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FACTORS AFFECTING FARMLAND PRICES IN FINLAND

Perttu Pyykkönen

ACADEMIC DISSERTATION

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Supervisor: *Matti Ylätalo*
Professor
University of Helsinki

Reviewers: *Barry K. Goodwin*
Professor
North Carolina State University

Kyösti Pietola
Professor
MTT Agrifood Research Finland

Opponent: *Markku Penttinen*
Adjunct Professor
The Finnish Forest Research Institute

Pellervon taloudellinen tutkimuslaitos PTT
Pellervo Economic Research Institute
Eerikinkatu 28 A
FI-00180 Helsinki
Puh.+358 9 348 8844
Fax. +358 9 3488 8500
E-mail econ.res@ptt.fi

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Abstract: The purpose of the study was to analyse factors affecting the differences in land prices between regions. The key issue was to find out the policy effects on farmland prices. In addition to comprehensive literature review, a theoretical analysis as well as modern panel and spatial econometric techniques were utilized. The data were exceptionally large, comprising more than 6 000 observations. This study supports the view that there are many other factors that affect farmland prices besides pure agricultural returns. It was also found that the support clearly affects land prices. Furthermore, a weak indication of the discount rate for support being a little lower was found. An important result of this study is that the structural differences between regions and the structural change in agriculture seemed to have a considerable role in affecting land prices. The introduction of the manure density variable proved to be an efficient way to aggregate the otherwise very difficult task of taking into account the environmental pressure caused by structural change in animal husbandry. Finally, infrastructure also has a very important role in determining the price level of agricultural land.
Keywords: *Farmland price, hedonic model, spatial econometrics*

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Tiivistelmä: Tutkimuksen tavoitteena oli selvittää, mitkä tekijät selittävät pellon hinnoissa tapahtuneita muutoksia ja alueellisia eroja sekä miten tukipolitiikan muutos ja rakennekehityspaineet vaikuttavat pellon hintoihin. Laajan kirjallisuuskatsauksen ja teoreettisen tarkastelun lisäksi tutkimuksessa käytettiin moderneja ekonometrisia menetelmiä. Tutkimuksen empiirisessä osassa käytettiin hyväksi sekä paneelianalyysia että hedonista analyysiä, johon liitettiin mukaan spatiaalinen analyysi. Tutkimuksen keskeisenä aineistona käytettiin tietoja noin 6 000 peltokaupasta vuosilta 1995-2002. Analyysit osoittivat, että pellon hintaan vaikuttavat monet muut kuin puhtaasti maatalouteen ja pellon tuottokykyyn liittyvät tekijät. Tukipolitiikan muutosten todettiin olevan pääsääntöisesti sellaisia, että niiden seurauksena pellon hinta nousee. Tutkimus vahvisti eräitä yleisiä yhteyksiä pellon hinnan ja kaupan koon sekä pellon tuottokyvyn suhteesta. Tuen todettiin myös pääomittuvan pellon hintaan hieman markkinatuloja voimakkaammin. Kotieläintalouden rakennekehitys ja tuotannon keskittyminen sekä ympäristötekijöiden huomioonottamisen tarve nousi myös selkeästi esiin pellon hintaa kohottavana tekijänä.
Avainsanat: *Pellon hinta, hedoninen malli, spatiaalinen analyysi*

PREFACE

The preparation of the thesis was quite a long process including many interruptions. It is a satisfying feeling to be at this stage. I am indebted to many persons who in one way or another have contributed to the work.

I am grateful to Professor Matti Ylätalo, whose role especially in the initializing stage of the thesis was very important, as were his comments on the work and his support throughout the whole process. I also wish to express my gratitude to my official pre-examiners, Professors Barry K. Goodwin and Kyösti Pietola. Their well-defined comments and constructive suggestions were very valuable. Furthermore, I want to thank Adjunct Professor Markku Penttinen for acting as my opponent at such short notice.

My work has also benefited from the comments of Professor Pekka Ilmakunnas, Dr. Juha Marttila and Dr. Matti Ryhänen.

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Of the persons whose encouragement during the preparation of this thesis has been of extreme value, I especially want to mention Dr. Mikko Siitonen and Mr. Seppo Aaltonen. I also want to thank Professor Viljo Ryynänen; without his guidance I would never have started my research career.

