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Swedish University of Agricultural Sciences

Department of Economics

Capitalising of Agricultural Support in Higher Land Price

– A study on how CAP affects agricultural land price in Sweden

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Abstract

This thesis aims to investigate to which extent EU: s decoupled direct payments to farmers capitalise in higher prices of agricultural land during 2003-2016 and how the capitalisation degree changes at the same time. To do so, it combines the traditional net present method with a hedonic pricing model, in order to evaluate the capitalising degree of different agricultural support forms. Quantile, OLS and panel data regressions are used to determine the correlation between the explanatory variables and the dependent variable (the price of agricultural land). The used explanatory variables are supposed to capture how the structure and profitability of the agricultural sector, localisation of the agricultural land, agricultural support and demand of agricultural land for other usage than agriculture influence the price of agricultural land.

The study finds that if the decoupled direct payments increase by one % in a median municipality that is correlated with a price of agricultural land that is 0.54-0.77 % higher, *ceteris paribus*. The result is in line with previous research in the field, especially with Johansson & Nilsson (2012) and Kilian et al., (2012). The regressions on the higher and lower percentiles may indicate that the capitalising degree is higher in municipalities with higher prices on agricultural land.

The common agricultural policy, CAP, EU: s agricultural policy, determine regulations and the rules for agricultural support. In 2013, the CAP was reformed, and several policies was changed, but how the combination of these policy changes affect the capitalising degree was not known at that time. This study finds out that the 2013 CAP reform may have led to a decrease in the capitalising degree, from an estimated effect on 0.5 % to around 0.2 %. However, the reform was not fully implemented until 2016, and therefore should the results be carefully handled.

Keywords: Common Agricultural Policy, the price of agricultural land, capitalising of agricultural support, Quantile regression, Panel data regression

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Abbreviations

CAP – Common Agricultural Policy
EU – the European Union
LFA – Less Favoured Areas
MS – Member states
SBA – Swedish Board of Agriculture
SFP – Single Farm Payments
SPS – Single Payments Scheme
UAA – Utilised Agricultural Area
OLS – Ordinary Least Square

1 Introduction

The background for the thesis, the problem description and the research questions are laid out in this chapter. In addition to that, delimitations and the aim for the thesis are described.

1.1 Problem background

Since Sweden joined the European Union (EU) in 1995, the price of agricultural land has increased by a factor of more than 6. The average price per hectare of arable land in 2016 was 75 000 SEK and 28 000 SEK for pasture, which over ten years gives an increase in nominal terms on 91 % and 56 %, respectively (Statens Jordbruksverk, 2017).

The average price of agricultural land differs widely in Sweden. The most fertile land in the southern parts of Sweden had a price of 180 000 SEK/ha in 2015, 80 000 SEK/ha more than in the second most expensive region. The average price of agricultural land in the northern parts of Sweden was at the same time 15 000 SEK (Statens Jordbruksverk, 2017).

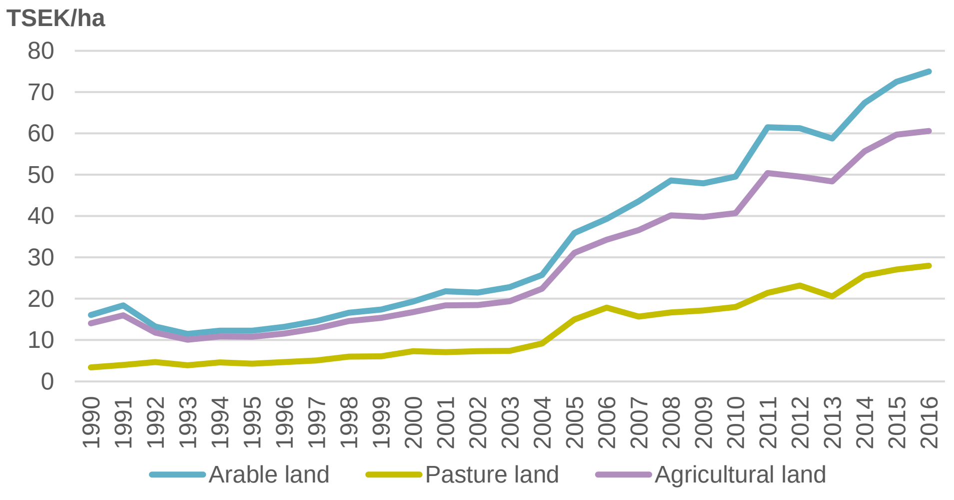

Figure 1. The average price of agricultural land. Source: SBA, own processing.

The average price per hectare is, however, probably higher than what the official statistic says. The Swedish Board of Agricultural (SBA) underestimate the price on arable land by 6-25 % and by 1-15 % for pasture. These underestimations occur since the statistic only include property transfers and not property regulations. Due to favourable tax regulations, property regulations often have a higher price per hectare and concern larger purchases (Statens Jordbruksverk, 2017). According to LRF Konsult, the average price for arable land was 125 000 SEK per hectare in 2016 (LRF Konsult, 2018), while the official statistic states 75 000 SEK per hectare.

Figure 2 is an index over the average price of agricultural land, income from agricultural activity and tenancy prices in Sweden. As can be seen, these three variables had the same development until 2004, when the price of agricultural land started to increase in a much higher pace. Since farmers pay the land rent with income from agriculture, the income from agricultural is closely connected with the tenancy price. The price of agricultural land can on the other hand depend on more factors than just the profitability since it can be viewed as an asset (Swinnen et al., 2013).

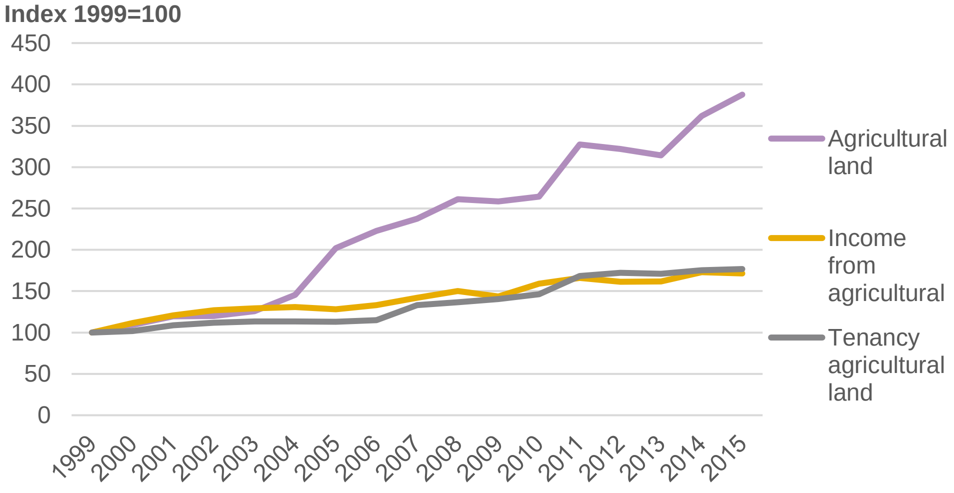

Figure 2. Price index over land price, income and tenancy price. Source: SBA, own processing.

Increased prices on agricultural land are beneficial for farmers that own the land they cultivate, but harmful for tenants (Johansson & Nilsson, 2012; Kilian et al., 2012). It is also negative for young farmers that want to buy land and start their career (Swinnen et al., 2008). Furthermore, high price on agricultural land decrease the speed of the structure rationalisation and decrease the growth in the sector since it increases the cost for farms to expand. On the other hand, high price on land force farmers to be more effective, regarding cost-efficiency and yield levels (Jordbruksverket, 2007; Johansson & Nilsson, 2012; Kilian et al., 2012).

EU: s agricultural policy, Common Agricultural Policy, CAP, provide substantial support to farmers within the union. The main support comes in forms of decoupled direct payments, a support system where farmers receive support in relation to the hectare size they cultivate. In the 2013 CAP reform, the model for how to calculate the decoupled direct payments was modified, from a historical/hybrid model to a regional model. Previously, support level could be based on both the number of hectares cultivated and historical numbers over the production and profitability, resulting in different payments per hectare among farmers. Between 2015 – 2020, Sweden will harmonise the support levels, with the result that the direct payments per hectare are equal for all farmers 2020 (Larsson, 2014).

Swedish governments have always, regardless of its political orientation, advocated for a reformed CAP. The goal has been a smaller budget, less trade-distorting policies and a more market based agricultural sector. A major criticism towards CAP from the Swedish government has been against the direct payments. Sweden argues that the direct payments increase the price of land, since the payments are capitalised in higher land value, which counteracts with the aim of a more market-orientated CAP (Elgström & Rosén Sundström, 2016).

The subject if, and how, agricultural support capitalise in higher land prices and land value has been widely discussed in the literature, e.g. Rosen, (1974); Pope et al., (1979); Burt, (1986); Palmquist, (1989); Weersink et al., (1999); Goodwin et al., (2003); Swinnen et al., (2008); Johansson & Nilsson, (2012); Swinnen et al., (2013) and Ciaian et al., (2014). A Swedish study by Johansson & Nilsson (2012) concludes that the price of agriculture land is on average 0.6 % higher in municipalities with 1 % higher direct payments. No study has however investigated how the direct payments affect the capitalising degree in Europe over several years or over a policy shift.

The modified model, introduced in the 2013 CAP reform, on how to calculate the level of the decoupled direct payments will, according to Kilian et al., (2012) and Swinnen et al., (2013), increase the amount of agricultural support that is capitalised in land values. The harmonisation of the support level will increase the demand for land on the margin, and since land prices and land rents are decided on the margin, capitalising will increase.

Other policy changes in the 2013 CAP reform, on the other hand, have a negative effect on the capitalising degree and will, therefore, be able to counterbalance the effect of the harmonisation (Ciaian et al, 2014). These policy changes are:

- A new greening support that introduces more climate and environmentally beneficial practices, such as crop diversification, maintenance of permanent grassland and ecological focus areas. Due to a more extensive regulatory framework may the greening support lead to a reduction in land productivity and profitability, and hence in lower bids on farmland. If the greening support rules are violated, a farmer can lose up to 30 % of the decoupled direct payments.

- A differentiation of support between farmers (extra payments to young farmers, for example), which will increase the variance in support level, leading to a decrease in demand for land on the margin.

1.2 Problem

It is, given the above considerations, i.e the increased landprices, the 2013 CAP-reform and the argument from the Swedish government, that agricultural support, mainly the decoupled direct payments, increase the price on agricultural land, interesting to investigate how the capitalising degree have changed over time. The research questions for this thesis are, therefore:

- *To which extent is EU' s agricultural support within the CAP, especially looking at the decoupled direct payments, capitalised in agricultural land prices in Sweden during 2003 – 2016 and how does the capitalising degree change over the same time, particularly after the 2013 CAP reform?*

The research questions are answered by a combination of the traditional capitalisation model and a hedonic pricing model. Conventional (mean) and quantile regressions will determine how the agricultural support affects the price of agricultural land. Also, a panel data regression for the years 2005, 2007, 2009, 2011 and 2013 is performed to investigate the overall effect that agricultural support has on the price of agricultural land.

1.3 Aim and delimitations

This thesis aims to investigate how agricultural support capitalises in agricultural land prices in Sweden and how the degree of capitalisation changes over time. Swedish data on agricultural land prices for the years 2003, 2005, 2007, 2009, 2011, 2013 and 2016 and variables that affect the price of land will be used for answering the research questions.

In the investigation, pasture and arable land will be treated as agricultural land. Combining these two types of land is not the best option since the two types of land have different prices, but it is necessary since the dataset used cannot isolate the capitalisation effect on one single type of land.

