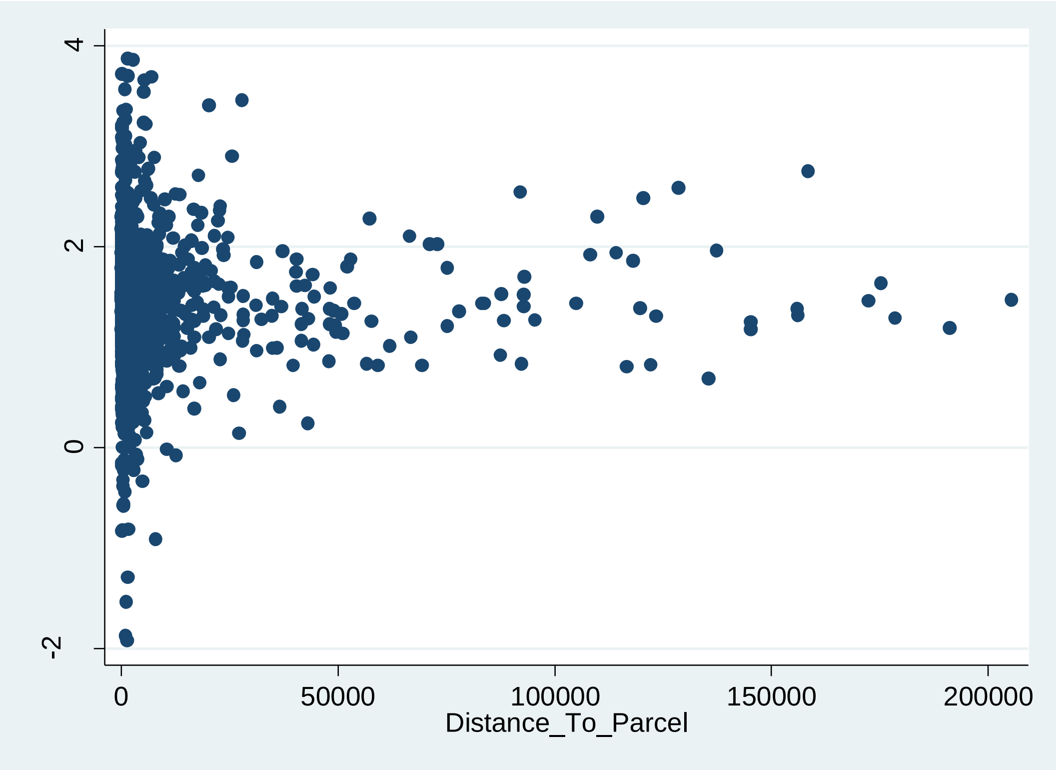

Figure 4 Scatterplot Log_Price and Distance

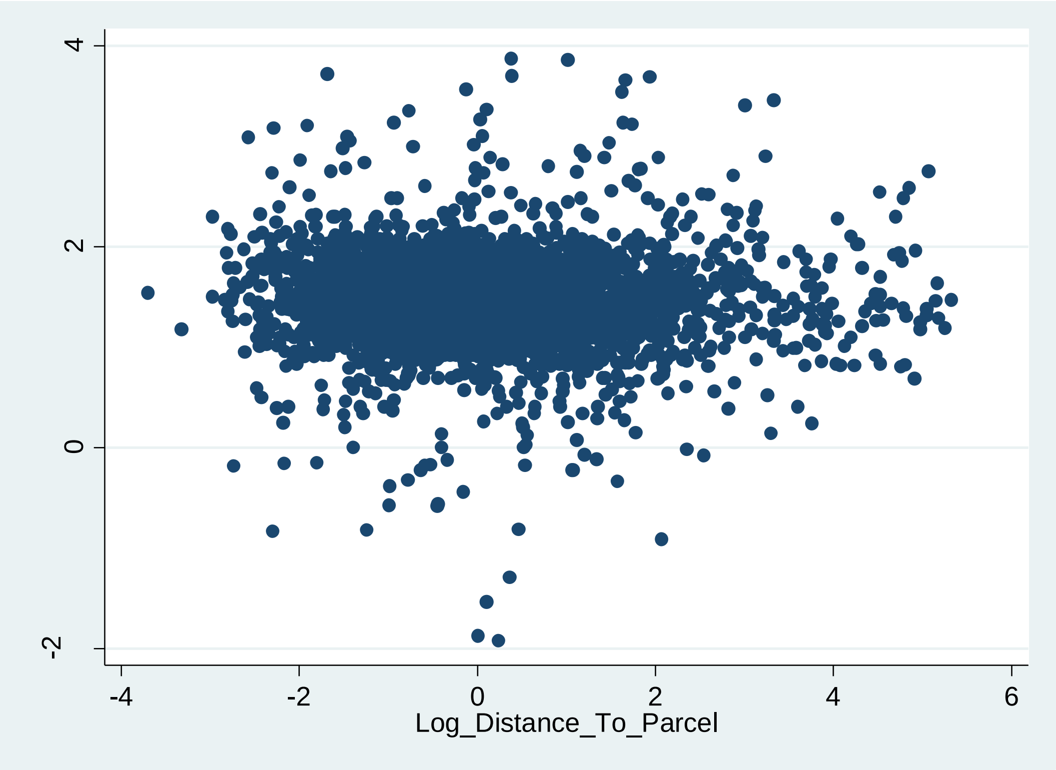