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Finally and most importantly, I want to thank my family. Without my wife Johanna’s belief in me I would never have started the work, and without her love and care during the process, I would never have completed it. I dedicate this thesis to you, Johanna, and to Anniina and Juhani, our precious children who were born during the process.

Anttila, 12th April, 2006

Perttu Pyykkönen

CONTENTS

1 INTRODUCTION

1.1 Background

Land is the fundamental input in agricultural production. In addition, land has several other functions that emphasize its special nature as a production factor. Land also produces services whose value cannot be measured in monetary terms. Thus, the value of land is not only based on its economic value. Oltmer (2003) has listed the basic functions of agricultural land based on Slangen's (1992), and Randall and Castle's (1985) work. In addition to its production function, land has ecological, cultural, informative and educational, recreational, and social functions.

Classical economists based their theory of land rent on the fixity of land supply (Ricardo 1815; von Thünen 1826). They also assumed that land cannot be substituted in the production process. Thus, the need for special treatment of land in economic analysis was clear. Later, both the fixity and substitution assumption have been relaxed, but land is still a very scarce production factor and inelastic in substitution. Even though the neo-classical theory considers land (as well as labour) as a similar production factor to other capital, the special role and properties of land are widely recognized.

The special nature of land follows from the facts that land cannot be moved, more land cannot be produced, and furthermore, land does not wear out. Miranowski and Cochran (1993 ref. Oltmer 2003) pointed out that the fixed location of land means that it is also bound to a geo-climatic environment that influences soil characteristics and productivity. Thus, the amount of land suitable for specific production processes is relatively limited. This is especially true in Finnish conditions.

The last two facts are not the whole truth, since there are some exceptions to these properties. The total supply of land is fixed (with the exception of reclaiming land from the sea), but not necessarily the supply of farmland. In some areas, drainage or irrigation can produce more farmland. In other areas, farmland can be cleared from forests (e.g. in Amazonia as well in Finland). On the other hand, farmland can be developed and used for housing and other non-farm operations or it can be forested (e.g. in Finland). The durability of land is also slightly debatable. Erosion is a problem in certain areas of the world, and land can actually be destroyed by over-cropping or insufficient maintenance.

Due to these special properties, land is valued differently from many other commodities. Land rent (or price) determines the allocation of land resources among different uses, as well as determining the value of land as collateral for credit or to define land taxes (e.g. Trivelli 1997; Oltmer 2003).

Due to the importance of land in agricultural production[1], the factors affecting land prices and price movements have also been a very important topic in agricultural economics research. During the last decade, the growing interest has concentrated on policy effects on land prices. This is quite understandable, since recent policy changes in both the EU and USA have decreased the importance of producer prices (market returns) and increased the importance of support incomes to farmers. At the same time, the purpose has been to apply more market oriented policy and decouple support from production.

The increase in support has led to discussion of a possible leaking of support outside agriculture. For example, the European Parliament and EU Commission, as well as the OECD, have been worried about the issue (e.g. Guyomard and Le Bris 2003; Report on the situation… 2000; Bureau 1998). If this leakage is substantial the policy cannot be considered very effective. Thus, there has been growing literature on this topic during the last ten years (see e.g. Bureau 1998; Le Mouel 2003).

In Finland, this topic is especially interesting, since our agricultural policy changed dramatically in 1995 when Finland joined the European Union (EU). The importance of support in the net income of Finnish farmers is among the greatest in EU countries, if not the greatest (Patjas 2002). After EU membership, land prices started to increase and the suspicions of support capitalizing into land prices became more obvious. An evaluation of LFA support made for the EU Commission at least in some sense supported these arguments (Neuvoston asetuksen (EY) n:o 950/97 mukaisten… 2000).

[1] The land is the greatest capital item in Finnish agriculture. According to Pyykkönen (2001a), arable land comprised about 35% of the total agricultural assets of Finnish farms.

1.2 Objectives

When land prices are concerned, two important matters require closer consideration. The first concerns the differences in land prices between regions. The factors causing the differences in price levels between regions and locally are the central topic of this study.

The second matter concerns the fluctuation of land prices over time. The objective of this study is to determine the nature of the fluctuation, and the factors that explain the changes in land prices over time.