Also, municipalities were agricultural land stands for less than two percent of the total area are excluded from the dataset. The exclusion of this municipalities is made since data from these municipalities would be based on few market transactions.

1.4 Disposition

Chapter 1 provides necessary knowledge about the prices on agricultural land in Sweden, the CAP and introduces the problem and research questions. Chapter 2 builds the theoretical framework and provides a literature review of factors that influence the price of agricultural land and earlier research on capitalising of support. The empirical framework is presented in chapter 3, where the method is developed together with the theoretical ground for how to estimate the value of land. Also, the data and regressions coefficients are described. The result of the study is presented in chapter 4 and discussed and analysed in chapter 5. Chapter 6 includes conclusions and suggestions for further research.

1.5 Contribution

This thesis will contribute with new knowledge on how EU: s direct payments capitalise in land value in Sweden and how the degree of capitalisation change over time and over policy changes.

2 Theoretical framework

The theoretical framework focus on the development of EU: s agricultural support scheme while the literature review study factors affecting agricultural land price and how agricultural support are capitalised in land value.

2.1 The Common Agricultural Policy

The MacSharry reform (1992) of EU: s Common Agricultural Policy introduced a new form of support to the farmers in the union, namely the coupled direct payments. Instead of a price support policy, where EU intervened and bought commodities every time the market price went under a threshold, farmers now began to receive support based on the number of animals the farmer had and the number of hectares the farmer cultivated. The coupled direct payments were less production-driving than the intervention policy, but trade and market decisions were still affected since the direct payments were coupled to production (O'Neill & Hanrahan; 2016, Kilian et al., 2012; Ciaian et al., 2014).

In 2003 CAP was reformed once again, the so-called Fischler Reform, implemented in 2005. The coupled direct payments where replaced by the Single Farm payment (SFP), introducing the decoupled direct payments. To be able to receive support under the SFP-rules, a farmer must cultivate at least four hectares, keep the land in a cultivatable condition and follow cross-compliance rules. The decoupled direct payments are based on the numbers of hectares a farmer cultivate, but farmers can receive different support levels per hectare, depending on the value of their entitlements. The number and value of each entitlement a farmer was given were based on a historical model, a regional model or a hybrid model (O'Neill & Hanrahan, 2016; Kilian et al., 2012; Ciaian et al., 2014).

In the historical model[1], the value of a farmer's entitlements was calculated by dividing the farmer's average direct payments between 2000 and 2002 with the average number of hectares the farmer cultivated under the same period. The farmers received as many entitlements as hectares they on averaged had farmed.

[1] Implemented by Austria, Belgium, France, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Wales and Scotland (Ciaian et al., 2014).

In the regional model[2], all entitlements in a region have the same value. The value was calculated by dividing the average sum of the region's coupled direct payments between 2000 to 2002 with the number of hectares in the implementation year. Each farm received as many entitlements as hectares the farm cultivated in the implementation year.

The hybrid model combines the historical and regional model, which gives a higher variance in entitlements value between farmers than in the regional model, but a lower variance compared to the historical model.

Figure 3 shows the evolution of EU: s agriculture support. The amount of coupled direct payments has decreased since 2005, almost totally replaced by the SFP/decoupled direct payments (European Commission: DG Agriculture and Rural Development, 2017).

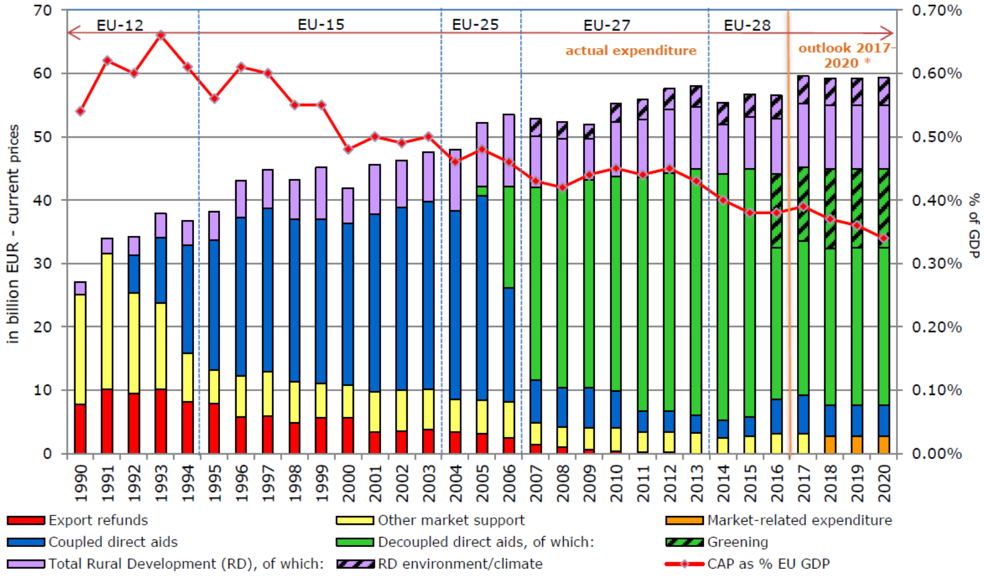

Figure 3. The evolution of CAP. Source: European Commission, 2017.

CAP was reformed once again in 2013. It was then decided that member states (MS) should change implementation model, from the historical/hybrid model to the regional (Ciaian et al., 2014). Because of this, Sweden will under 2015–2020 shift from the hybrid to the regional model. In 2020, all entitlements in Sweden will have the same value, expected to be 193 EUR (Larsson, 2014). Other policy changes are differentiation of support between farmers and the new greening support (Ciaian et al., 2014).

[2] Used by Malta and Slovenia (Ciaian et al., 2014).

2.2 Literature Review

Johansson & Nilsson (2012) use a cross-sectional log-log quantile regression approach, using market data on property transfers in Sweden 2007-2008 as dependent variable. Johansson & Nilssons results indicates that the price of agricultural land is 0.6 % higher in municipalities with 1 % higher decoupled direct payments, compared with the median municipality. The authors do also find that the capitalising degree of the decoupled direct payments is higher for the 75th quantile than for the median and lower for the 25th quantile than for the median, estimated to be 0.72 and 0.47 respectively, compared to the estimated median elasticity on 0.6. This implies that in municipalities with high prices on agricultural land is a larger amount of support capitalised in land prices.

Environmental compensation has, on the other hand, a negative correlation with the land value, indicating that municipalities that receive more environmental support than average are characterized by lower land prices. The negative connection between environmental supports and the price of land is probably linked to the fact that farmers who gets higher environmental compensation cultivate poorer and more restricted land. This imply that farmers may be under-compensated for their environmental commitments.

The authors stress however the importance of causality and correlation. The estimated positive effect of the decoupled direct payments and the negative connection between environmental support and the price of agricultural land indicates that it exists a correlation between support and the price, but it does not say anything about the causality. The direct payments per hectare are higher in municipalities with higher agricultural profitability and prices on land hectare due to the hybrid implementation model. It is therefore not sure that the decoupled direct payments drive up the price on agricultural land, only that it to a large extent capitalise into land value.

Except for the *direct payments* and *environmental compensations*, the following variables have a significant effect on the price of land; *fertility of the soil*, *average farm size in the municipality*, *if there are more horse farms in the municipality than average in Sweden* and *the level of urbanisation in the municipality.*

Kilian et al. (2012) discuss how policy changes in the 2003 CAP reform, the Fischler reform, affect the degree of capitalisation and land value and conducts a cross-sectional log-log regression analysis on the capitalising degree of decoupled direct payments in land rental prices in Bavaria, Deutschland.

The connection between agricultural support and land increase due to the Fischler reform, due to the decoupling of the direct payments. Decoupled direct payments have, compared with coupled direct payments and the former intervention price policy, a stronger connection to the area cultivated. The stronger connection occurs since the decoupled direct payments are based only on the number of hectares a farmer cultivates, which previous support has not been based on. From this follows that the amount of land a farmer cultivates is more important then before, when it comes to the level of the agricultural support. The effect of a stronger connection between land and support should therefore be an increase in land value, *ceteris paribus*, and that the degree of support that capitalise in land value increases, compared with before the Fischler reform.

Another finding is that the support level is expected to have a higher value at the margin in the regional entitlements model than in the historical model, implying a higher capitalising degree in the regional model. On the other hand, due to reduction in the support budget, the value of SFP will decrease over time and since cross-compliance regulations can impose higher costs for farmers, the marginal value may reduce.

Included in the regression analysis are variables that capture the effect of natural conditions, market structure, agricultural support and other land market demands. Following variables are found to be statistically significant: *soil quality, plot size, share of rental area, share of utilised agricultural land* (UAA) *on total land area, direct regional payments, direct historical payments, support to less-favoured areas* (LFA), *agri-environmental payments and share of new rental contracts*.

The result indicates that *direct payments* have a highly significant positive influence on rental prices, and thereby on land prices. The estimated elasticity is of 0.413 and 0.35 for cropland, and 0.777 and 0.28 for all agricultural land, respectively. Hence, one more euro in direct payments will increase the price of renting cropland/agricultural land with 28 – 78 cents.

Agricultural environmental payments have a significant negative effect, with an associated estimated coefficient equal to -0.22 on cropland, but no significant effect on the price on all agricultural land. The negative effect on cropland is probably due to higher restrictions on land use, restrictions which on the other hand should be covered by the payments. The negative sign can indicate that more farmers with less productive land than what was thought are applying for environmental payments. *Payments to less-favoured areas* are positive, with an estimated elasticity of 0.292 for cropland, 0.191 for all utilised agricultural land. The positive effect of the LFA-support can be due to over-compensation.

Ciaian et al. (2014) investigate what effect the 2013 CAP reform has on the capitalising degree of support in land rental prices and land value.

The article highlights that the degree of capitalisation differs depending on several factors. These factors are, among others, the ratio between entitlements–and eligible arable land, the implementation model (regional, hybrid or historical), cross-compliance and land market regulations, tradability of entitlements, imperfections on the capital market and length of rental contracts.

The article stresses the fact that the degree of capitalisation is higher for farms with low-value entitlements. Farms with low-value entitlements cannot pay as high rent as farms with high-value entitlements, with the result that a larger part of the low-value entitlements will be capitalised in land rental and land prices. From this follows that the capitalisation will be higher in MS that have implemented a regional or hybrid model, compared to the historical model, since the variance between the payments is lower, or equal to zero, as Figure 4 shows. According to this, the change from a historical to a regional model in the 2013 reform will increase the capitalisation degree.

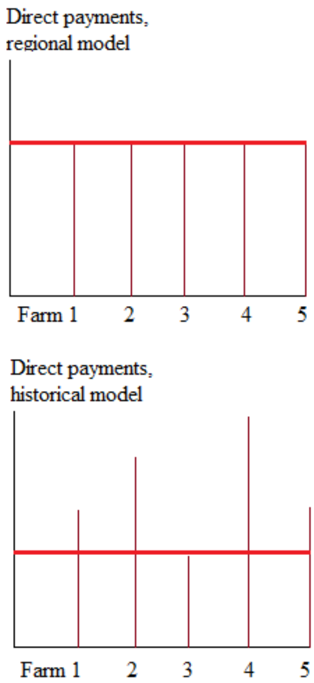

Figure 4. Capitalization degree in the historical and regional model. The red line is the capitalising degree in the two different models, indicating a larger capitalising in a regional model. Own processing.