Figure 5 Scatterplot Log_Price and Log_Distance

7.3 GIS maps

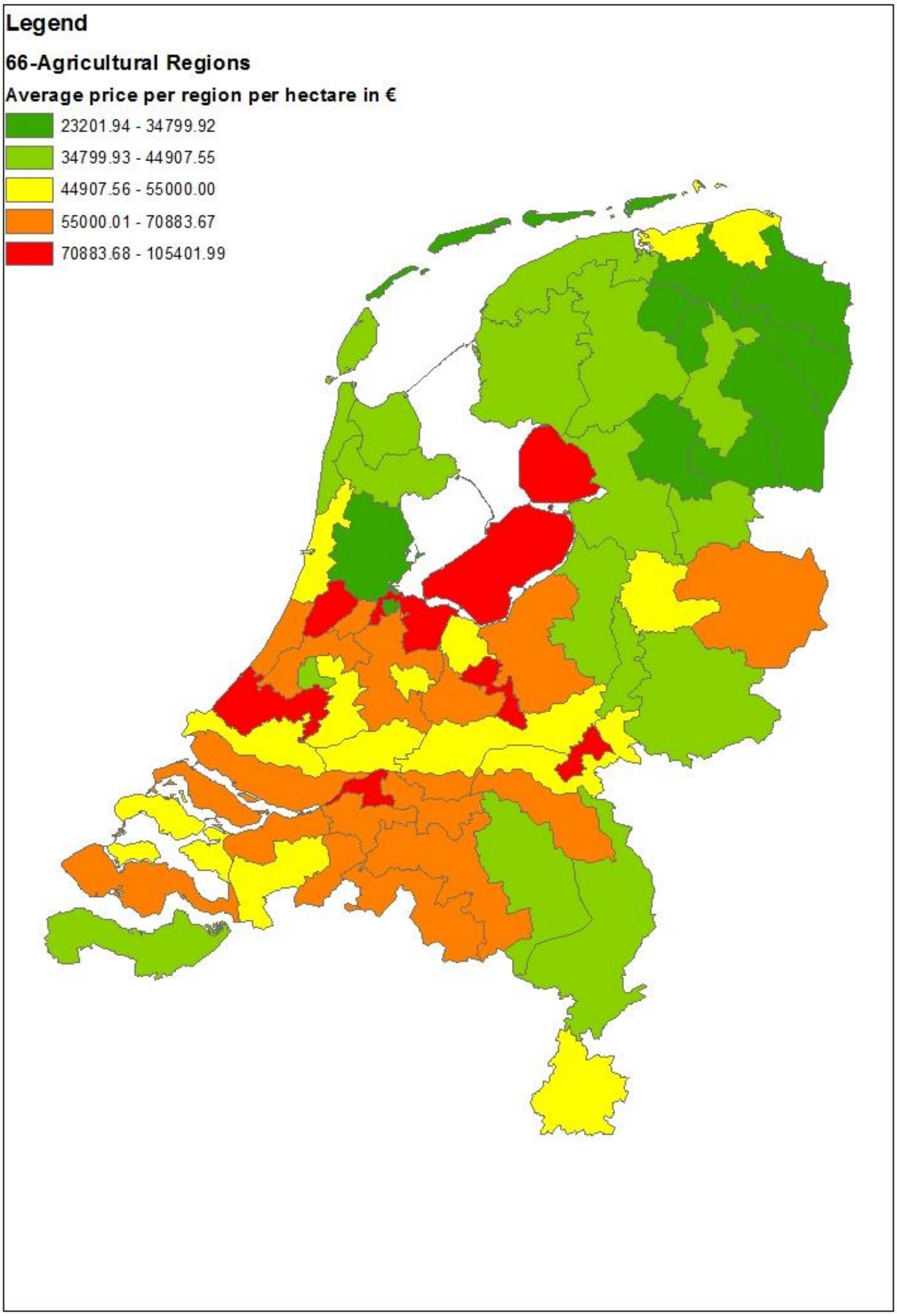

