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Determinants of agricultural land prices in Ostrobothnia Finland

- A Hedonic Pricing Approach

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Abstract

The objective of this thesis was to examine the determinants of parcel prices in Ostrobothnia, Finland. A hedonic pricing model was used to analyse 147 transactions over the years 2013, 2014 and 2015. The model consisted of 14 explanatory variables, categorized into structural and natural attributes. The results indicate that the structural variables, e.g. the size of the cropland, has a nonlinear relationship with the per hectre price of parcels. Specifically, price per hectare increases up to 9 hectares and then it begins to decline. The results also show that an increase in the distance from areas of trade lowers the price by 1% per kilometre. Furthermore, the results suggest that farm sizes in each municipality has a positive effect on the parcel prices. With respect to natural attributes, e.g. soil quality and geographical location, the estimated results reveal that the organic soils are 79.3% and moraine soils are 36.4% lower priced than fine-grained soils. The geographical results indicate a 19.9% higher price in the southern part of Ostrobothnia, compared to the middle part.

Sammanfattning

Jordbruksmarken i Österbotten är dyr, den dyra jorbruksmarken skapar hinder för nya jordbrukare att etablera sig på marknaden, samt för de existerande jordbruken att expandera sin verksamhet. Den dyra jordbruksmarken pressas bl.a. av de expanderande tätorterna. För att kunna ge indikationer på eventuella policy instrument eller riktlinjer för jordbrukare vid inköp av jordbruksmark, är det viktigt att veta vilka faktorer som driver priserna. Därför undersöker denna uppsats vilka faktorer som påverkar priset på jordbruksmark. Denna uppsats har analyserat 147 transaktioner från åren 2013, 2014 och 2015. 14 oberoende variabler inkluderades i studien. Resultaten indikerar att strukturella variabler t.ex. storleken på jordbruksmarken har ett icke-linjärt samband med priset. Priset ökar upp till 9 hektar varefter priset börjar minska. Resultaten visar också att en ökning av avståndet till handelsområden sänker priset med 1% per kilometer. Dessutom pekar resultaten på att ökade genomsnittliga gårdsstorlekar på kommunnivå, höjer priset på jordbruksmark. Resultaten erhållna av naturliga variabler, såsom jordmån indikerar att torvjordar är 79.3% billigare än finkorniga jordar och moränjordar är 36.4% lägre än de finkorniga jordarna. Resultaten visar att jordbruksmarken i de södra delarna av Österbotten är 19.9% dyrare än centrala Österbotten.

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1 Introduction

Ostrobothnia is a region in western Finland (see appendix figure 4) where the agricultural sector is an important industry. The agricultural sector makes up a large share of the labour market, which ranges from around 7% in the middle and northern part of Ostrobothnia to 11% in the southern part of the region (Ahlstedt and Niemi, 2015). Taking into account the importance of the agricultural sector in Ostrobothnia, it is necessary to be aware of the current and future challenges, which the agricultural sector may be facing, both economic and structural. Economical issues could be expressed as challenges and opportunities with profitability in the market, the structural issues could be asserted as farm expansion, or the barriers for new farmers to enter the market.

In the context of farming and land use, the price-formation of parcels has been diligently studied (Drescher et al. 2001; Bentley et al. 2015). Greenhalgh and Samarasinghe (2009) emphasize the importance of parcels because of their non-renewability. The non-renewability of parcels underlines the importance of allocating land to a valuable use, the potential usage areas could be stated as farming, residental area or recreational areas (Shi et al. 1997; Moss et al. 2008). In Ostrobothnia where the agricultural sector is important, the parcel allocation has to be stressed, the magnitude of the urban pressure is therefore important to investigate. It has been shown in many studies that the pressure from growing urban areas reallocates the parcel use from agriculture to higher valued residental and recreational usage (Moss et al. 2008; Maddison 2000).

It is also evident that the current age structure of the agricultural sector in Finland is changing, the number of farmers over 55 years has increased from 26% in 2001 to 39% in 2014 (Ahlstedt and Niemi 2015). The rise in the number of older farmers indicates a decrease in the willingness of new farmers to enter the industry, the development could also imply barriers for new farmers to enter the market. The current transformation of the agricultural sector with aging farmers, has also been noted in Ostrobothnia.

Between 2010 and 2015, the farm sizes in Ostrobothnia have increased from 36 to 46 hectares, respectively. In contrast, the total number of farms in the region has decreased from 5 699 to 4 704 farms over the same period (NLS[a], 2016; NLS[b], 2016). Such a decrease in the number of farms and increase in farm sizes depicts the magnitude of the agricultural sector growth and implys increasing demand for agricultural land in the region (Kässi et al. 2015). The increased demand for parcels, assuming the parcel quantity to be fixed, leads to a shift in the demand function and results in an increase of the prices payed for parcels (Latruffe and Le Mouël, 2009). The deduction made by Latruffe and Le Mouël (2009) may also be recognized in the Ostrobothnian case, as emphisized by Kässi et al. (2015). The price development of parcels is shown in figure 1 below.