Also, since all farmers in the regional model receive the same payments per hectare, the asymmetric information on the market will decrease, resulting in a more transparent market and higher prices on agricultural land according to Ciaian et al. On the other hand, the differentiation of support between farms and the greening can counterbalance these effects. The differentiation of payments between farmers creates variance in the entitlements value while the greening reduces land productivity due to cultivation restriction, as explained in the introduction of this thesis.

However, is it not possible to identify the net effect of the 2013 CAP reform, despite knowledge on how each policy change probably may affect the capitalisation degree, since MS can implement policies differently and all MS have unique agricultural sectors.

Latruffe & Le Mouël (2009) has made a meta-study that provides an overview of the existing empirical and theoretical literature concerning capitalisation of agricultural support. A finding that Latruffe and Le Mouël does is that the evolution of agricultural support in industrialised countries, from price support instruments to different variants of direct support, often area-based, results in a higher degree of capitalisation, due to the stronger connection to the land. The overview shows that all studies that have found a relationship between agricultural support and price of land conclude that the elasticity of land price has an estimate between zero and one. This means that support raises the price of land, but the increase in price is never larger than the increase in support. An explanation for this inelasticity could be an uncertainty about the future, in the sense that farmers cannot be sure that they will receive support forever.

Brady et al. (2017) investigate how the decoupling of direct payments and removal of the set-aside area in 2005 have affected the agricultural structure in the south of Sweden, with a focus on passive farming. Passive farming occurs when farmers found it more profitable to keep land in a cultivatable condition and receive direct payments for it, without cultivating the land, so-called fallow. Passive farming slows down the rationalisation of the agricultural sector in theory since land that could be used by expanding farmers is put in fallow.

The study's result is that passive farming mostly exists on low productive land, which prevents the marginal farmland from being abandoned. Therefore, passive farming does not have any large negative effect on the economy or agricultural development since the land would not have been used for commodity production due to bad profitability. Contrary, if the profitability in the sector were to increase can fallow easily be converted to agricultural land, since it has been kept in good condition.

Lundell & Östlund (2010) investigate what factors that affects the price of agricultural land around Mälardalen in Sweden. Three hedonic pricing models are used on a cross-sectional dataset, where the dependent variable is divided into three subgroups, depending on the reason for the purchase (agricultural production, interest group and accommodation group).

Significant influencing factors for the production group are *interest rate*, *average price on cereals*, *average yield in the area*, *average salary in the municipality*, *population density*, *hunting possibility* and *distance to the country road*. The biggest effect on the price of land has the average price of cereals. It has been found in this study that if the price per kilogram of wheat increases by 1 SEK, the per hectare price of agricultural land increase by 13 660 SEK.

For the people who buy a property for interest but not are full-time farmers are the significant variables *time dimension*, *average yield in the area*, *population density, the number of sales in the area* and *travel time to Stockholm*. The travel time to Stockholm influence the price much, one extra hour of travel reduces the price per hectare with 19 000 SEK.

For the accommodation group, buyers that only buy the property for living reasons, the following variables are significant: *interest rate*, *the time dimension*, *population density, if a real estate agency sells the property, travel time to closest city, hunting possibility, travel time to Stockholm* and *the possibility to rent out the agricultural land.*

Westman (2013), investigate what factors that influence the price of agricultural land in Östergötland by a hedonic pricing model, using a cross-section dataset. The explanatory variables are divided into four groups: i) production variables, ii) the structure of the agricultural sector, iii) location and iv) time. The *fertility of the soil* is highly significant and important for determining the value of land. If the average yield increase with 1 000 kilograms more per hectare will the price per hectare increase of 33 000 SEK, *ceteris paribus*. Interestingly is none of the location-specific variables (*distance to a city with more than 10 000 inhabitants, distance to country road* and the *number of sold vacation homes*) statically significant, which can be compared to Lundell & Östlund (2014). However, an explanation for this can be that the dataset only includes agricultural land and not sales of land with buildings on it.

Table 1. Summary of factors influencing the price of land from the literature review.

Author(s)	Country	Year	Studied year	R2	Obs.	Variable	Effect	Significane
Johansson & Nilss	Sweden	2012	2007-2008	52%	273	Fertility of soil	0,58	***
Dependent variable: SEK/ha in municipality						Share of pasture	0,19	
Logarithmic form						Average farm size	0,22	***
						Number of sales	-0,07	
						Spec. Cattle & milk	-15	*
						Spec. pig/poultry	6,08	
						Spec. horse	16	**
						DP per hectare	0,62	***
						Envi. Comp payments/ha	-0,38	***
						Nr. of recreation house	0,07	*
						Urbanization index	0,34	***
Kilian, et. al.	Germany	2012	2005	54%	1072	Soil quality	3,62	***
Dependent variable: Rental price of cropland, EUR/ha.						Average field size	51,9	***
Logarithmic form						Share of rental area	-112	***
						Farms per 100 ha UAA	2,60	
						Installed biogas power (kW/ha	0,63	
						The share of EAA of total lanc	55,1	***
						DP historical (EUR/ha)	0,41	***
						DP regional (EUR/ha)	0,35	***
						Payment to LFA (EUR/ha)	0,29	*
						Envi. comp payments/ha	-0,22	**
						% with new rental contracts	0,20	**
Kilian, et. al.	Germany	2012	2005	59%	1154	Soil quality	3,82	***
Dependent variable: Rental price of UAA, EUR/ha.						Average field size	39,0	***
Logarithmic form						Share of rental area	-84,5	***
						Farms per 100 ha UAA	8,97	***
						Installed biogas power (kW/ha	0,85	**
						The share of EAA of total lanc	87,1	***
						DP historical (EUR/ha)	0,78	***
						DP regional (EUR/ha)	0,28	***
						Payment to LFA (EUR/ha)	0,19	*
						Envi. comp payments/ha	-0,06	
						% with new rental contracts	0,16	**
Lundell & Östlund	Sweden	2010	2005-2009	47%	54	Average yield	0,01	*
Dependent variable: SEK/ha						Interest rate	-4,03	*
Production group						Average price cereals	0,01	*
Logarithmic form						Average salary in municipality	0,37	*
						Population density	-0,10	*
						Hunting possibility (d)	-7,66	*
						Distance to road	6,23	*
Lundell & Östlund	Sweden	2010	2005-2009	63%	35	Time dimension	6,23	*
Dependent variable: SEK/ha						Average yield	0,01	*
Interest group						Population density	-0,13	*
Logarithmic form						Number of sales	-2,12	*
						Distance to Stockholm	-0,33	*
Lundell & Östlund	Sweden	2010	2005-2009	60%	27	Time dimension	5,34	*
Dependent variable: SEK/ha						Interest rate	5,29	*
Accommodation group						Population density	0,23	*
Logarithmic form						Hunting possibility (d)	13,8	*
						Distance to town	0,29	*
						Sold by real estate agency (d)	31,7	*
						Renting out arable land (d)	8,85	*
Westman	Sweden	2013	2009-2012	87%	74	Average yield	0,71	***
Dependent variable: SEK/ha						Net wealth in municipality	0,56	***
Logarithmic form						Share of cropland in property	0,27	***
						Number of farmers > 200 ha	0,16	**
						Sales in 5km?	0,09	***
						Sold in 2010?	-0,08	***
						Arable area	0,07	**
						Property <10 ha	0,06	
						Dist. to town > 10 000 inhabita	-0,07	
						Dist. country road	0,03	
						Property regulation?	-0,03	
						10-50 ha	0,04	
						Sold in 2012? (d)	-0,05	
						Share cropland in municipality	-0,05	
						Cows/ha cropland in municipal	-0,10	
						Num. of sold vacation homes	-0,29	
						Region for direct payments	0,06	
						Sold in 2009? (d)	-0,01	
						Sold in 2011? (d)	0,00	

*** indicates statistical significance at 1 % significance level

** indicates statistical significance at 5 % significance level

* indicates statistical significance at 10 % significance level

2.4 Summarised findings in the theoretical framework

Factors that influence the price of agricultural land

Economists have over a long period discussed which factors affect the price of agricultural land. Early on was the distance to market (Smith, A., 1776) and fertility of the soil (Thünen, J.H., 1826) known as factors that influenced the price of land. But, as found in the literature review, there are other factors, such as urbanisation, the structure of the agricultural sector, government regulations and demand for agricultural land for usage as industry or housing land, that influence and determine the price of agricultural land.

In Table 1 are all regressors in the econometric studies gone through in the literature review presented. The table provides an overview of which factors that, according to these studies, influence the price of agricultural land. The variables found that affects the price of land can be divided into different subgroups; *Agricultural economic variables, Location/urbanisation variables* and *Agricultural support variables*. In chapter *3.3 Regression coefficients* are the variables used in this thesis described and explained.

Capitalising degree and policy changes

It has been found that EU: s direct payments capitalise in agricultural land price value. The capitalising degree in Sweden was found to be 0.6 % in 2007-2008 (Johansson & Nilsson, 2012) and between 0.28-0.77 % in Bavaria (Kilian et al., 2012). Environmental support has in both studies a negative correlation with the land price, while LFA-support is found to have a positive effect on the land price in Bavaria.

The decoupling of direct payments stipulated in the 2003 CAP reform should increase the capitalisation degree according to the literature review. This since the decoupled payments only depend on the area cultivated, strengthen the connection between land and support.

Furthermore, the capitalisation degree will also depend on which entitlement model (regional, historical or hybrid) that was implemented by the MS. Those MS that implemented a regional or hybrid model will have a higher capitalising degree since the variance of entitlement value is lower on the marginal. Since the 2013 CAP reform states that MS should shift to the regional entitlements model is it likely that the capitalising degree will increase. With start in 2015, Sweden will shift towards a regional model, a shift that will be finished in 2020.

Other changes in the 2013 reform that may affect the capitalising degree are the differentiation of support to farmers and the greening-support, where farmers are obliged to follow new and stricter environmental rules. These policy changes have a negative effect on the capitalising degree since they increase the variance in payments and may reduce the productivity and profit in the sector due to harder restrictions.

Gap in literature

The literature review has provided knowledge on which factors that influence the price of agricultural land and how agricultural support capitalise in land value. However, the literature has not been able to provide any empirical studies on how the capitalising degree changes over time or on how the policy changes in the 2013 CAP reform affect the capitalising degree. This thesis will, therefore, be the first that empirically investigate the effect of the policy changes in CAP, implemented in 2014 on the capitalising degree, and how the capitalising degree changes over time.

3 Empirically framework and data

In this chapter is the theory behind and the econometric methods for solving the research questions described and developed. Data for the dependent variable, the price of agricultural land in Sweden, is presented, together with the regressors that will be included in the regressions.