Figure 6: Average land price for each region

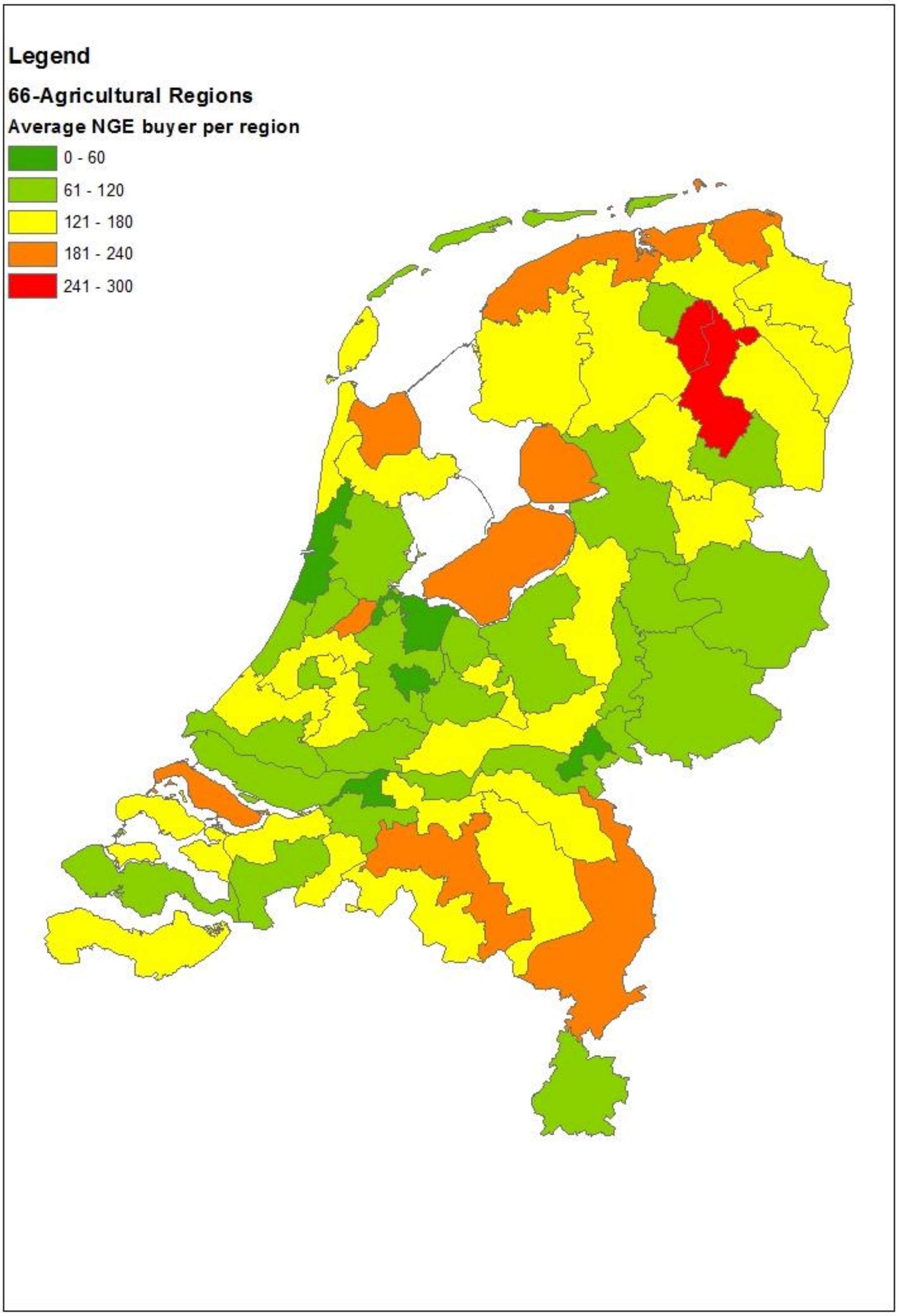