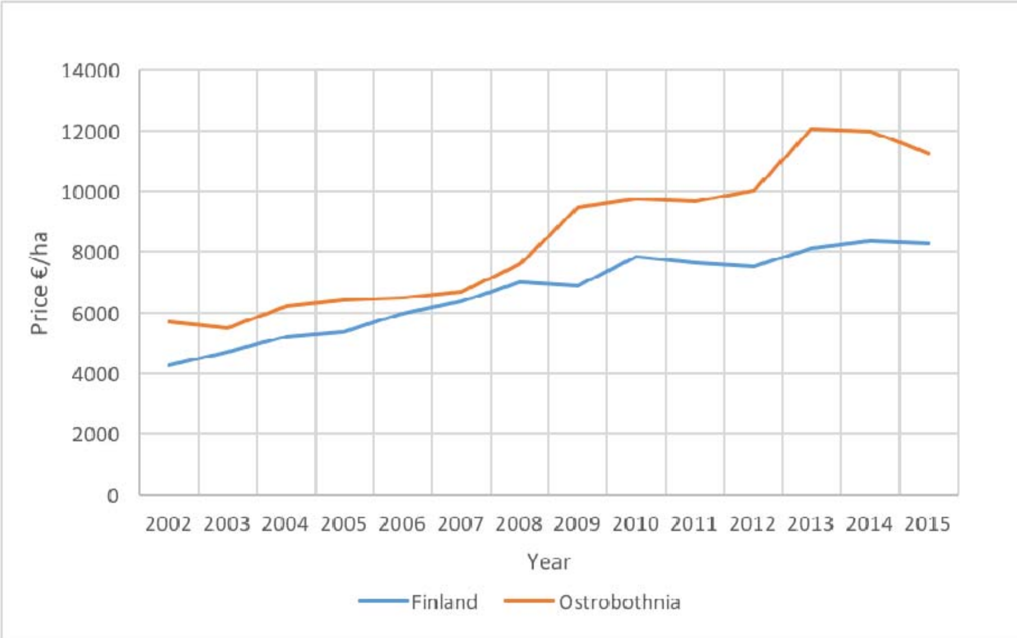

Figure 1. Parcel prices in Finland and Ostrobothnia. Source: National Resources Institute Finland (2017)

Figure 1 shows that the parcel prices in Ostrobothnia have accordingly continued to increase during the previous years. Assuming a fixed quantity of parcels, the growth of prices indicates an increase in the demand for parcels where the expanding farms demand additional parcels. The expansion of farms and transaction of parcels to active farmers is important considering the magnitude of the agricultural sector in Ostrobothnia. Regarding the increase in the price of parcels and the growth of farms in Ostrobothnia, it has been noted that the transactions of parcels to expanding farms is not flawless. Kässi et al. (2015) have highlighted the current situation regarding parcel prices in Ostrobothnia and described the phenomenon as “failure of parcel markets”. By failure of parcel markets, Kässi et al. indicates the lack of affordable parcels to the expanding farms. Taking into account the importance of the agricultural sector in Ostrobothnia, the difficulty of transferring parcels to new and growing farms is an alarming progress.

A closer look at figure 1 shows that parcel prices in Ostrobothnia have, over the period 2002–2014, been comparatively higher than the parcel prices at the national level. This fact underlines the notation that the agricultural sector is an important industy in Ostrobothnia in relation to Finland. When looking at the growth rate trend in figure 2, it is obvious that parcel prices in Ostrobothnia have experienced a notably higher volatility than in Finland as whole. For instance, when parcel prices deflated in Finland in 2008, they rose by around 25% in Ostrobothnia. The high volatility of the prices on the parcel markets point out a risk or a potential profitability opportunity, where the farmer could either gain or lose from a parcel purchase. I.e. assuming a farmer purchasing a parcel in 2010 in Ostrobothnia, the farmer could profit highly by trading the parcel again in 2012, alternatively a farmer could buy a parcel in 2012 and lose value of the parcel in 2013 and 2014.

Figure 2. Growth rate of parcel prices in Finland and Ostrobothnia based on statistics from Luke. Source: National Resources Institute Finland (2017)

It is essential to emphisize the fact, that the parcel-sales and -rental markets in Finland are hardly regulated, compared to Belgium and the Netherlands, where the regulation level is essentially higher (Swinnen et al. 2016). The low regulation rate of the parcelmarket indicates some free market functionality, where market-supply and -demand form a market-clearing price. The clearing price theory originates from Adam Smith, as he presented the concept of the "invisible hand" and the price of land is derived from the value coupled with the usage area of the land (Smith 1776). The low regulation rate of the parcel market in Finland, should be underlined if the market is compared to stricter regulated areas. The rate of regulaton could open the possibility of stricter regulations if indications of such a need should appear.

Given the socio-economic importance of agricultural production in Ostrobothnia, such high and volatile parcel-prices in recent years represent a major problem. The high and volatile prices may have substantial concequences on agricultural production and employment in the region. Policymakers need therefore to be aware of this problem and address this parcel market failure in Ostrobothnia to avoid its adverse impacts on the agricultural sector.

The objective of this paper is therefore to investigate the main factors that determine the prices of parcels in Ostrobothnia. Specifically, the research question, which this thesis seeks to answer, is stated as; "What are the determinants of parcel prices in Ostrobothnia?"

1.2 Structure

This thesis is structured as follows. The next section will present the theory of hedonic pricing; the hedonic pricing theory applied to land valuation is also described. In the next section also a review of relevant literature regarding hedonic pricing and land valuation is provided. The third section presents the methodology used for conducting the model, the variables used for the thesis including the expected outcomes are also shown. In the fourth section, the results are presented and discussed. The final section conducts a conclusion and a critical reflection including limitations with the thesis.

2 Theoretical framework

2.1 Hedonic Pricing Model

In this thesis, a hedonic pricing model was used to estimate the value of parcels in Ostrobothnia. The use of the hedonic concept was partly based on the general usage of the method, but also on the comprehensability of the method (Palmqvist, 1989; Xiao. 2017). By means of the hedonic concept, the value of parcels is easily clarified and the attributes, which contribute to the value of parcels, are clearly identified. The hedonic theory has its base in the theory of the consumer demand developed by Lancaster (1966). Lancaster showed that the characteristics of a good contribute to the demand decision, which is made by the consumer. The theoretical concept of hedonic pricing was further developed to include pricing models by Rosen (1974). Rosen has been widely cited and the theoretical framework developed by him has frequently been used when different consumer goods are valued e.g. housing prices and agricultural land valuation (Rehdanz, 2006; Ng and Wills, 2009. Feichtinger and Salhofer 2016). Rosen´s theoretical framework was used as reference in this thesis due to the theoretical framework including pricing models, which are an essential part of parcel price determination.