3.1 Land value theory: Net present method

Studies on land value have often been based on supply-demand models, even if economists early on noted that other factors than supply and demand affect land value, (Weersink et al., 1999). Furthermore, land cannot be viewed as a classic supply-demand market and not estimated as one, since land is a highly inelastic product (Burt, 1986). Also, supply-demand models developed in the 1960's did not explain price developments and structural changes that agricultural land went through in the 1970's (Pope et al., 1979). Due to this, most studies after the 1970's exclude the supply side and focus solely on demand drivers (Weersink et al., 1999), using a traditional capitalisation model (net-present value model) (Latruffe & Le Mouël, 2009). In a net present value model, the value of the land is thought to be the present value of all future earnings and cash flows discounted with the risk that each earning has (Goodwin et al., 2003):

$$L_t = \sum_{i=0}^{\infty} \frac{E(R_{t+i})}{(1+r_{t+1})(1+ r_{t+2)} \ldots (1+r_{t+i})}. \quad [1]$$

L_t is the price of land per hectare at the start of period t; R_t is the real return from each hectare land at the end of period t; r_t is the real discount rate for period t; and E is the expectation on return conditional on information in period t (Weersink et al., 1999). Assuming that agents are risk neutral, that discount rate is constant and that it is the same tax rate on rental income and capital, the net-present model becomes:

$$L_t = (1 + r)^{-1} \sum_{i=0}^{\infty} \frac{E(R_{t+i})}{(1+r)^i} \quad [2]$$

Equation [2] can be simplified to the traditional capitalisation formula if the residual return R_t is assumed to be constant in each period, R^* (*ibid.*):

$$L_t = \frac{R^*}{r} \quad [3]$$

Since farmers often have earnings from both markets transfers and government payments can the traditional capitalisation model be developed to account for several net returns' components:

$$L_t = \sum_{i=1}^{\infty}(b_1^i E_t P_{t+i} + b_2^i E_t G_{t+1}) \qquad [4]$$

P represents market returns and *G* government payments; b_j is the discount rate for the *j*th source of income. The model allows for using different discount rates for different sources of income, related to the uncertainty of that earning (*ibid.*). However, if all cash flow grows at the same pace and all cash flows from the same source have the same discount rate (b_i^j = b_j for all *i*), then [4] simplifies to

$$L_t = \beta_1 E_t P_{t+1} + \beta_2 E_t G_{t+1} \qquad [5]$$

In equation [5] is all government farm payments lumped into one indicator (*G*). However, since it can exist several supports to farmers from the government, new variables can be added (Goodwin et al., 2003).

3.2 Land value theory: Hedonic pricing model

The price of land is however made up of more variables than the amount of future earnings, as the literature review has shown. In 1776, Adam Smith suggested that the distance from the parcel to the market affected the price of agricultural land. Von Thünen looked at the localisation of land and distance from cities and markets, while Ricardo stressed the importance of the fertility of the soil (Smith, A. (1776); Von Thünen, J.H. (1826); Sraffa P. & M.H: Dobb (2005), see Johansson & Nilsson. (2012)).

The net present method explains only the part of the price that is made up of future earnings. A hedonic pricing model can be used to grasp the effect of other variables. It investigates the inferences between the price and the land characteristics. To intuitively explain what hedonic pricing model is, think of two identical parcels, with the only difference that the soil quality of parcel 1 yields an average harvest of 5 tons of wheat per hectare while the soil quality of parcel 2 yields an average harvest of 6 tons wheat per hectare. *Ceteris paribus,* on a competitive land market, the difference in market price between parcel 1 and parcel 2 should only depend on the difference in soil quality and, thus reflect the value of the soil quality. Hence, the hedonic pricing model is a way to set a marginal value of the characteristics of a good (Haab & McConnell, 2002).

In 1974, Rosen developed a model, based on the theory of hedonic pricing, for valuing consumer products, taking the products different characteristics into account. A product formed by *n* characteristics is described by (Rosen, 1974) as:

$$z = (z_1, z_2, z_3, \ldots, z_n) \qquad [6]$$

Given [6] can the price of product *z* be derived, as a function of its characteristics (ibid):

$$P(z) = P(z_1, z_2, z_3, \ldots, z_n) \qquad [7]$$

Rosen's model was further developed by Palmquist to a model of the derived demand for a differentiated production factor, especially agricultural land (Palmquist, 1989). Palmquist shows, using Rosen's hedonic pricing model [7], that both buyers and sellers are unable to influence the market equilibrium price P. A farmer's willingness to pay for a parcel depends on its characteristics z, its output *x* and the farmer's availability and capability to farm, α, which creates equation [8] (Palmquist, 1989):

$$g(z, x, \alpha) = 0 \qquad [8]$$

Some recent studies combine the traditional capitalisation model and the hedonic pricing models, making it possible to see both how earnings from farming the land and possible alternative usage of the land affect the value (Johansson & Nilsson, 2012).

To conclude, the traditional way of valuing land value by a capitalisation formula (equation [5]) captures the effect of agricultural related future payments. However, the literature review has shown that there are more factors than just future payments that influence the price of land. A model for investigating how non-agricultural factors and characteristics influence the price of land is the hedonic pricing approach (equation [7]). It is possible to combine the two models (equation [8]) and by a regression analyse investigate the inferences between land characteristics and land prices.

3.3 Regression techniques

OLS regression

The most common regression technique for running a multiple cross-sectional regression is Ordinary Least Square (OLS) regression. OLS estimates the effect of the regressors on the mean value of the dependent variable (Stock & Watson, 2015). The basic OLS model looks like:

$$P_i = \beta_0 + \beta_1 E_i + \beta_2 S_i + \beta_3 L_i + \varepsilon_i \qquad [9]$$

The dependent variable P_i is the price per hectare of agricultural land in municipality i, β_0 is the intercept and the parameters $\beta_{1, 2, 3}$ are the different regression coefficients associated with the various explanatory variables. E is a vector with agricultural economic explanatory variables for each municipality i; S is a vector containing agricultural support explanatory variables for municipality i receive; and L is a vector with explanatory variables that relate to location-specific characteristics in municipality i. ε_i is the stochastic error term.

The variables in the regression analysis are transformed into logarithmic forms as the parameters β1, β2 and β3 are estimates of elasticities. Hence, the estimated coefficients show the percentage change in the dependent variable when the relevant explanatory variables change with one percentage, simplifying the interpretation of the econometric results (Stock & Watson, 2015).

$$logP_i = \beta_0 + log\beta_1 E_i + log\beta_2 S_i + log\beta_3 L_i + \varepsilon_i \qquad [10]$$

The market transactions that make up the dependent variable in the model show a large spread since both very high and low sale prices on agricultural land are included in it, as Figure 5 and Table 2 (page 24) show.

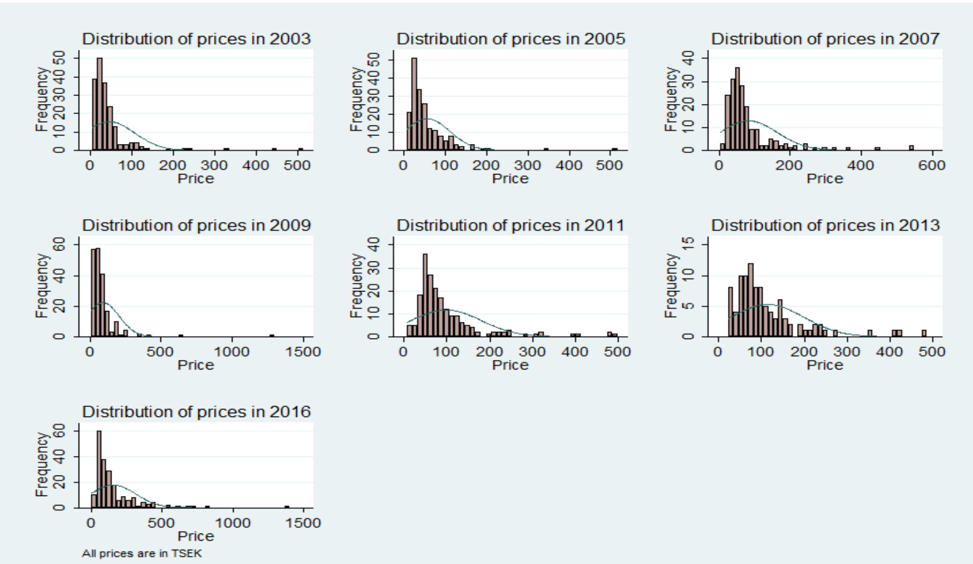

Figure 5. Distribution of prices. Source: NAI Svefa, own processing.

Figure 6 and Table 2 indicate that the data are positively skewed, ranging between 2 and 7. This means that the data is right skewed distributed, meaning that most of the prices are lower than the mean price, while extremely high price creates a right-wing tail (Desbois et al., 2013).

In an OLS-regression may skewness, asymmetric and large spread lead to heteroscedasticity, which means that the variance of the conditional distribution of the error term is not equal over the independent regressor (Stock & Watson, 2015). Heteroscedasticity implies that the regression coefficients are systematically misjudged, and their corresponding p-values might lead to wrong statistical diagnosis, which may lead to the conclusion that a regressions coefficient is statically significant even if not.

Quantile regression

A quantile regression can be more useful than an OLS-regression when the dependent variable suffers from skewness and the underlying regression model is characterized by heteroscedasticity of the error terms. Quantile regression estimates on a specific quantile/percentile on the dependent variables distribution while keeping all observations in the model, rather than the estimate on the conditional mean, as an OLS-regression does (Desbois et al., 2013, Johansson & Nilsson, 2012). While OLS matches a line through the minimised squares of the residuals, the quantile regression finds a line through the minimised sum of the absolute residuals. Also, quantile regression weight outliers to have a smaller impact, which results in a more robust estimate (Koenker & Hallock, 2001).

Also, since there is a large spread in the dependent variable, a quantile regression is positive to use since the effect of the regressors on the dependent variable may be different for different quantiles, as Johansson & Nilsson (2012) found out.

The quantile regression model has the following form (Young, et al., 2008)

$$Q_{yi}\{\tau|x\} = \beta_0 + log\beta_1 E_i + log\beta_2 S_i + log\beta_3 L_i + F_u^{-1}(\tau) \quad [11]$$

where Q_{yi} is the conditional value of the dependent variable given τ in the ith trial. τ denotes the quantile/percentile, x is the value of the independent variable in the ith trial and F_u is the common distribution function of the error, given τ.

Even if the OLS-regression have some drawbacks when the dependent variable is asymmetrically distributed, both OLS-regression and quantile regressions are used in this study. Using both techniques gives a better understanding of how direct payments are capitalised into agricultural land prices since it combines estimations on the average, median, quantiles and the 95th percentile and therefore provides a broader picture.

Stepwise regression

The quantile and OLS regressions are executed by using an automatic backward stepwise technique in Stata 13. The decoupled direct payments regressor is locked in and cannot be removed since that explanatory variable is of most interest for this study. The usage of a backward stepwise technique provides the best model for each unique regression and it simplifies the interpretation of the results since there may be fewer regressors to examine. Since this thesis considers 35 regressions (one panel data regressions, six OLS regressions and 28 quantile regressions), an easy interpretation is needed.

But, the backward stepwise regression has some drawbacks. It may not always result in the best model since the regressor removed or added in each step is conditioned on the previously included regressors, which make the order of adding or removing important. A regressor that is insignificant may be significant if another regressor(s) is removed from the model (Lewis, 2007). Also, the automatic removal and adding do not understand the data or the implication of it. Therefore, a better understanding of the data and a better model may reduce the need for stepwise regression (Judd et al., 2015).

However, the extensive literature review has provided a good understanding of the model and the data. Furthermore, the risk that some regression may not be regressed in the best way can also be true for the model when all regressors are included. Therefore, despite its shortcomings, is the backward stepwise technique used in the thesis.

Panel data

Panel data consists of observations on the same entity, *i*, (in this case 239 municipalities) over two or more time periods, *t* (in this case the years 2005, 2007, 2009, 2011 & 2013). A fixed effect regression is, which gives an opportunity to control for omitted variables that vary between municipalities but not over time (local culture, for example). The dataset used in the thesis is balanced, meaning that it has observations on all variables for all years (Stock & Watson, 2015).