Figure 7 Average buyer's NGE for each region

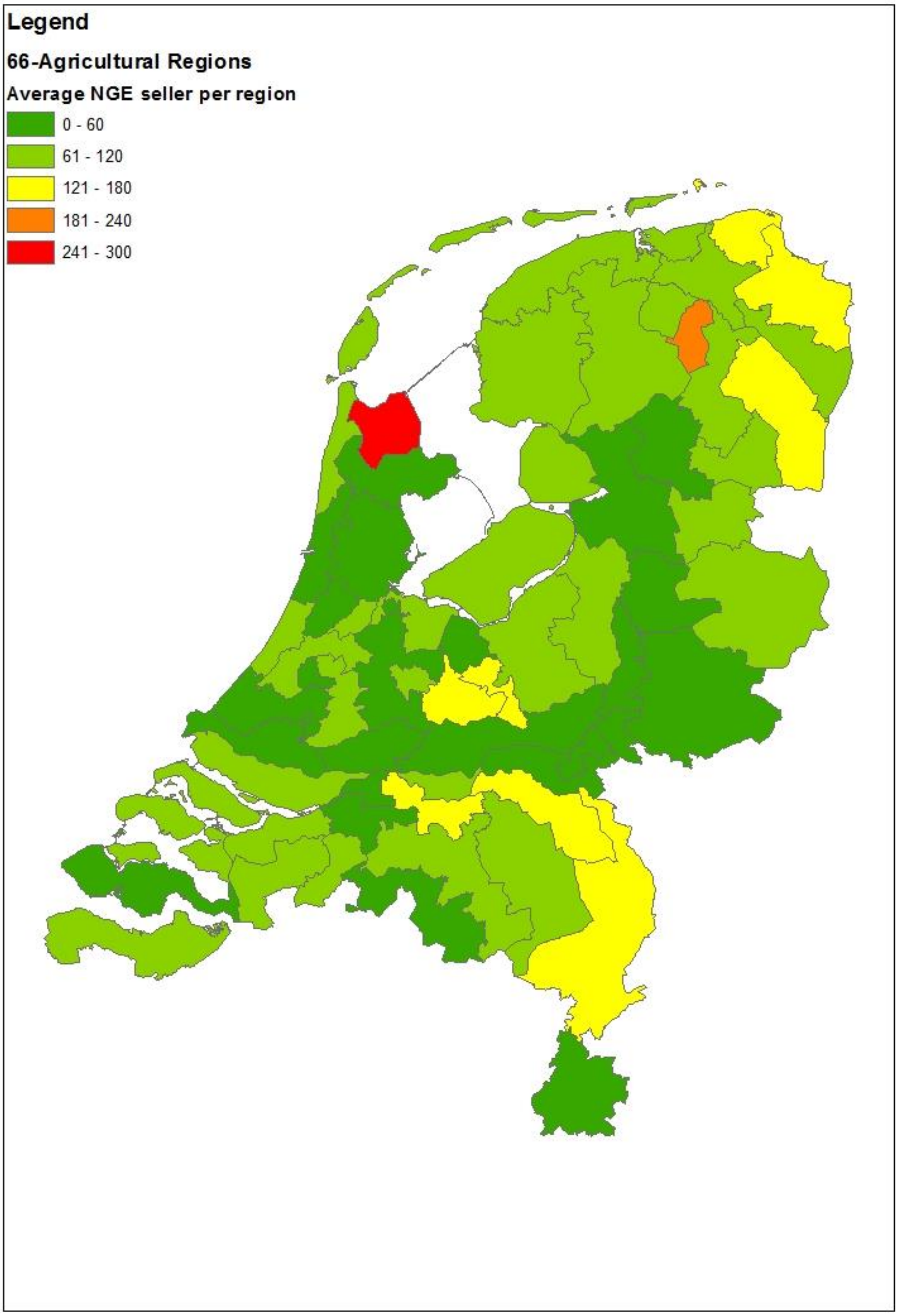

Figure 8 Average seller's NGE for each region