Rosen (1974) showed that the hedonic pricing is a reduced form of the demand and supply functions. The demand function is derived from the consumers' real marginal willingness to pay (WTP) for a certain good. The supply is similarly determined by the suppliers' real willingness to accept (WTA) payment for a certain good. In figure 3 the formation of the price is visualized, points A and B are two equilibriums formed by two different consumers and sellers. The theory is symmetrical on consumer and supplier side, therefore in this thesis a commentary was only done on the consumer part. The marginal willingness to pay and accept is based on the appreciation regarding the characteristics of a good. To point out the validifaction of the theory, Rosen introduced the following model, $p(z)=p(z_1,z_2,z_3,z_4 \ldots,z_n)$, where $p(z)$ is the price of a good and $p(z_1,z_2,z_3,z_4 \ldots,z_n)$ represents the different characteristics of the good. The bundle of characteristics forms the price; these characteristics reflect the consumers' WTP for a good.

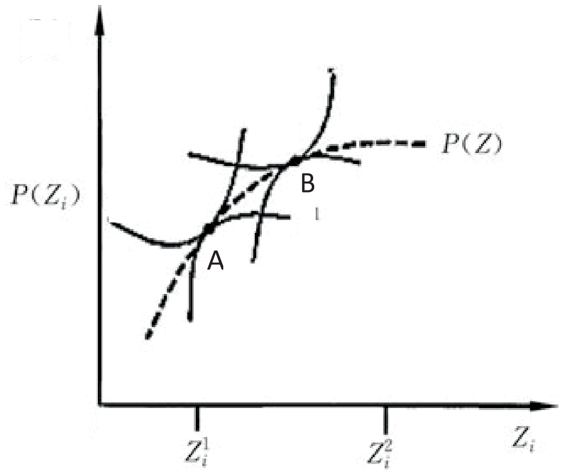

Figure 3. Market Equilibrium. Source: Follain and Jimenez (1985)

Further, Rosen (1974) showed that the consumers' decisions are based on utility maximization, where utility is a function of a vector of prices and corresponding vector of characteristics of the good. Further he presented how the consumer maximizes the utility, which is a function of the price of goods p_i and the characteristics z_i of the good $u_{max}(p_i,z_i)$ with subject to a household income restriction. The first order condition of the utility function generates the utility maximization bundle which is chosen by a utility maximizing consumer. One of the assumptions regarding the consumer utility maximisation is the asence of assymetric information i.e. the consumer makes the decisions based on perfect information (Rosen 1974). Additionally, the aggregated consumers WTP form a market demand function, which under perfect competition generates a market-clearing price (Rosen 1974). Regarding market-clearing prices, Rosen argued that if the perfect competition assumptions holds, the different market-clearing prices hold at all qualities of a certain good. The market clearing price forms a market demand and supply function shown by the P(Z) function in figure 3.

Palmqvist (1989) introduced the hedonic pricing theory to the area of parcel valuation. Utilizing the theoretical framework of hedonic pricing model developed by Rosen (1974), Palmqvist derived the consumers (farmers) WTP for parcels and expressed the price payed for parcels, as a function of the parcel attributes demanded by the farmer. Specifically, Palmqvist derived the following model for valuation of parcels, $g(x, z, \propto) = 0$, where x represents the output potential of a parcel; z represents the parcel characteristics (the focus of this thesis) and α shows the capability of the farmer. Palmqvist argues that the farmer bases his WTP on the model shown above and maximizes the utility by setting the first order utility function equal to zero.

2.2 Hedonic Pricing Critics

Even if the hedonic pricing method has its´ strength in reflecting the real WTP and WTA, there has also been some critique pointed at the hedonic pricing model, as a valid method for applied valuation of the marginal WTP. Maddison (2001) points out the assumption of equilibrium under perfect competition as a non-valid assumption. He argues that if the transaction costs of a sale form a substantial amount of the parcel sales cost the assumption does not hold. Further, it has been pointed out, that if the equilibrium condition is not satisfied, the resulting prices are biased and this results in a disequilibrium of prices (Xiao, 2010; Lee et al. 2010).

2.3 Literature review

Several studies have used the hedonic pricing approach to derive the value of agricultural land (Samarasinghe and Greenhalgh 2013; Maddison 2000). Nonetheless, it has to be noted that hedonic pricing studies on parcel prices in Finland are rare, therefore studies included in this literature review, targeting parcel prices using the hedonic pricing method have been included regardless of the locational target of the study reviewed. It is therefore important to be aware of the origin of the study reviewed and how the attributes analysed might differ and might not be generelisable to the Ostrobothnian context.

In hedonic studies, it has been found common to include the structural attributes when analysing the value of land. Structural attributes can be defined as variables, which may be altered with. The closeness to urban areas or areas of trade are examples of structural variables which have been widely used (Samarasinghe and Greenhalgh 2013; Salman et al. 2016; Fujita 2012). The common outcome of the closeness to urban area variable has been a negative relationship to the price payed, i.e. an increase in the distance to an urban area lowers the price of parcels. The negative relationship implies a pressure from expanding urban areas where the expanding areas stress a conversion of land to a more valuable usage, such as expanding recidential areas or public recreational areas (Shi et al. 1997; Drescher et al. 2001; Moss et al. 2008). The higher prices of parcels close to urban areas push the farmers further away from the areas of trade, which could in some cases be remarked as an increase in transportation costs for the farmer (Salman et al. *2016*).

Distance to roads is another structural variable, which has been frequently used. Salman et al. (2016) found a negative relationship between distance and parcel prices in Pakistan. The negative relationship underlines the importance of acessibility to the parcels and how the more distant parcels (in relation to roads) are valued lower by the buyer. Several other studies have also concluded that the road distance variable has a negative relationship with the price of parcels (Drescher et al. 2001; Bentley et al. 2015). Comparing the results from different studies it could be noted that the impact of distances to roads show a larger negative impact in Pakistan than the results indicate in e.g. Drescher et al. (2001) in Minnesota. The difference in the degree of impact could depend on the distinct difference in the infrastructural network between Pakistan's rural areas and Minnesota.