Since agriculture is strongly regulated, the possible policy effects on farmland prices call for special attention. These questions are especially interesting at present when the Common Agricultural Policy of European Union has faced one of the greatest reforms in its history. More research is needed, especially in Finnish conditions where the proportion of the support is much bigger than elsewhere in the EU. The effect of land-based income support on land prices is the first policy effect that needs to be explored.

The second policy-related issue possibly affecting land prices is structural change. There is ongoing pressure to improve the structure of Finnish agriculture (i.e. promote the growth of farms). Thus, the aim of the study is to analyse how the structure of agriculture and changes in it affect land prices.

The main interest in this study is to analyse sales prices, but lease prices will also be examined.

1.3 Structure of the study

The study is organized as follows. After this introductory chapter the Finnish land market is described in chapter 2.1. The change in agricultural policy due to the EU membership and the continuing pressure to change the policy even further makes the question of policy effects on land prices increasingly interesting. Thus, a brief description of the agricultural policy in Finland is warranted. This is presented in chapter 2.2. Chapter 2.3 provides a short overview of the changes in infrastructure that are connected to agriculture.

Chapter 3 provides a literature review that begins by reviewing the basic theories on land rent and its capitalization (chapters 3.1-3.3). The remainder of the chapter is devoted to previous studies concerning land prices and the factors affecting them, which are divided here into two categories. The first group consists of studies that mainly concentrate on price differences between regions (chapter 3.4.1) and the second group concentrates on the price movements over time (chapter 3.4.2).

The division might well be based on other distinctions. For example, Shi et al. (1997) also divided previous studies into two categories. Their first category included studies based on the income from agriculture as the major determinant for land rent and prices (capital asset pricing models), while the second category placed more emphasis on non-farm factors.

Le Mouel (2003) divided the literature firstly into studies that concentrate on the capitalization formula and large variation over time, and secondly into studies that concentrate on the distribution of the benefits of agricultural support programs.

Weersink et al. (1999) also had a different division, which they based on econometric issues, but they only concentrated on studies that explain variation over time. The distinction was made between traditional time series and modern co-integration estimation methods. Another possible distinction based on econometrics could be the division into three categories: time series, cross-section, and panel models.

Agricultural support can have two types of effect on land price. Firstly, the increase in support and decrease in producer price may change production behaviour, which has an effect on land rent. In chapter 4.1, a simple theoretical model is developed that enlightens this side of the effect of support on land prices. Secondly, market income and support income may capitalize differently. The empirical analyses carried out thus far have concentrated on this side of the support effect. This has briefly been considered together with the production behaviour change in chapter 4.2.

Chapter 5 provides empirical analyses of factors affecting Finnish land prices. The chapter begins with an introductory section and continues with more or less technical time series analysis of imputed land prices based on cash rents. The comparisons between imputed land values and market prices are also drawn in this section (chapter 5.2). The first econometric analysis is a panel data model. This analysis is a rough application of the present value model in which only the agricultural factors are taken into account (chapter 5.3). The second econometric analysis is a more precise semi-hedonic model that also takes into account the spatial nature of the data (chapter 5.4). In both analyses, the possibly different capitalization of support income is under investigation. The discussion section in chapter 6 concludes the study.

2. OVERVIEW OF THE FINNISH LAND MARKET AND AGRICULTURAL INFRASTRUCTURE IN 1990-2004

2.1 Overview of the Finnish land market

2.1.1 Land transfers in Finland

The structural change in Finnish agriculture has been quite rapid when measured in terms of the number of farms over the last 40 years. Since EU membership in 1995 the number of farms has decreased from 96 000 to 72 000 in 2003 (PTT 2004). Estimates based on previous development in farm number and generation transfers or on a sector model have indicated that the number of farms will decline to less than 50 000 by the year 2010 (Pyykkönen 2001b; Strategy project 2001; Lehtonen 2001). Even though the decline in the number of farms has now become slower, the rapid change is expected to continue in the near future (Gallup Elintarviketieto 2005; Lehtonen and Pyykkönen 2005).

The land market can be divided into two main categories: whole farm transfers, and transfers of additional land. Both of these categories can be further divided into two subcategories: sales and rental contracts. Whole farm transfers can also be divided in another way into subcategories depending on whether the farm is kept as an independent unit or is additional land for some other farm. The first mentioned cases are usually generation transfers.