A fixed effects regression model uses OLS-technique to execute the regression. The equation looks like:

$$P_{it} = \beta_0 + lg\beta_1 E_{it} + log\beta_2 S_{it} + log\beta_3 L_{it} + \ y + \ \beta_4 Z_i + \varepsilon_i \quad [12]$$

where Z_i is an unobserved variable that varies over entities but not over time (local culture, for example). The variables of interest are $\beta_{1,\,2,\,3}$, hence the slopes of the different independent variables. y is a dummy variable for the years, which aim to grasp the effect of each year on the dependent variable. Since Z_i vary over municipalities but is constant over time, the regression model can be interpreted as having n intercepts, one for each municipality. Then $\beta_0 + \beta_4 = \alpha_i$, and equation 12 can be simplified to the fixed effects regression model (ibid):

$$P_{it} = log\beta_1 E_i + log\beta_2 S_i + log\beta_3 L_i + y + \alpha_i \ + \varepsilon_i. \qquad [13]$$

α_i is the entity fixed effect, which differs for all municipalities, while the slope of $\beta_{1,\,2,\,3}$ is the same for all municipalities. Hence, α_i can be viewed as the effect of being in municipality i, each municipality's unique intercept. By using this technique, the effect of the agricultural support over time can be estimated, taking variables that vary between municipalities into account (ibid).

Measures of goodness of fit

The coefficient of determination, R^2, which is the fraction of the sample variance of the dependent variable, explained by the explanatory variables, is used for determining how well the model fits the data. A high value indicates a correlation between the regressors and the dependent variable. However, a value R^2 close to one does not mean that the chosen regressors are the best to explain variance in the dependent variable since that also depend on the data material, data-quality and the economic theory used (Stock & Watson, 2015).

To determine if the estimated regressors have a statistically significant impact on the dependent variable or not, the p-value is used. The p-value indicates whether the null hypothesis can be rejected or not. In this study is the significance level 1 %, 5 % and 10 %, indicated by asterisks. If the significance level is over 10 %, the regressor is not significant, and its impact on the dependent variable is questionable (ibid).

3.4 Data

All data in this study is aggregated to municipality level. There are 290 municipalities in Sweden, but it has not been possible to find correct data on all years for all municipalities. The number of municipalities for each regression is showed in the results table. The source and explanation for each regressor are found in chapter *3.3 Regression coefficients.*

The dataset does not include any time dimension variable. Because of this, the regression for each investigated year does not say anything about how regional variations in agricultural land price change over time, only how the price fluctuates due to variations at a given point in the time. Due to this, there is no need for macroeconomic variables since all buyers and sellers meet the same level on interest rates, prices, inflation and so on at a given point in time (Johansson & Nilsson, 2012). However, since regressions are executed for several years may indications on how policy changes affected the capitalising degree be view in the results.

3.5 Agricultural land value data

The land value data comes from a database for market transactions that evaluation institute NAI Svefa has provided. It consists of price on agricultural property transfers, which mean that the calculated average SEK/hectare prices for agricultural land may be lower than it really is, since no property regulations is included in the data.

As previously written, Figure 1 showed a price gap between arable land and pasture land. It would have been favourably to be able to separate these two land types in the dataset, in order to see the capitalisation degree on arable land since that is where the largest price increase has occurred. It is, however, difficult to separate these two types of land given the information in the database. The database, which consists of 17 260 market transactions, provides information on the purchases sum, the municipality and the hectares of agricultural land in each purchase. With this information is has been possible to calculate the average price of agricultural land in the municipality.

Figure 6 shows the average SEK/hectare for agricultural land between 2003-2016. The price is highest in the coastal areas, close to the greater cities and the larger, where the most fertile soil is located. This follows the theoretical framework, that prices are higher close to cities and where the soil is more fertile.

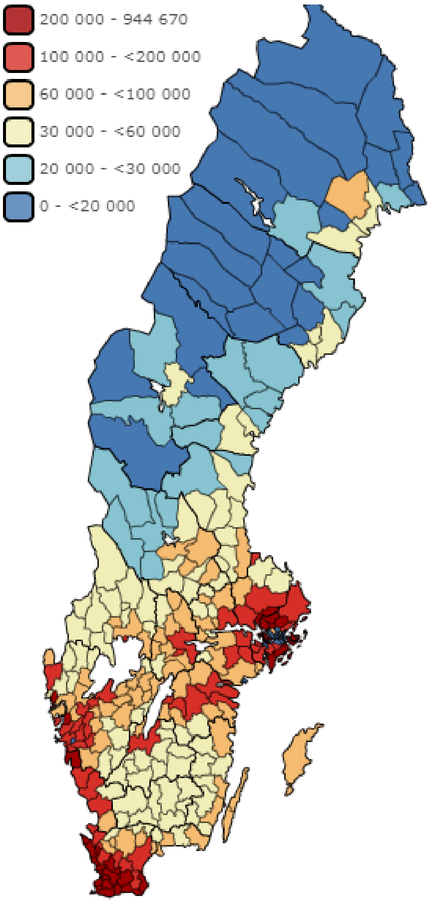

Figure 6. Average purchase sum 2003-2016. Source: NAI Svefa, own processing.

The descriptive statistics in Table 2 shows that the median- and mean price increase for all years, and that the gap between the mean and median increases from 15 00 SEK to 48 00 SEK between 2003 and 2016. The skewness is, as mentioned earlier, positive, which indicate an asymmetric distribution of prices. The municipalities with the high average prices in 2009 and 2016 are Lysekil and Lund.

Table 2. Descriptive statistics for agricultural land prices. Source: NAI Svefa, own processing.

Agricultural land pric	2003	2005	2007	2009	2011	2013	2016
Mean	45 911	55 182	83 182	91 855	97 966	114 025	153 821
Median	30 663	38 771	59 958	65 005	72 256	89 091	105 584
Standard Deviation	60 695	54 743	80 083	112 362	81 920	84 814	158 187
Minimum	4 061	5 910	5 500	13 299	7 500	24 140	5 000
Maximum	513 550	518 740	547 929	1 295 625	499 333	487 000	1 402 339
Skewnes	5	5	3	7	3	2	4

3.6 Regression coefficients

The regression coefficients are chosen since they capture the effect of the profitability and structure of the agricultural sector, agricultural policies, urbanisation and demand for agricultural land for other reasons than farming. These factors were in the literature review pointed out as important variables when it comes to determining the price and value of agricultural land. To increase the clarity in this chapter, the coefficients are divided into three different subgroups; *Agricultural economic variables*, *Agricultural support variables* and *Location/urbanisation variables.*

Agricultural economic variables

Average yield in the municipality is a variable that relates to the fertility of the soil, which is a major driver of the price on agricultural land (Johansson & Nilsson, 2012, Kilian et al., 2012). The data used are from the Swedish Board of Agricultural and are the average yield of spring barley between 1985 to 1989. The age of the data is not a problem; it is rather an advantage. At that time were cultivation techniques not as developed as today and the organic production, in which the yields are lower, were not as common as today. Therefore, this older value should lead to a more true value of the soil quality, less depending on farmer's knowledge, other inputs and the production technique. The maximum yield of 5 760 kg arrives from Trelleborg, the south of Sweden. Better soil quality should correspond to a higher price per hectare.

Table 3. Descriptive statistics of the average yield. Source: SBA, own processing.

Average yield, kg/ha	
Mean	3 291
Median	3 256
Standard Deviation	823
Minimum	1 300
Maximum	5 760

Table 4 displays the descriptive statistics for the other of the agricultural economic variables. The *average farm size* relates to the structure and profitability of the agricultural, and a higher average farm size indicates a higher degree of rationalisation and economy of scale. Areas with more rationalisation should show higher prices on agricultural land since the value of an extra hectare is higher than for small-scale farmers. The average farm size differs widely across the municipalities, but the median and mean are rather close to each other.

The last three regressors, *share of pasture of agricultural land, share of fallow of agricultural land* and *share of agricultural land of total municipality area*, display the structure of the agricultural and land usage in the municipalities. A larger share of pasture in a municipality should have a negative effect on the price on agricultural land, since the price for pasture land is much lower than the price for areal land, as Figure 1 showed.

Brady et al., (2017) show that passive farming is something that mainly occurs in regions with lower profitability and on marginal land. Therefore, in municipalities with a high share of fallow, the price on agricultural land should be lower.

The share of agricultural land of the total area in the municipality could have both a negative and positive impact on the price. The more land there is to buy, for any reason, leads to, according to ordinary supply-demand rules, to a lower price. On the other side, in municipalities with a high share of agricultural land are farming probably a more important sector, leading to more farmers that can bid on the land.

Table 4. Descriptive statistics of agricultural economic variables. Source: SBA, own processing.

Average farm size	2003	2005	2007	2009	2011	2013	2016
Mean	46	41	40	40	41	52	48
Median	39	35	34	34	35	48	42
Standard Deviation	22	20	20	18	20	23	24
Minimum	15	11	11	11	11	19	11
Maximum	149	154	162	119	150	156	167
Share pasture	2003	2005	2007	2009	2011	2013	2016
Mean	0,16	0,17	0,16	0,15	0,16	0,13	0,16
Median	0,12	0,12	0,12	0,1	0,13	0,1	0,12
Standard Deviation	0,11	0,12	0,12	0,11	0,12	0,11	0,12
Minimum	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Maximum	0,6	0,6	0,6	0,5	0,6	0,6	0,6
Share fallow	2003	2005	2007	2009	2011	2013	2016
Mean	0,09	0,1	0,09	0,06	0,06	0,05	0,06
Median	0,09	0,09	0,08	0,04	0,04	0,04	0,05
Standard Deviation	0,05	0,05	0,06	0,05	0,05	0,05	0,05
Minimum	0,01	0,01	0,01	0	0	0,01	0,01
Maximum	0,26	0,27	0,39	0,24	0,29	0,21	0,24
Share agricultural	2003	2005	2007	2009	2011	2013	2016
Mean	0,19	0,19	0,18	0,18	0,2	0,28	0,21
Median	0,01	0,01	0,01	0,01	0,01	0,02	0,01
Standard Deviation	0,16	0,16	0,15	0,15	0,17	0,19	0,18
Minimum	0,02	0,02	0,02	0,02	0,02	0,03	0,02
Maximum	0,79	0,79	0,83	0,79	0,79	0,79	0,83

Location/urbanisation variables

To investigate how demand for agricultural land for other purposes than agricultural and how urbanisation influences the price on agricultural land, the following regressors are considered: *population density (population/km^2) in the municipality*, *the number of apartments started in the municipality each year* and *the average price of agricultural land on the county* included in the model. The urbanisation and usage of land for other things than agricultural are an important determinant of the price, as described in the literature review. See for example Smith (1776), Von Thünen (1826) and Dobb (2005).

Table 5 shows the descriptive statistics for the population density, number of apartments started each year and the average county price. The population density minimum and maximum values differ a lot, from 1 inhabitant per km^2 to 2 098. The values for the median and mean do also indicate that the population's density varies across municipalities. The same accounts for the variable *number of apartments started in the municipality each year*. The smallest value is 1, while the maximum is 2 040 apartments started for one single year.

Higher population density should correspond with a higher price on agricultural land since it indicates that the degree of urbanisation is higher.

The apartments started each year indicate the rate on conversion. When building houses, land sometimes is converted from agricultural land to housing land, which increases the competition on the remaining agricultural land, leading to higher prices.

The price on land in one municipality depends not only on factors inside the municipality but also on factors outside. Therefore, the average price of agricultural land in the county us used as a variable, to be able to determine the connection between nearby areas and the investigated municipality. The average county price increase for all years, as Table 6 shows. The effect of the price in nearby municipalities should correspond with higher price of agricultural land in the investigated municipality.

Table 5. Descriptive statistics of location variables. Source: SBA, own processing.