The size of parcels has been an important variable and has also been used extensively. The estimation outcomes from earlier studies differ somewhat. Pyykkönen (2005), Sengupta and Osgood (2003) and Helen et al. (2014) found a negative price relationship from the size variable. The negative size variable indicates a decrease in the price as the size increases. The negative impact of the parcel size is suggested to result from a decrease in the transction costs per unit, as the parcel size increases (Maddison 2000; Pyykkönen 2005). By transaction costs, Maddison (2000) and Pyykkönen (2005) imply the costs coupled with a purchase of land, e.g. administration fees and costs for repackaging the parcels. The size of parcels has also been found to have a nonlinear relationship with the price. Maddison (2000) found that the size has a positive relationship to a certain size after which the price starts to decline. The decline of prices after a certain size is argued to originate from the transaction costs explained above, with the distinction of the negative impact after a certain parcel size (Maddison 2000).

There are also natural variables, which are used in the literature. Natural variables are characterized by the non-alternability of the attribute. As of the importance of water for the agricultural sector, the closeness to water is a natural attribute, which is a commonly used variable. Earlier studies have concluded a negative price development due to an increase in the distance to a water source (Salman et al. 2016; Sengupta and Osgood 2003). It is notable that the study made by Salman et al. is in Pakistan. In comparison, Pyykkönen (2005) studied the parcels in Finland and found a positive relationship between the distance and the parcel prices. The difference in the results indicate a scarcity of water in the area studied in Pakistan, while water appears to be abundant in Finland.

The impact of soil quality on the price of parcels has been shown to be an important variable when estimating the hedonic price of parcels. To capture the soil quality, different approaches have been used. Samarasinghe and Greenhalgh (2013) used particle sizes to determine the soil quality. There are also national soil gradiants, which have been used (Maddison 2000; Feichtinger and Salhofer 2016). Pyykkönen (2005) used natural attributes such as yield and closeness to water from which he derived the soil quality. A comparison between studies is difficult, due to the diversity of techniques used for soil quality measurements. The diversity of soil quality estimation, probably depends on the availability of data regarding the soil characteristics. It can however be concluded that the soil characteristics have a substantial effect on the price of parcels.

There have also been different demographic variables used for explaining the value of parcels. Ng and Wills (2009) have emphasized the importance of the socio-demographic attributes. They point out the importance of the socio-demographic structure when analysing the impact of local market structures on the housing prices. By local market structure, Ng and Wills suggest e.g. the number of familymembers or the income level per household in a certain area. The same approach as Ng and Wills (2009) has also been used by Elad et al. (1994), where Elad et al. shows that the different socio-demographic attributes have an effect on the price payed for parcels. Elad et al. (1994) do not capture a clear relationship, they conclude that the socio-demographic structures have locational differences, i.e. the size of the farms or the density of the farms in different areas affect the price in different ways.

3 Methodology

3.1 Model specification.

The constructed hedonic price model in this study aimed at finding the determinants of parcel prices in Ostrobothnia in Finland. The determinants reflect which characteristics contribute to the price payed for the parcels sold. The hedonic pricing functional form is a reduced form of demand and supply. Xiao (2017) clarifies that the hedonic pricing model can be divided into four different functional forms, linear, log-linear, log-log and a box-cox transformation. He also points out that the specification of a functional form has no clear rules, but the functional form is an empirical issue and has to be modified to suite the data to be analysed. The functional form of the econometric analysis in this thesis is a log linear model which has a similar structure to the model used by Dresher et al. (2001),

$$\text{Ln}P = \beta_0 + \sum_{j=1}^{m} \beta_j X_j + \varepsilon.$$

The dependent variable LnP is the log of price per hectare and the independent variables X_j have a nonlinear impact k on the price, where k unit change in X_j would lead to a $100(exp^{k\beta_j}\text{-}1)$ unit change in P (Drescher et al. 2001). The model can be rewritten as follows:

$$\text{P} = exp^{\beta_0 + \sum_{j=1}^{m} \beta_j X_j + \varepsilon}$$

Where the implicit prices for the variables are derived through the first derivative of P with respect to the characteristic in question.

The selection of variables for this log linear structural model was mainly based on previous studies. The aim was to capture information regarding important structural, natural and demographic variables. The variable selection also targeted at defining the variables in a way that the results could point out indicators for as well farmers as policymakers in their decision process concerning parcel usage. The descriptive statistics including the expected signs are to be seen in table 1. To get a better overview of the data and what type of characters may be altered, the variables were divided similarly to Samarasinghe and Greenhalgh (2013) and Pyykkönen (2005). The variables were named structural and natural variables. The structural variables in this dataset were based on the alteration ability of the variable, i.e. the characteristics may be modified. The natural variables on the other hand consist of attributes, which may not be easily reshaped.

The dependent variable LnP is the natural logarithm of the price, the price implies euro payed per hectare. The model includes closeness to several geographical attributes; distance to nearest water source (DWAT) is a variable that is not easily changed. Thereby the variable is a natural variable. Water is also abundant in Ostrobothnia, parts of the parcels are located in the flood areas (Environment.fi 2017). Pyykkönen (2005) found that the increase in distance should have a positive impact on the price. Distance to highway (DHWY) is an alternable variable in the sense that new highways are built and the distance is thereby affected. The distance to highway is therefore counted as a structural variable. According to Drescher, et al. (2001) the increasing distance to highway should lower the price of parcels. The distance to area of trade (DAOT) has the same characteristics as highways, which indicate a structural variable. Von Thünen was the earliest known developer of the theory regarding higher prices payed for land closer to areas of trade (Fujita, 2012). Another structural variable is the size of the parcel (SZ) and size squared (SZ^2). Maddison (2009), Pyykkönen (2005) and Drescher et al. (2001) found that an increase in size contributes to a decrease in price. Based on Maddison (2009) the nonlinear relationship is studied.