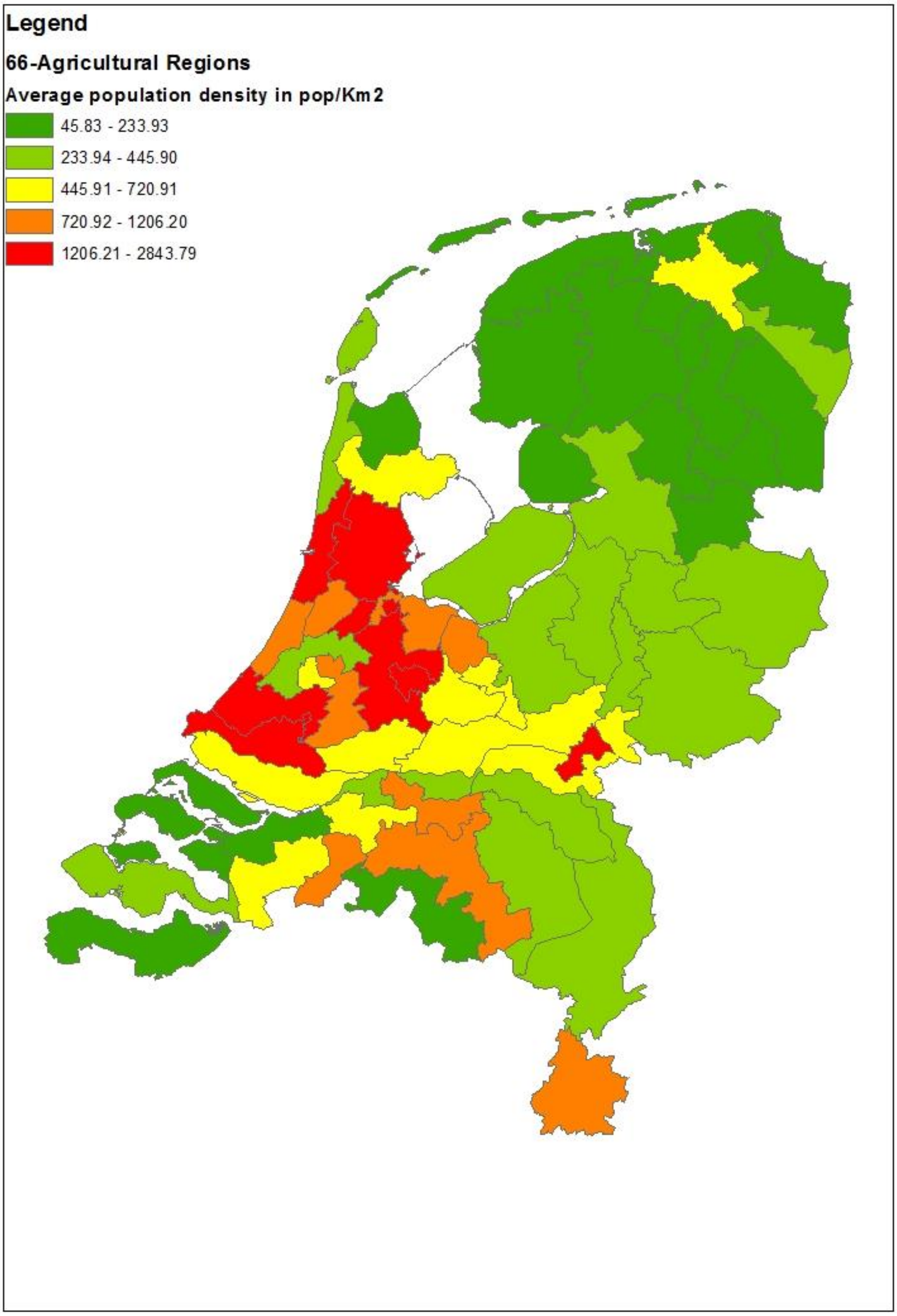

Figure 9 Average population density for each region