Population density	2003	2005	2007	2009	2011	2013	2016
Mean	53	50	49	50	62	48	70
Median	30	27	26	26	30	33	33
Standard Deviation	97	91	92	94	166	52	179
Minimum	2	1	1	2	2	5	2
Maximum	1 061	1 076	1 095	1 126	1 931	387	2 098
New apartments	2003	2005	2007	2009	2011	2013	2016
Mean	82	105	85	58	89	104	211
Median	19	28	25	20	21	28	45
Standard Deviation	2 039	1 849	1 797	1 007	2 010	1 330	3 160
Minimum	1	1	1	1	1	1	1
Maximum	2 040	1 850	1 798	1 008	2 011	1 331	3 161
Average county price	2003	2005	2007	2009	2011	2013	2016
Mean	49 051	56 288	90 044	90 749	104 084	128 818	148 512
Median	36 236	48 322	72 732	101 139	86 502	102 523	124 358
Standard Deviation	45 672	34 309	57 154	41 681	61 912	92 036	93 622
Minimum	7 184	10 657	19 656	19 886	21 474	21 010	29 943
Maximum	221 584	187 303	371 200	188 891	260 079	651 496	338 323

Agricultural support variables

There is a broad range of support in the CAP, but for simplicity, supports with the same aim are merged into four different categories in this thesis. All support is expressed in SEK/hectare and calculated by dividing the sum of each support in the municipality by the hectare agricultural land in the municipality. This procedure results in some very low SEK/ha values since not all farmers in a municipality receive all kind of support, but the support is divided among all farmers land.

Single Farm Payments (SFP) are the decoupled direct payments that started to replace the coupled direct payments in 2005. SFP should increase the capitalisation degree of agricultural support, as the literature review showed (Latruffe & Le Mouël, 2009; Johansson & Nilsson; 2012, Kilian et al.,2012; Swinnen et al., 2013 and Ciaian et al., 2014).

Coupled refers to coupled direct payments in 2003, and after 2003 only to coupled support, often to agricultural branches with lower profitability. The effect of the coupled support on the capitalisation degree should be positive before 2005.

LFA is a support to farmers in less favourable areas and aims to compensate the farmer for the less fertile soil and lower profitability. Kilian et al (2012) estimated the effect of LFA-support and gained the result that the support had a positive effect on the price of agricultural land.

ENVIECO is a group of supports to farmers that conducts environmental measurements, such as care of pasture land, perennial grass cultivation, maintenance of natural- and cultural elements, convert to organic farming or already are practising organic farming, etc. These supports are not as likely as the SFP to capitalise in higher land prices since the farmer needs to fulfil extra requirements to receive them (holding animals on grazing or establish a wetland). Johansson & Nilsson (2012) show that environmental-support correlates with lower hectare price on agricultural land, probably linked to the fact that support for environmental measurements is more used in areas with lower productivity and fragile environmental land. Also, organic farmers and farmers that applied for environmental support must obey stricter rules, which might correspond to a lower price on agricultural land.

Table 6. Descriptive statistics of agricultural support. Source: SBA, own processing.

SFP, SEK/ha	2003	2005	2007	2009	2011	2013	2016
Mean		1 545	1 831	2 018	1 839	1 957	1 174
Median		1 508	1 800	1 981	1 811	1 933	1 214
Standard Deviation		273	252	283	299	310	317
Minimum		661	1 198	1 336	1 203	1 303	188
Maximum		2 235	2 535	2 955	2 895	3 332	2 296
Coupled, SEK/ha	2003	2005	2007	2009	2011	2013	2016
Mean	1 053	167	83	89	96	41	268
Median	1 094	154	78	79	73	26	263
Standard Deviation	326	88	48	56	117	38	147
Minimum	188	10	0	3	1	1	11
Maximum	1 757	425	259	289	1 075	157	773
LFA, SEK/ha	2003	2005	2007	2009	2011	2013	2016
Mean	471	381	472	458	450	323	407
Median	472	204	244	252	238	84	227
Standard Deviation	318	478	619	586	610	601	578
Minimum	0	0	0	0	0	0	0
Maximum	1 299	2 372	3 330	3 324	3 577	3 398	3 245
ENVIECO, SEK/ha	2003	2005	2007	2009	2011	2013	2016
Mean	416	782	767	768	890	923	392
Median	355	798	763	759	917	942	361
Standard Deviation	276	323	334	348	378	423	193
Minimum	9	121	63	142	89	68	41
Maximum	1 346	1 713	1 734	1 798	1 846	2 633	1 135

4 Results

The result chapter presents the findings of the study, with a focus on the SFP variable. The focus is on the decoupled direct payments variable since it is of most interest for the study and for being able to answer the research questions. The full results table, for all regressions on all quantiles, are found in the appendix.

4.1 Median regression

Agricultural economic variables

None of the agricultural economic variables are significant in 2003, as Table 7 shows. The fertility of the soil (*yield*) has an estimated positive connection with the price of agricultural land on 0.32 % in 2003 and 0.30 % in 2013, but the effect is not statistically significant. Even if the yield variable does not have a statistically significant effect on the price of agricultural land, the positive direction of this explanatory variable is probably right, since previous studies have concluded that a higher fertility of the soil corresponds to higher prices on agricultural land (Lundell & Östlund (2010), Johansson & Nilsson (2012), Kilian et al (2012), Westman (2013).

The average farm size has a statistically significant negative estimate in 2005 but has a statistically significant positive connection in 2013 and 2016.

If the share of pasture increases by 1 % in a municipality, it induces a statistically significant negative correlation with the price of agricultural land, by -0.08 % in 2013 and -0.1 % in 2016. As described in chapter 1 the price of pasture land is lower than the price of arable land, and since agricultural land includes both pasture and arable land, it is expected to find a negative effect of this explanatory variable on the price of land.

The result does not show any statistically significant estimation for the share of fallow, but it shows one negative estimation for 2013. However, even if that estimation not is statistically significant, the negativity is in line with Brady et al., (2017) finding, that most of the passive farming is conducted on margin land in low profitability areas, where the price on agricultural land is lower.

The share of agricultural land in the municipality has one statistically significant estimation, 0.14 % in 2009. The positive sign indicates that in municipalities with a larger share of agricultural land than in the median municipality the price of agricultural land is higher.

Location-specific variables

The average county price is statistically significant at a 1 % level for all estimated years. It has a positive effect on the price of agricultural land with estimates ranging from 0.29 to 0.51 %. This finding indicates that there is a connection between surrounding areas and the investigated municipality, but not the causality. The investigated municipality may have influenced the surrounding areas or vice versa.

The variable for apartments construction has a statistically significant positive effect on the price of agricultural in 2003, 2007, 2009 and 2016. The effects are however small, 0.07 % at most. This is consistent with the literature, that the demand for agricultural land for other usages than agricultural, mainly urban usage, is positively connected with the price of agricultural land.

The population density has for all investigated years a positive and statistically significant effects on the price of agricultural land. The effects range from 0.12 to 0.36, thus indicating that the price on agricultural land is higher in more urban municipalities with higher population density, a finding that is in line with the theory.

Support variables

The single farm payments variable indicates when regressed on the median, that the decoupled direct payments capitalise in higher land prices, with statistically significant results for 2009 and 2011. In municipalities with a 1 % increase in decoupled direct payments the price of agricultural land is 0.54 % higher in 2009 and 0.77 % higher in 2011. This finding is in line with previous research work in the field and with theoretical findings (see Latruffe & Le Mouël, 2009, Johansson & Nilsson, 2012, Killian et al., 2012, Swinnen et al, 2013, Ciaian et al., 2014).

The other support variables, which all are continuous, indicate a statistically significant negative correlation with the price of agricultural land. Support to less-favoured areas has in 2009 an estimated negative relationship with the price of land at -0.04 %. This negative result is opposite to the one found in Kilian et al (2012), which received a positive result.

The negative connection with the price of land of coupled support is estimated to be -0.09 % in 2009 and -0.1 % in 2011. The coupled support in 2009 and 2011 is coupled support to specific branches and not coupled to direct payments.

The estimated effect of environmental-organic support is -0.23 % in 2003 and -0.18 % in 2005. This means that in municipalities with a 1 % higher environmental support the price on agricultural land is 0.2 % lower. The negative effect is in line with the findings of Johansson & Nilsson (2012) and Kilian et al., (2012).

The R-squared for the regressions are lowest in 2003 when it is 34 % and it is as highest in 2013 when it is 45 %. Overall, the model does explain a greater variance in the dependent variable for the later years than for the first years.

Table 7. Estimated effects on the price of agricultural land at the median.

Median regressions Variables	2003	2005	2007	2009	2011	2013	2016
Yield	0.319					0.301	
	(0.271)					(0.264)	
Average farm size		-0.257***				0.232**	0.413***
		(0.0942)				(0.106)	(0.0928)
Share pasture						-0.0808*	-0.0975**
						(0.0467)	(0.0424)
Share fallow						-0.0696	
						(0.0472)	
Share agriland				0.136***			
				(0.0513)			
Population density	0.163***	0.124**	0.361***	0.146***	0.163***	0.266***	0.138**
	(0.0621)	(0.0536)	(0.0528)	(0.0434)	(0.0539)	(0.0554)	(0.0559)
Newbuild	0.0704***	0.0744***		0.0745***	0.0369	0.0343	0.0428*
	(0.0211)	(0.0194)		(0.0215)	(0.0245)	(0.0214)	(0.0234)
Avg. county price	0.292***	0.510***	0.405***	0.341***	0.372***	0.355***	0.425***
	(0.0829)	(0.0721)	(0.0851)	(0.0703)	(0.0856)	(0.0706)	(0.0755)
SFP		0.509	0.0567	0.536*	0.771***	0.106	0.153
		(0.311)	(0.327)	(0.278)	(0.259)	(0.306)	(0.119)
Coupled	-0.0694			-0.0917***	-0.0995***	-0.0255*	
	(0.0890)			(0.0277)	(0.0364)	(0.0146)	
LFA					-0.0359*		-0.0368
					(0.0209)		(0.0228)
ENVIECO	-0.232***	-0.180*					
	(0.0652)	(0.108)					
Constant	2.508***	1.241	2.116**	1.366	0.521	0.783	1.428***
	(0.806)	(1.021)	(1.036)	(1.036)	(0.898)	(0.979)	(0.533)
Observations	212	211	205	209	214	221	223
R^2	34%	38%	34%	34%	41%	45%	44%

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.2 Quantile & OLS regression

Figure 8 displays all statistically significant SFP estimations for all quantiles and the OLS-regression. It does not present any other variables than the decoupled direct payment due to the reason previously stated; it is the decoupled direct payments that are of most interest to the study. The full results, together with the standard errors, are displayed in Appendix 1.

In 2005 and 2016 the 25th percentile and the OLS regression is significant, in 2009 the median and 75th percentile is significant, in 2011 the 25th percentile, the median and the OLS regression is significant. From 2005 to 2011 the estimated elasticity does vary between 0.5 to 0.8 %, while the capitalising degree for 2016 is around 0.2 %. There is no statistically significant regression on the 95th percentile, or for 2007 and 2013. Also, it is important to notice that 2016 shows a much lower capitalising degree then the previous year.

The result of the quantile regressions shows that the capitalising degree of the decoupled direct payments is different for different quantiles, due to the skewness and asymmetric dependent variable. It can be noted that for those years that have at least two statistically significant results (OLS not included), 2009 and 2011, the trend is that higher quantiles exhibit a higher capitalising degree. This indicates the same thing as the study of Johansson & Nilsson (2012) does, that the capitalising degree is higher in municipalities with higher prices on agricultural land.