Other structural variables that are included in this study attempt to capture the agricultural socio-demographic structure in Ostrobothnia. The size of the farm (HAFA) is based on the average hectare per farm in each municipality. Farm density (FADEN) is calculated by dividing the number of farms by the available land in each municipality. The information regarding HAFA and FADEN were obtained from NLS, the Natural Resources Institute Finland. The geographical partition is captured by categorical variables in the following way; southern region (DSOU), middle region (DMID) and northern region (DNOR). By means of geographical division, the local variations were intended to be captured, a similar partition was also done by Drescher et al. (2001). The regional partition is displayed in the appendix figure 5.

Table 1. Descriptive statistics and expected sign.

Variable	Median	Std. Dev.	Max	Min	Exp. Sign.
DWAT	587.28	666.81	2 787.80	17.20	+
DHWY	857.26	1 144.39	7 503.53	29.51	+
DAOT	21 060.14	12 232.60	54 824.01	1 054.13	-
SIZE	3.86	5.59	39.7	2	+
$SIZE^2$	14.90	198.85	1 576.09	4	-
HAFA	36.35	6.59	49.54	17.69	+
FADEN	0.03	0.006	0.057	0.02	+
DSOU	0	0.495	1	0	+
DMID	0	0.498	1	0	
DNOR	0	0.344	1	0	-
DORG	0	0.21	1	0	-
DCOA	0	0.26	1	0	-
DMOR	0	0.26	1	0	-
DFIN	1	0.40	1	0	

Source: NLS, National Land Survey of Finland (2017).

To capture the impact of soil quality, categorical variables were generated. The soil classification was based on the study done by Ronkainen (2012) and published by the Finnish Environment Institute. The soil characteristics were divided into fine-grained soil (DFIN), coarse (DCOA), moraine (DMOR) and organic (DORG). DFIN consists mainly of clay, where more than 50 percent of the grains are equal or smaller than 0.06 mm, DCOA consist of less than 50% grains smaller than 0.06 mm. DMOR is a mixture of different grain sizes. DORG has more than 20% of its soil weight consisting of organic substance (Ronkainen 2012.) A similar soil partition made by Ronkainen could be visualized in the maps obtained from the Geological Institute of Finland (GTK).

It is notable that the distance to area of trade varies significantly, as the closest parcel is located just above 1 kilometer from an area of trade, while the most distant parcel is located over 54 kilometers from an area of trade. The high variation of the distance shows that there is agricultural activity spread over a large area. Regarding the size variable, a high variation could also be identified. The size ranges from 2 hectares to 39.7 hectares. The median is however only 3.86 hectares, which implies a large number of smaller parcels.

3.2 Data and data sources

This study has a quantitative approach, where price data including coordinates regarding each parcel sold in Ostrobothnia in the years 2013, 2014 and 2015 were included. The data was acquired from the National Land Survey of Finland (NLS). As this data is not publicly available, price and locational information was purchased from the NLS under the contract number (Maanmittauslaitos lupanro 51/MML/17). As per the contract, it should be highlighted that this data was deleted after the completion of the analyses.

The obtained price data was in nominal prices; hence, the prices were adjusted for inflation using 2015 real prices. Information regarding soil quality and trade area maps were obtained from the Geological Survey of Finland (GTK), water resource information was acquired from Finnish Environment Institute (SYKE) and the road information was collected from the Finnish Transport Agency. The information collected from authorities was dealt with by means of Geographical Information System (GIS).

After acquiring the data from GIS, an OLS analysis was computed using R programming language. The OLS approach encountered heteroscedasticity problems, therefore a weighted least square regression was used. The size variable caused the heteroscedasticity problems and was therefore used as the weighted explanatory variable.

The reason for the subsume data from the years 2013, 2014 and 2015 is the small number of transactions each year as shown in table 2. Based on a discussion with the supervisor of this thesis, the combination of three years was considered a sufficient number of transactions for the purpose of the econometric analysis. Another reason for including data from these three years is the expenditure for accessing enough data by minimal cost, since the data had to be purchased from the NLS.

Table 2. Number of sales and quantity sold in the years studied.

Year	Number of sales	Total area, ha	Average size, ha
2013	39	220.07	5.64
2014	64	347.16	5.42
2015	44	242.25	5.63

Source: NLS, National Land Survey of Finland (2017).

In table 2, an overview regarding the data is displayed. It is observable that the average size of the parcels sold is around 5.5 hectares. Comparing this average with the maximum parcel size of almost 40 hectares, as outlined in table 2, it can be concluded that the bulk parcels are small-sized. The data analysed include only cropland parcels with no forest areas attached to the transactions.

4 Results and Discussion

To check the multicollinearity in the regression results, a Variance Inflation Factor (VIF) test was performed and the results are shown in table 4 in the appendix. No multicollinearity problems were detected. The Breusch Pagan test was carried out to check for heteroscedasticity (see table 3) and the results indicate the absence of heteroscedasticity. The adjusted R^2 shows a relatively good fit, with an expalanatory degree of 66.1%. It is also notable that the significant intercept implies the absence of important variables. It is remarked that the influence of more important variables might have an effect on the outcome of the model.

Table 3 Regression results. (Size used as the weighted variable)

Variable	Coefficient	T-statistic	P-Value
Intercept	8.295 ***	21.29	7.74e-45
DWAT	0.002	0.529	0.597
DHWY	-0.006	1.123	0.263
DAOT	-0.001 ***	-2.997	0.003
SIZE	0.057 ***	4.180	4.64e-09
$SIZE^2$	-0.003 ***	-7.499	7.94e-12
HAFA	0.020 ***	2.792	0.006
FADEN	4.548	0.632	0.529
DSOU	0.199 **	2.234	0.027
DMID			
DNOR	0.145	1.382	0.169
DORG	-0.793 ***	-6.269	4.64e-09
DCOA	0.147	1.418	0.159
DMOR	-0.364 **	-2.552	0.012
DFIN			
Number of transactions			147
Adjusted R^2			0.661
F-Statistic			37.40
P-Value			2.2e-16
Breusch pagan test for heteroscedasticity			0.17

'***' shows statistical significance at 1 percent level, '**' shows statistical significance at 5 percent level and '*' shows statistical significance at 10 percent level.