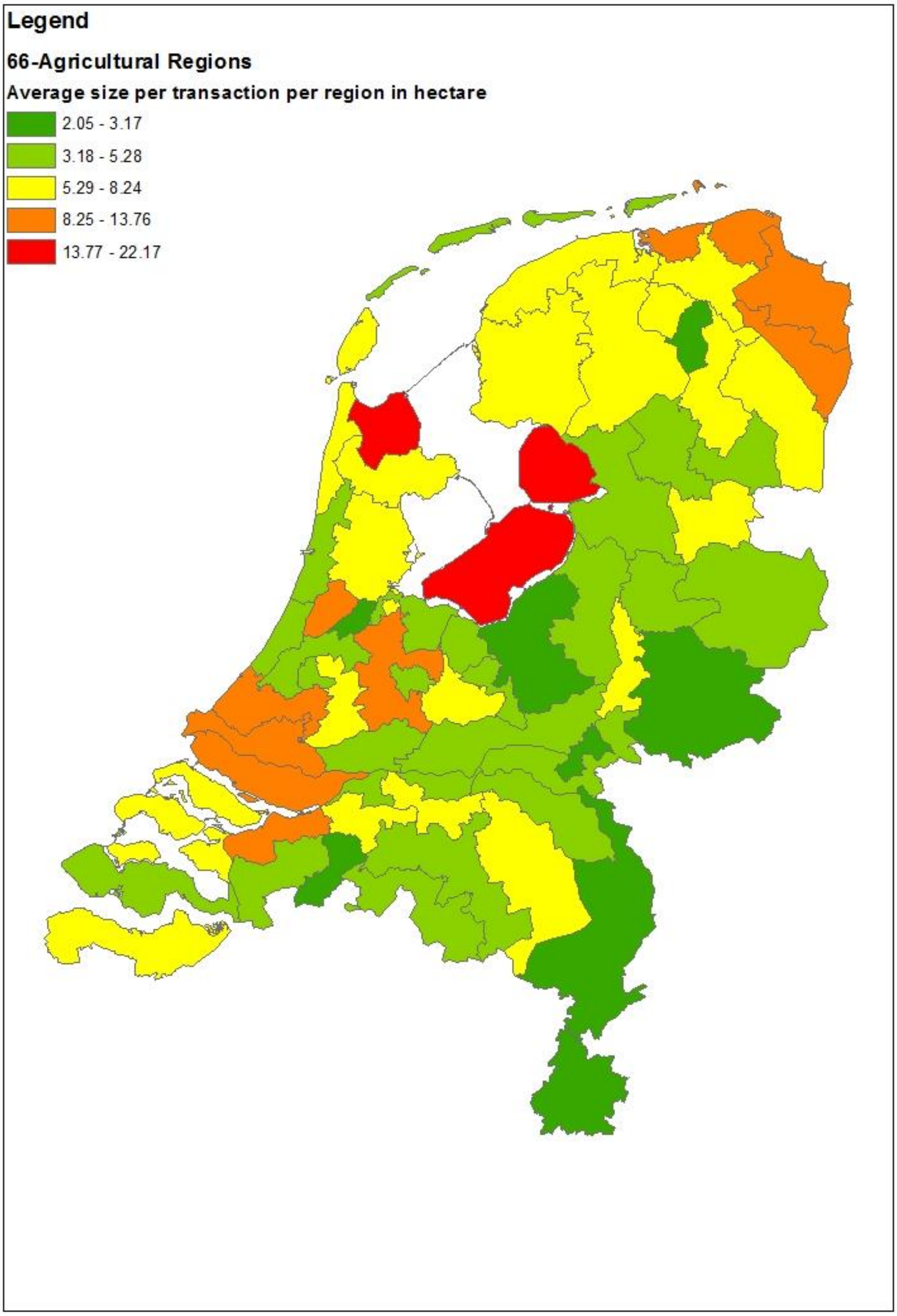

Figure 10 Average size per transaction for each region