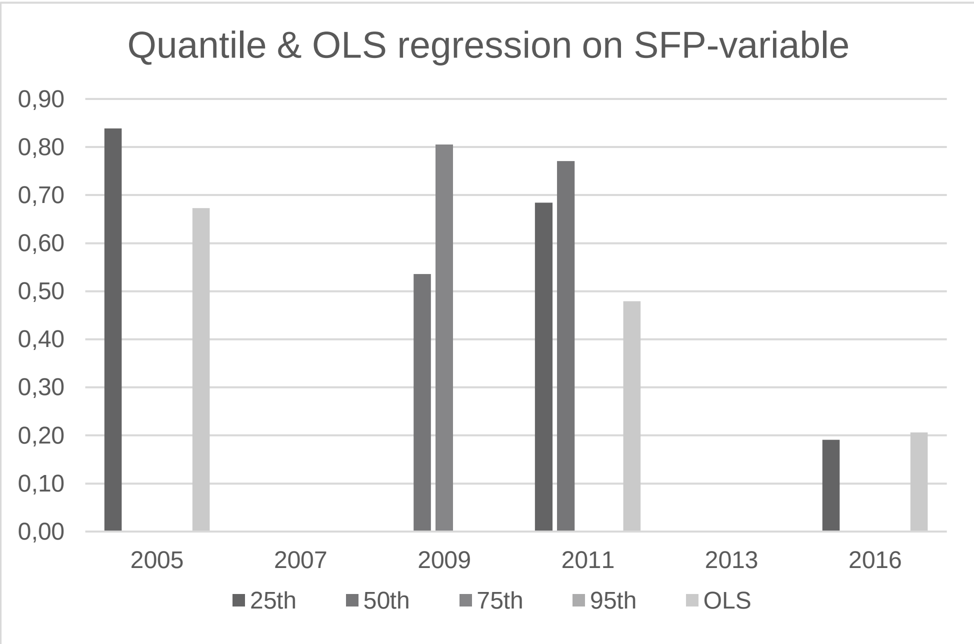

Figure 7. The estimated capitalising degree of the decoupled direct payments. All piles shown in the figure are statistically significant on at least 10 % level.

4.3 Panel data regression

Table 8. Panel data regression results.

Panel data Variables	2005-2013
Farmsize	0.00176
	(0.269)
Share pasture	-0.201
	(0.144)
Share fallow	-0.00713
	(0.0486)
Share agriland	0.326
	(0.313)
Population density	0.429
	(0.721)
Newbuild	0.0211
	(0.0151)
Avg. county price	0.558***
	(0.0691)
SFP	0.0482
	(0.274)
LFA	-0.0140
	(0.0437)
Coupled	-0.0112
	(0.0107)
ENVIECO	-0.103
	(0.111)
2007	0.0958***
	(0.0304)
2009	0.0801**
	(0.0403)
2011	0.134***
	(0.0344)
2013	0.117***
	(0.0418)
Constant	1.611
	(1.684)
Observations	1,060
Number of id	235
R^2	0.360

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The result pertaining to the panel data regression is displayed in Table 8. The estimated effect of the decoupled direct payments is positive, 0.05 %, but it is not statistically significant. The LFA-support, as well as the coupled support and the environmental-organic support are not statistically significant.

The average county price is statistically significant correlated with the dependent variable, estimated at 0.56 %

The share of pasture has a statistically negative correlation on -0.25 % with the price of agricultural land. The average county price is positively correlated with the dependent variable, 0.56 %.

All time dummy variables are statistically significant and have a positive correlation with the price of agricultural land.

The R^2 is 36 %, which is in line with the R^2-values in from the median quantile regressions.

5 Discussion

The result of the study, the model and limitations of the study is discussed in this chapter.

The result of this study supports the idea and theory that agricultural support may influence and capitalise in agricultural land value. It indicates that the decoupled direct payments are capitalised in agricultural land prices, with an estimated elasticity on the median that range between 0.54 % (2009) and 0.77 % (2011). Hence, the results indicate that in municipalities with 1 % higher decoupled direct payments compared to the median municipality, the price of agricultural land is correlated to be 0.54 - 0.77 % higher. This finding is in line with the theoretical framework and previous research, especially with the two most comparable studies, by Johansson & Nilsson (2012) and Kilian et al., (2012). Johansson & Nilsson estimate an elasticity of 0.6 % on the median municipality, while Kilian et al., estimate the elasticity on the mean to be between 0.28 – 0.78, depending on the type of land and entitlements model. The result is also in line with Latruffe & Le Mouël (2009) and Swinnen et al., (2013). They conclude in their meta-studies that the estimated elasticity between agricultural income payments and the price of agricultural land always are between zero and one.

The estimations on decoupled direct payments on the median are however only significant for two years, 2009 and 2011. It is hard to say why significant results only occurs for two years, but it makes it clear that it is important to interpret the results with caution and not take it for the only truth. When looking at the mean, median, quantiles and OLS regression there are, however, significant and positively correlated results for five of the seven years, which underpin the idea that the decoupled direct payments capitalise in higher land prices.

Furthermore, the results of the quantile regressions and mean regression indicate that the capitalisation degree for decoupled direct payments is higher in municipalities with higher prices on agricultural land, a finding that also is consistent with Johansson & Nilsson (2012). The higher capitalising degree in more expensive areas such (Skåne & Östergötland, for example) may depend on the fact that the direct payments have been higher in these areas, since the profitability have been higher in these areas. The high direct payment per hectare may have worked as a driver for farmers to buy more land, since the value of the entitlement that is linked to the land is higher. An implication of the larger capitalising is that it becomes harder for young people to buy land in these areas and start their career as farmers. This can in a longer timeframe have a negative impact on the area since the age structure of the farmers may be difficult to change. The result and explanation could however be more carefully examined and discussed in further studies where the result shows a more significance.

The LFA-support and ENVIECO-support are on the other hand, contrary to the results for direct payments, negatively connected with the price of agricultural land. In those municipalities that receive more LFA support and/or environmental-organic support the price of agricultural land is lower, compared with the median municipality. Johansson & Nilsson (2012) and Kilian et al., (2012) do also find a negative correlation between environmental support and land value, but the later article finds a positive correlation between LFA areas and land value.

The negative capitalising degree that ENVIECO-support exhibits can be due to under-compensation to farmers. The restrictions that farmers must obey to get the ENVIECO-support may create a larger loss in earnings than what the support cover for. The same reasoning can be valid for those cases where the LFA-support exhibits that the profitability of the land is lower than what the support compensate for. In LFA-areas in Bavaria farmers may on the other hand be overcompensated.

However, the findings in the thesis need to be interpreted with caution. Correlations between different forms of agricultural support and the price of agricultural land has been found, but the causality of the correlation has not been investigated. The price of agricultural land is, as Figure 7 shows, higher in the south of Sweden and at the larger cereal plains. The agriculture sector in these areas are more rationalised than average, the soil is more fertile, the production is higher, and the agricultural land is more expensive, as Figure 3 indicates. Due to the higher production and the hybrid implementation model, these areas have received higher decoupled direct payments per hectare. Therefore, this study cannot conclude whether the direct payments drive up the price on agricultural land, only that it exists a connection between the price of land and the decoupled direct payments.

A clear change in the capitalising degree of the decoupled direct payments can be seen when comparing the results from the quantile and OLS regression from 2016 with the other investigated years. It is much lower in 2016 then before, down from a span of 0.8 – 0.5 to 0.2. The lower values for 2016 may be due to the reformed CAP, which was rolled out in 2014.

The harmonisation of decoupled direct payments in the 2013 CAP reform are thought to have a positive effect on the capitalising degree, while the differentiation of support to farmers and greening support are supposed to have a negative effect. Since the harmonisation starts in 2015 and ends in 2020 in Sweden, the effect of it in 2016 may be small. On the other hand, since the greening and differentiation of support to farmers were implemented from 2015 and onwards, they could have had a negative effect on the capitalising degree in 2016.

The agriculturally related variables in the study (*yield*, *average farmsize*, *share pasture*, *share fallow* and *share agriland*) do not always indicate statistically significant correlations with the price of agricultural land, as the full result table in appendix 1 shows. This is in contrast with the literature review, in which these factors were found to influence the price, especially the fertility of the soil. Why these variables not always indicate statically significant correlations can have a natural explanation – they do not influence the price of agricultural land.

However, that explanation is not very likely since it stands against previous studies and literature. It is more likely that it depends on the data. For example, the dependent variable price per hectare is for some year and municipalities constituted of just three-four market transactions, which can give a misleading average price of agricultural land for that municipality and year. A way for solving this problem could have been to aggregate to county level instead of municipality level. But, in that case, the number of observations would decrease from around 210 to just 21. Also, using support level per country instead of per municipality would not have worked well together with the fact that the support per hectare differs in counties.

Why the, according to previous studies and literature, important factor soil fertility does not show statically significant correlation with the price of agricultural land is difficult to explain. One explanation may be that the data on soil fertility is older than the market transactions, but as discussed in the data chapter the effect of using old data can even be positive, since it can show a more true value of the soil fertility.

An important point to make is that the variable *average county price* is made up of the same market transactions that lie behind the dependent variable. This creates a risk of endogeneity in the regression. However, even if the *average county price* is based on the same data as the dependent variable, is it not influenced by the dependent variable.

6 Conclusions

Here the conclusions of the study are drawn and proposal for further research and policy recommendations are made.

The aim of this study, to answer the research questions "*To which extent is EU' s agricultural support within the CAP, especially looking at the decoupled direct payments, capitalised in agricultural land prices in Sweden during 2003 – 2016 and how does the capitalising degree change over the same time, particularly after the 2013 CAP reform?"* has been fulfilled by using a combination of the traditional capitalisation model and hedonic pricing model. Conventional (mean) and quantile regressions have been used to a cross-sectional dataset for the years 2003, 2005, 2007, 2009, 2011, 2013 and 2016 to determine how agricultural supports affects the price of agricultural land. Also, a panel data regression for the years 2005, 2007, 2009, 2011 and 2013 was performed to investigate the overall effect the agricultural support had on the price of agricultural land under the first CAP-period with decoupled direct payments. For all regressions, the price of agricultural land, aggregated to municipality level and based on 17 000 market transactions, has been the dependent variable.

The literature review focused on how agricultural support capitalises in land prices and which factors influence the price of agricultural land. It was found that factors like the fertility of the soil, agricultural structure, profitability, share of pasture and fallow land in the municipality, localisation, agricultural policies and usage of agricultural land to other purposes have an impact on the price of agricultural land. These factors have been used, together with a variable for decoupled direct payments, coupled payments, LFA-support and environmental-organic support, as regressors in the regressions. In the panel data regression a time dummy variable is also included.

The answer to the first research question, to which extent the agricultural support, especially the decoupled direct payments, has capitalised in higher agricultural land prices in Sweden between 2003 and 2016, is an estimated elasticity between 0.19 – 0.84 %. If the result for 2016 are excluded, the estimated span is between 0.48 – 0.84 %, well in line with the literature, mainly Latruffe & Le Mouël (2009), Johansson & Nilsson (2012), Kilian et al., (2012).

It is important to note that the result of the thesis indicates a correlation, but not the causal relationship between the decoupled direct payments and price of agricultural land. This thesis cannot conclude that decoupled direct payments drive up the price, only that the decoupled direct payments is capitalised in agricultural land prices.

The LFA-support, ENVIECO-support and coupled support show all a negative correlation with the price of agricultural land, in contrast to the decoupled direct payments.

The results of this thesis indicate that the answer to the second research question, if the capitalising degree changes over time, particularly after the 2013 CAP reform, is yes. Figure 8 shows that the capitalising degree is much lower after 2013 then what it is previous in the 2013 CAP reform, which may depend on the policy changes in the reform.