The SIZE variable has a non-linear relationship presented by $0.057X - 0.003X^2$, which indicates that the price of parcels increases up to 9 hectares, after which the price starts decreasing. E.g. Pyykkönen (2005); Drescher et al. (2001); Elad et al. (1994) and Maddison (2005) have identified a similar relationship. The decrease in the price after 9 hectares has been suggested to be caused by the decrease in the transaction costs per hectare, i.e. as the parcel-size increases, the transaction costs are divided on a larger amount of hectares. Eventhough the size parameter was statistically significant, the results have to be interpreted with caution. The results show that parcels larger than 19 ha are lower priced than 2 ha parcels. In addition, as the parcel size increases, the price drops substantially and parcels exceeding 30 ha are very low priced. The low prices could be biased by the small amount of larger parcels. The number of parcels above 10 ha only counted to 15 and just two parcels were over 30 ha. The small number of larger parcels indicate a problem with the obtained results. The parcels exceeding 30 ha: s could be interpreted as outliers and should therefore have been excluded. The observed large parcel bias indicates that the nonlinear relationship cannot be deducted. The bias caused by the lack of larger parcels could be improved by expanding the sample size, where a larger amount of larger parcels are included.

The significant results regarding the area of trade DAOT indicate a decrease in the parcel prices by 1% per increased km from an area of trade. The obtained results in this thesis correspond to the theory developed by von Thünen (Fujita 2012), more recent empirical studies have verified the relationship (Samarsinghe et al. 2009; Drescher et al. 2001). The results could indicate that there is some increased pressure on the parcels located closer to the areas of trade. The reason could be an increased demand for land convertion to residential use or other construction purposes. Moss and Schmitz (2008) discuss the conversion of urban areas to recreational public goods, in form of e.g. parks. Which increases the demand for parcels located closer to areas of trade. Because of the increased prices closer to areas of trade, the farmers are pushed further away from the market, which leads to increased transportation distances. Therefore, the transportation costs also increase, which could be reflected in the profitability of the farm.

The farm-size variable HAFA shows an increase of 2% in the parcel price due to an increase of the farm-size by one hectare. The results underline the statement from the introduction of this thesis, whereas the larger farm-sizes result in larger difficulties when acquiering affordable parcels. Additionally, the increasing farmsizes may create even higher barriers for new farmers to enter the market. Furthermore, the barriers of market entrance could result in an aging farming industry. The aging farmers have been a widely discussed issue and the solution to the problem is not straightforward (Ahlstedt and Niemi, 2015). It would be possible from a policy perspective to support the rejuvenation of the industry through subsidising generational-transitions. The suggested action could make the renwability of the industry easier and the trend with aging farmers could be turned. However, it is important to remark that the causal relationship between larger farms and higher parcel prices in all municipalities is not clear. The simple fact that farms tend to cluster around fertile soils, could result in larger farms around areas, which are more suitable for farming. This is why it is not possible to conclude a causal relationship between larger farms and higher parcel prices on a generalized Ostrobothnian municipality level.

The geographical dummy variables point out a 19.9% higher price in the southern part of Ostrobothnia (DSOU) in relation to the middle part. The reason for the outcome of this result could partly be explained by the importance of the agricultural sector in the southern region, the share of population working in the agricultural sector make up for over 11 percent, which is the highest share in Finland (Ahlstedt and Niemi, 2015). The result of the higher prices in the southern part strengthens the difficulty of the renewability of the farms in the southern part additionally, compared to the middle part. It is also possible that the southern part of Ostrobothnia has a soilquality which is higher valued than the typical soil quality in the middle part, this could however not be concluded in this thesis.

The variables controlling the soil quality, (DFIN, DCOA, DMOR and DORG) where DFIN was used as the reference soil because it had the largest amount of observations. The results show that in relation to DFIN, the DMOR parcels are 36.4% cheaper. The results were in line with Eurofins Viljavuuspalvelu (2008), where the DMOR soils are substantially less fertile than DFIN. When it comes to DORG the results presented an even lower price than DMOR, the magnitude of this coefficient was substantial 79.3%. Eventhough the results show a large difference in price, the results are verified by the soil analysis made by Eurofins Viljavuuspalvelu (2008). They describe the qualities of the DORG soil as substantially less suitable for farming than other types of soils. Even though the soils are not beneficial farming soils, the soils are still used for farming. The higher price payed for the DMOR soils in relation to the DORG may also indicate possible alternative usage areas for this soil type. According to Ronkainen (2012), the DMOR soils are more solid with larger grainsize. This fact could suggest that the soils might be suitable for e.g. for residental usage, other construction purpose or forestry.

5 Conclusions

In this thesis, a hedonic pricing analysis was carried out to identify the determinants of parcel prices in the Ostrobothnia region of Finland. To this end, data on parcels transactions in Ostrobothnia region during the years 2013, 2014 and 2015 were used. The number of transactions studied were 147 and the size of the parcels varied from two hectares to nearly 40 hectares. Determinants used were both structural and natural variables, some demographic variables were also included. The size of the parcel was a significant structural variable. Out of the demographic variables, farmsize showed a significant relationship with parcel price. Of the natural variables, soil qualitites DMOR and DORG were significant. In addition, the locational attribute DSOU turned out to be statistically significant.