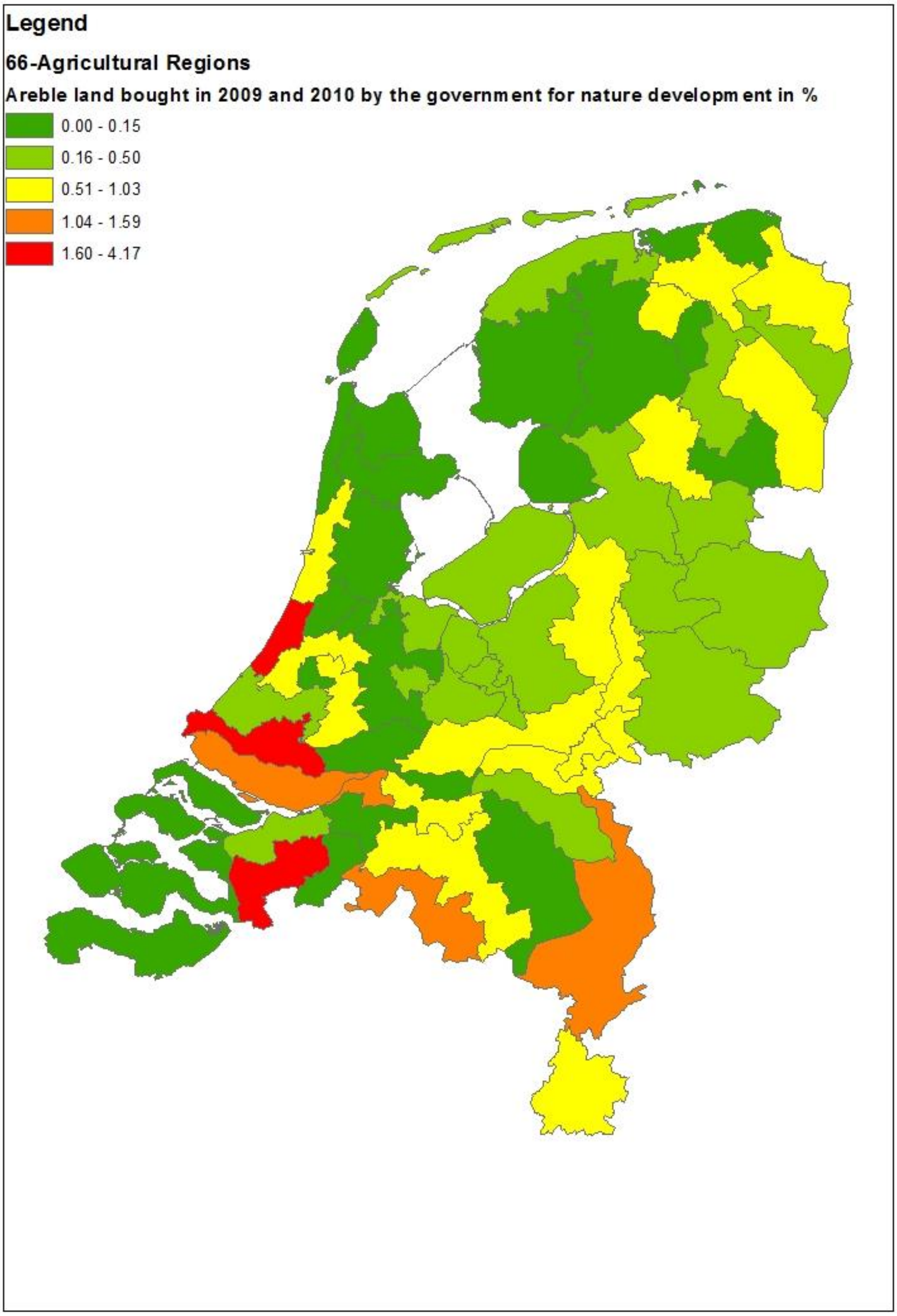

Figure 11 Average share of areble land bought for nature development for each region