To better examine the second research questions could further research be conducted. This thesis does only examine data for one year after the 2013 CAP-reform. For a deeper understanding on how the 2013 reform affect the capitalising degree, data for more years after 2013 could be used. Such further research would probably also better capture the effect of the shift from a hybrid to a regional implementation model.

Another interesting research area, which has not been widely discussed in the thesis, is the effect on the ownership structure of agricultural land that the decoupled direct payments have. Sweden, among others, argues that one effect of the decoupled direct payments is that it becomes more expensive for young farmers to get into the business. Also, since the decoupled direct payments are capitalised in higher land values those farmers that own land is more benefitted than those farmers that rent land. Therefore, it would be interesting to investigate deeper what effect the decoupled direct payments have on the ownership structure and how this affects the profitability and the generation renewal in the sector.

This study has shown that the agricultural support within the CAP influences land value. The decoupled direct payments, which stands for more than half of the CAP budget as Figure 3 shows, have the largest effect on the price, as this study has shown. Therefore, the policy recommendations given will concentrate on the decoupled direct payments. However, to give policy recommendations the goal of the policy must be known. Since the introduction of this study highlighted the negative effects of the price increase of agricultural land, the goal of the given policy recommendations is to slow down the price increase. Given the correlation between the decoupled direct payments and the price of agricultural land, one way to reduce or slow down the increase in price, could be to reduce the amount of decoupled direct payments, which is the policy that Sweden argues for in the EU. It is also possible to increase the support to young farmers while decreasing the overall payment.

A switch like that would create a variance in the direct payments and lead to a decrease in the capitalising degree.

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Appendix

Appendix 1, econometrics result

Year			2003					2005		
Regressor/model	25th	50th	75th	95th	OLS	25th	50th	75th	95th	OLS
Yield	0.578**	0.319							-0.761	
	(0.288)	(0.271)							(0.465)	
Average farmsize				0.373		-0.254*	-0.257***		0.604***	-0.183*
				(0.229)		(0.133)	(0.0942)		(0.180)	(0.103)
Share pasture			-0.0931	-0.133						
			(0.0825)	(0.123)						
Share fallow				-0.178					-0.148	
				(0.156)					(0.0980)	
Share agriland				-0.378***		0.156*		-0.105	-0.451***	
				(0.128)		(0.0822)		(0.0832)	(0.120)	
Population density	0.143**	0.163***	0.217**	0.151	0.168***	0.0888	0.124**	0.204***	0.478***	0.148***
	(0.0659)	(0.0621)	(0.0944)	(0.110)	(0.0576)	(0.0656)	(0.0536)	(0.0694)	(0.0918)	(0.0537)
Newbuild	0.0766***	0.0704***	0.0434	0.0933**	0.0616***	0.0845***	0.0744***	0.0621**	0.0464	0.0660***
	(0.0224)	(0.0211)	(0.0330)	(0.0370)	(0.0203)	(0.0234)	(0.0194)	(0.0256)	(0.0310)	(0.0193)
Avg. countyprice	0.254***	0.292***	0.572***	0.923***	0.489***	0.387***	0.510***	0.586***	0.811***	0.458***
	(0.0880)	(0.0829)	(0.111)	(0.142)	(0.0645)	(0.0904)	(0.0721)	(0.0984)	(0.134)	(0.0733)
SFP						0.839**	0.509	0.208	0.438	0.673**
						(0.417)	(0.311)	(0.454)	(0.562)	(0.318)
Coupled	-0.0155	-0.0694	-0.128	0.184	0.00611				0.138**	0.0422
	(0.0944)	(0.0890)	(0.134)	(0.169)	(0.0813)				(0.0591)	(0.0345)
LFA						0.0365		-0.0389	-0.132***	-0.0328
						(0.0276)		(0.0256)	(0.0384)	(0.0222)
Envieco	-0.127*	-0.232***	-0.140	-0.158	-0.171***	-0.240*	-0.180*		0.355*	
	(0.0691)	(0.0652)	(0.0978)	(0.116)	(0.0594)	(0.141)	(0.108)		(0.202)	
Constant	1.262	2.508***	2.304***	-1.047	2.368***	0.909	1.241	0.911	-0.850	0.286
	(0.856)	(0.806)	(0.740)	(1.195)	(0.436)	(1.438)	(1.021)	(1.496)	(2.171)	(0.927)
Observations	212	212	212	212	212	211	211	211	211	211
R^2	33%	34%	33%	50%	54%	37%	38%	37%	41%	58%

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Year			2007					2009		
Regressor/model	25th	50th	75th	95th	OLS	25th	50th	75th	95th	OLS
Yield					0.239	-0.361				
					(0.218)	(0.278)				
Average farmsize	0.209								0.433**	
	(0.127)								(0.215)	
Share pasture					-0.0624					
					(0.0406)					
Share fallow										
Share agriland	0.107					0.204***	0.136***		-0.163	0.0986
	(0.0729)					(0.0727)	(0.0513)		(0.141)	(0.0619)
Population density	0.210***	0.361***	0.316***	0.307*	0.243***	0.0839	0.146***	0.188***		0.109**
	(0.0583)	(0.0528)	(0.0794)	(0.164)	(0.0532)	(0.0545)	(0.0434)	(0.0579)		(0.0476)
Newbuild	0.0457*		0.0357		0.0461**	0.0705***	0.0745***	0.0405	0.169***	0.0781***
	(0.0241)		(0.0340)		(0.0216)	(0.0262)	(0.0215)	(0.0296)	(0.0436)	(0.0231)
Avg. countyprice	0.415***	0.405***	0.435***	0.643**	0.439***	0.338***	0.341***	0.516***	0.639***	0.400***
	(0.0825)	(0.0851)	(0.114)	(0.264)	(0.0787)	(0.0976)	(0.0703)	(0.0904)	(0.165)	(0.0758)
SFP	-0.171	0.0567	0.182	0.765	0.204	0.377	0.536*	0.805***	-0.346	0.375
	(0.360)	(0.327)	(0.425)	(1.014)	(0.290)	(0.347)	(0.278)	(0.301)	(0.691)	(0.301)
Coupled	-0.111**						-0.0917***	-0.131***		-0.0770**
	(0.0539)						(0.0277)	(0.0380)		(0.0319)
LFA	0.0408*		-0.0320							
	(0.0229)		(0.0269)							
Envieco						-0.262**			-0.310	-0.106
						(0.103)			(0.194)	(0.0925)
Constant	2.746**	2.116**	1.784	-0.960	0.706	3.794***	1.366	-0.342	3.047	1.907*
	(1.243)	(1.036)	(1.474)	(3.211)	(0.816)	(1.421)	(1.036)	(0.971)	(2.506)	(1.123)
Observations	205	205	205	205	205	209	209	209	209	209
R^2	33%	34%	40%	42%	56%	33%	34%	37%	37%	55%

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Year			2011					2013		
Regressor/model	25th	50th	75th	95th	OLS	25th	50th	75th	95th	OLS
Yield	0.476*			1.573***	0.419**	0.766***	0.301	0.312	-0.661	0.370
	(0.254)			(0.598)	(0.197)	(0.291)	(0.264)	(0.276)	(0.492)	(0.225)
Average farmsize				-0.341		0.147	0.232**	0.194*		
				(0.263)		(0.120)	(0.106)	(0.114)		
Share pasture	-0.123**		-0.0940**	-0.136	-0.0445	-0.129**	-0.0808*	-0.136***	-0.197**	-0.119***
	(0.0587)		(0.0462)	(0.109)	(0.0404)	(0.0517)	(0.0467)	(0.0446)	(0.0757)	(0.0418)
Share fallow	-0.138***		-0.0970**		-0.0644*	-0.125**	-0.0696			-0.0729*
	(0.0446)		(0.0419)		(0.0369)	(0.0533)	(0.0472)			(0.0421)
Share agriland									0.170	
									(0.130)	
Population density	0.0770	0.163***	0.147***		0.141***	0.188***	0.266***	0.240***	0.239***	0.207***
	(0.0538)	(0.0539)	(0.0489)		(0.0440)	(0.0603)	(0.0554)	(0.0589)	(0.0839)	(0.0485)
Newbuild	0.0509**	0.0369	0.0350		0.0276	0.0349	0.0343	0.0370		0.0462**
	(0.0234)	(0.0245)	(0.0223)		(0.0193)	(0.0235)	(0.0214)	(0.0229)		(0.0190)
Avg. countyprice	0.358***	0.372***	0.469***	0.390*	0.350***	0.253***	0.355***	0.464***	0.783***	0.403***
	(0.0934)	(0.0856)	(0.0812)	(0.225)	(0.0743)	(0.0784)	(0.0706)	(0.0766)	(0.134)	(0.0635)
SFP	0.684**	0.771***	-0.0457	-0.287	0.479*	-0.391	0.106	-0.334	-0.0255	-0.140
	(0.296)	(0.259)	(0.274)	(0.657)	(0.245)	(0.336)	(0.306)	(0.266)	(0.471)	(0.275)
Coupled	-0.117***	-0.0995***	-0.0773**	-0.148*	-0.112***		-0.0255*	-0.0178	-0.0699**	-0.0175
	(0.0339)	(0.0364)	(0.0343)	(0.0858)	(0.0280)		(0.0146)	(0.0158)	(0.0287)	(0.0130)
LFA		-0.0359*	-0.0561***							-0.0328*
		(0.0209)	(0.0197)							(0.0184)
Envieco	0.155									
	(0.123)									
Constant	-1.615	0.521	2.591***	-0.612	-0.0307	1.292	0.783	1.898*	3.363	1.572
	(1.052)	(0.898)	(0.890)	(1.891)	(0.594)	(1.021)	(0.979)	(1.014)	(2.140)	(1.009)
Observations	214	214	214	214	214	221	221	221	221	221
R^2	37%	41%	49%	48%	63%	39%	45%	50%	49%	67%

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Year			2016		
Regressor/model	25th	50th	75th	95th	OLS
Yield					
Average farmsize	0.325***	0.413***			0.199***
	(0.0631)	(0.0928)			(0.0763)
Share pasture	-0.125***	-0.0975**	-0.117*	-0.146*	-0.104**
	(0.0360)	(0.0424)	(0.0705)	(0.0857)	(0.0459)
Share fallow	-0.0901**			-0.0964	-0.0699
	(0.0354)			(0.0817)	(0.0435)
Share agriland					
Population density	0.136***	0.138**	0.192***	0.263***	0.148***
	(0.0401)	(0.0559)	(0.0670)	(0.0944)	(0.0472)
Newbuild	0.0440***	0.0428*		0.0530	0.0569***
	(0.0163)	(0.0234)		(0.0385)	(0.0192)
Avg. countyprice	0.403***	0.425***	0.458***	0.593***	0.512***
	(0.0496)	(0.0755)	(0.109)	(0.111)	(0.0591)
SFP	0.191*	0.153	0.231	0.338	0.206*
	(0.0989)	(0.119)	(0.204)	(0.235)	(0.118)
Coupled	-0.126**		-0.195	-0.291**	-0.177**
	(0.0530)		(0.120)	(0.139)	(0.0715)
LFA		-0.0368	-0.0721**		
		(0.0228)	(0.0326)		
Envieco			0.283**	0.217	0.0887
			(0.125)	(0.142)	(0.0730)
Constant	1.537***	1.428***	1.613**	0.684	1.169***
	(0.335)	(0.533)	(0.814)	(0.891)	(0.447)
Observations	223	223	223	223	223
R^2	42%	44%	46%	52%	68%

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1