Eventhough some results in this hedonic pricing analysis may be questioned, as the nonlinear relationship with the parcel-size and the farm-size, there are interesting facts, which could be raised. The decreasing prices further away from areas of trade is noteworthy. The policymakers encounter the issue, when the consideration regarding usage-areas for parcels located near areas of trade is dealt with. The policymakers have to weigh the values added by different usage possibilities of the parcels. Additionally, the policymakers have to be aware of the issue emphasized in this thesis regarding the non-renewability of the parcels. In an area like Ostrobothnia, where the agricultural sector is of great importance from an employment point of view, the additional costs that the farmers encounter, due to longer transportations, could have a negative impact on the regional employment of Ostrobothnia. The alternative use of parcels close to areas of trade could on the other hand generate new places of employment, which could be beneficial for the society. The essence of the results is however that the policymakers are obliged to be aware of the potential impact, which a conversion of a parcel could have. The farmers' perspective should be considered when decisions concerning parcel usage are done.

Eventhough the farmsize-price causal relationship could not be deducted with certainty. It could be argued, assuming that farms cluster near fertile soils that in fertile agricultural areas, the barriers for new farmers to enter the agricultural market is higher than in less fertile areas. Again, taking into account the importance of the agricultural sector in Ostrobothnia, continuation of farming is an important issue. The low regulation rate of the parcel market in Finland, which was emphisized in the introduction, could give some potential opportunities to correct the market failure. In addition, the fact that the prices in the southern region are clearly higher than in the middle part, imply that the barriers for new farmers to enter the market are higher compared to the middle region. Taking into account the importance of the agricultural sector from an imployment point of view. The effect from higher prices could have several consequences, such as issues concerning rejuvination of the farming industry and difficulties for expanding farms to acquire additional parcels. Because of the stated fact, it is important for the policymakers to comprehend the extent of the parcel-price problem in the southern region. In addition, it is important for policy makers to acknowledge the situation, when policy decisions concerning the agricultural sector and the parcel market are made.

Finally, the fact that soil-quality has a considerable impact on the determination of parcel prices, could give new farmers opportunities to purchase more affordable soils. The lower priced soils come with a compromise regarding the soil fertility and could lower the yield, compared to higher quality soils, such as fine-grained soils. The presented evidence concerning the impact of soil-qualities, also gives indications regarding the importance of accounting for soil-quality, when alternative usage of parcels is considered. Emphisizing the non-renewability of parcels and soils, it is important to allocate parcels to usage areas in a sustainable manner.

5.1 Limitations

The correlation between subsidies and parcel prices has been widely studied and the impact of subsidies has been shown to have a substantial impact on the prices of parcels (Feichtinger and Salhofer 2011; Góral and Kulawik 2015; Latruffe et al. 2013). The exclusion of the subsidies therefore consctructed a potential limitation of the results. It was however not possible in the frame of this project to collect the information regarding the subsidies coupled with the parcels.

It has to be noted that the number of parcels analysed in this study is smaller than the usual number of sales used in studies relating to parcel prices e.g. Yukoner (2005) used 6 511 transactions and Drescher et al. (2001) used 620 and 1 699 observations. The small number of sales created a limitation in form of not reflecting the true value of the different attributes, e.g. the parcel size, as discussed earlier. It has however not been possible to acquire a larger sample, due to the financial restriction in form of the expenses for acquiring the data from NLS.

Eventhough, the results in this thesis show several significant outcomes, there are important variables missing, which could reflect the implicit marginal prices of parcels more accurately. Therefore, the presented results should be interpreted with caution. Due to the imperfect results of this thesis, a further development including subsidies could be a potential future study. Future work could also be performed through the includence of spatial dependencies between the performed parcel transactions.