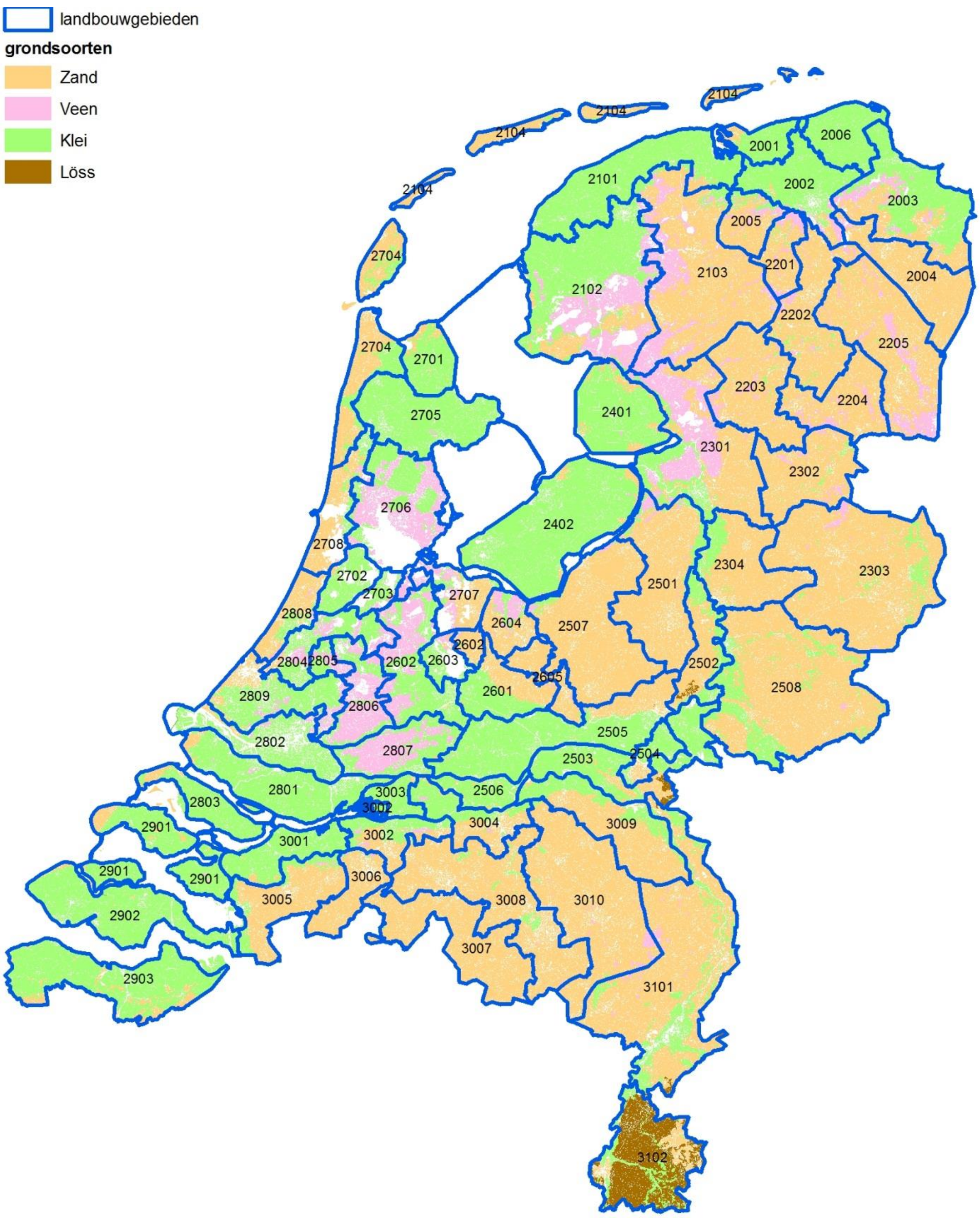

Figure 12 Soil map; Used to determine dominant soil type per region