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Appendix

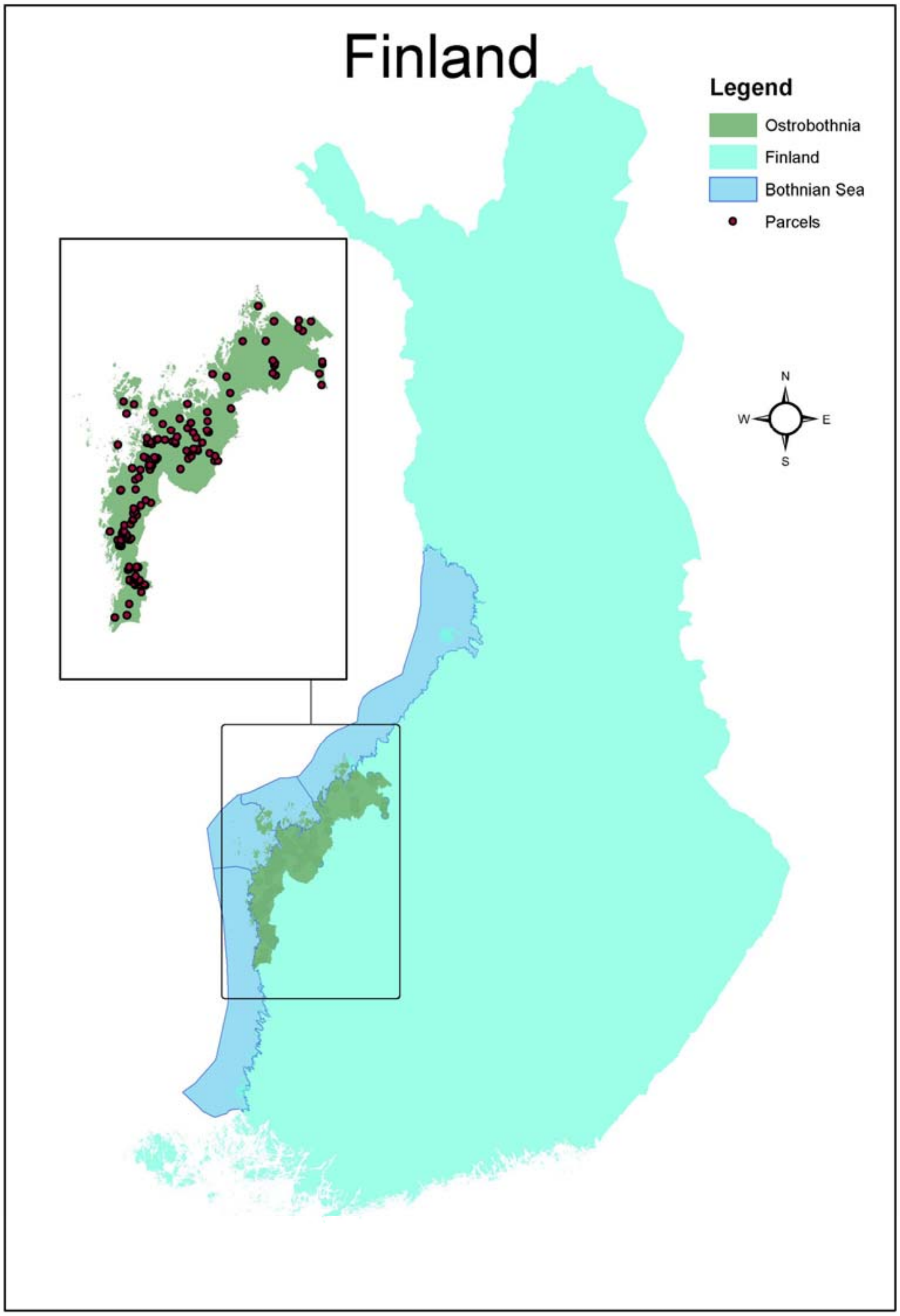

Figure 4. Finland and Ostrobothnia including the parcels.
Created by: Dahlvik (2017), based on Data from NLS, National Survey of Finland, (c) Maanmittauslaitos lupanro 51/MML/17

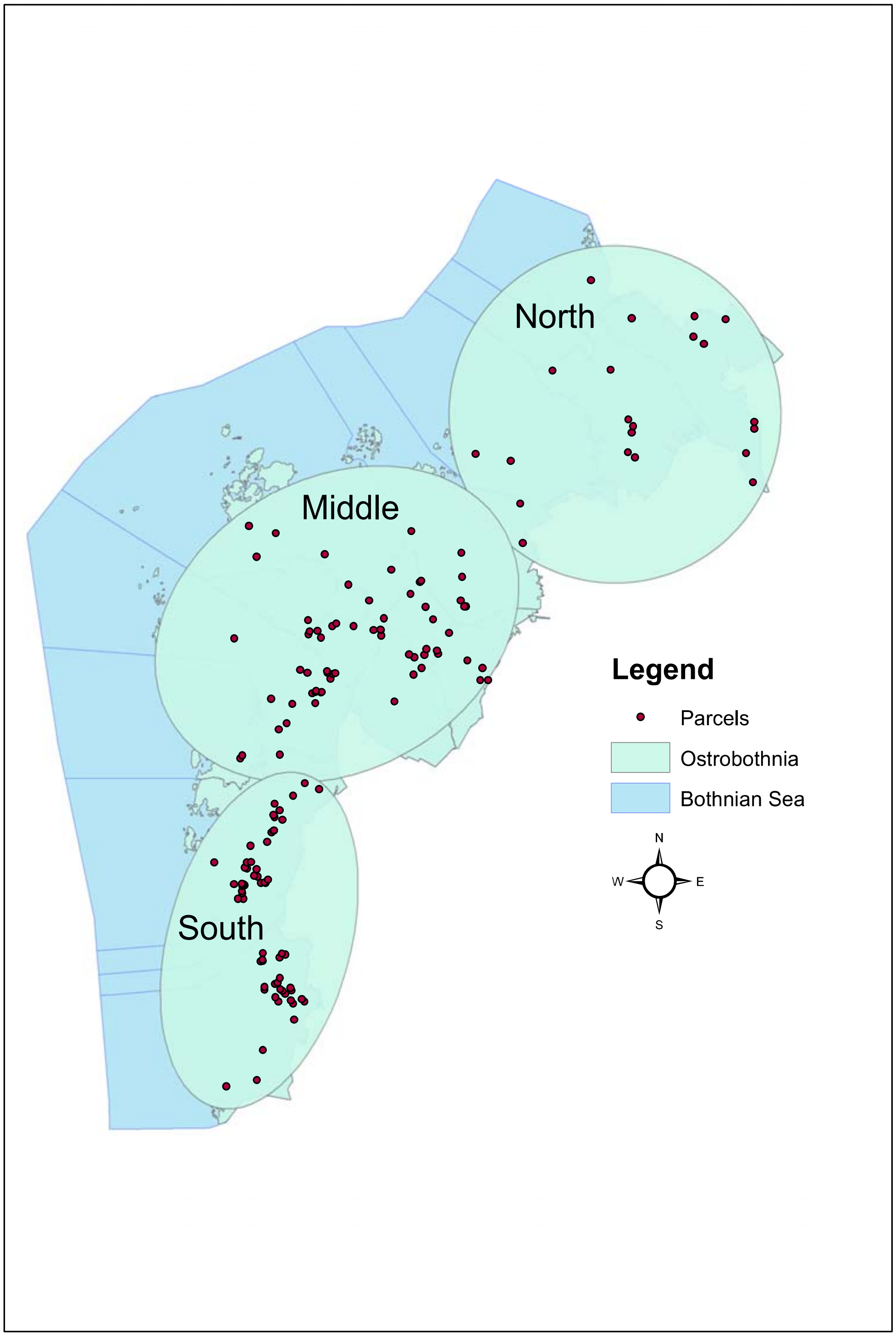

Figure 5. Ostrobothnian areas South, Middle and North, including parcels.
Created by: Dahlvik (2017), based on data from NLS, National Survey of Finland, (c) Maanmittauslaitos lupanro 51/MML/17

Table 4. VIF (Variance of inflation)

VARIABLBE	VIF
DWAT	1.173
DHWY	1.094
DAOT	1.825
SIZE	10.280
$SIZE^2$	10.021
HAFA	2.592
FADEN	1.499
DSOU	1.890
DNOR	1.649
DCOA	1.351
DMOR	1.160
DORG	1.367