By using different data sources, we can divide land transfers into subcategories for the year 1999.[2] According to the price statistics of the National Land Survey (NLS), the total transferred arable land area in 4 175 sales was about 40 000 ha. Of these, 626 sales (about 10% of the transferred area) were such that the transfer was not between relatives, the

[2] Unfortunately, the databases restrict the division to quite a rough level for several reasons. Whether the farm is kept as an independent unit or is an additional land for some other farm cannot be separated. Neither is the exact number of generation transfers available. The market description is restricted here to the year 1999 due to the availability of data. However, the situation has very probably been quite similar during the last ten years.

lot was sold without buildings or other property, and only consisted of arable land.[3] At the same time the rented area on Finnish farms grew by 39 000 ha (calculated from IACS register[4]). Thus, the total transferred areas in sales and new rental contracts were almost identical. Both of them were slightly less than 2% the total arable land area in Finland (about 2.2 mil. ha), and the total transferred area was 3.7%.

The relationship between sales and rentals has changed during the last ten years. The rental area has risen rapidly whereas the sales area, especially due to fewer generation transfers, has decreased (Pyykkönen 2001b; Myyrä 2004).

In Finland, the relative proportion of the rented area has traditionally been very low. This has roots in our quite peculiar agricultural history with, for instance, the change in the tenant farmers' position in the 1920s and the settlement policy after the Second World War. Compared to other EU-countries the relative proportion of rented agricultural land has been one of the lowest. However, situation has changed tremendously in recent years (Figure 2.1).

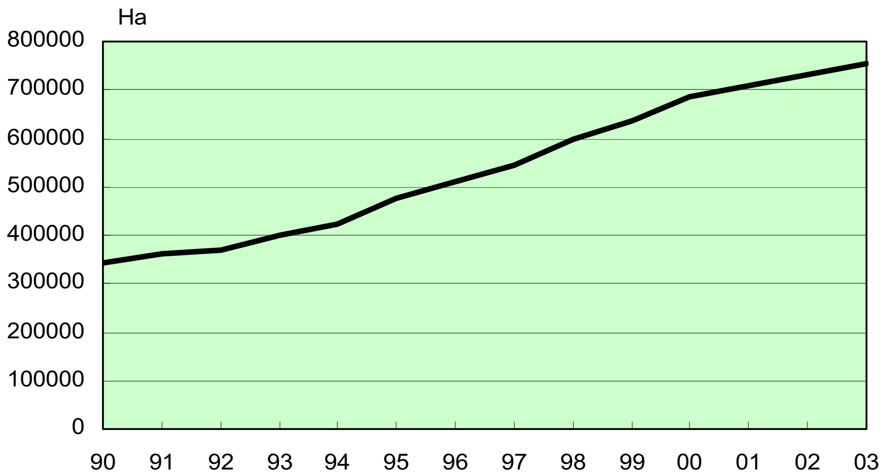


***Figure 2.1**. The area of rented agricultural land in Finland.*

[3] These sales are hereafter referred to as the representative sales. Sometimes they are also termed as arms-length sales.
[4] Integrated Administration and Control System of the Ministry of Agriculture.

At the beginning of the 1990s, the relative proportion of rented land was only about 15%, but by the year 2000 the proportion had already reached more than 30%. Thus, the rented area has doubled in only ten years.

Almost all of the rental area has traditionally been so-called additional land, since the renting of whole farms as independent units has been very rare. In recent years the situation has slightly changed since some generation transfers have phased out by first leasing the farm and then later transferring the ownership of the farm. Still, the proportion of whole farm renting is quite small. Unfortunately, no exact data are available.

The representative sales (about 10% of the total sales area, as mentioned earlier) can all be considered as additional land. Of the remaining 90% (36 000 ha) of the sales area, a considerable proportion is also additional land.[5] Again, there are data problems, and we can only roughly estimate this amount. Taking into account that the number of generation transfers was about 900 (see Pyykkönen 2001b) in 1999, and the average arable land area (owned) in those transfers was about 25 ha[6], it can be calculated that the generation transfer area was about 23 000 ha. Therefore, the remaining 13 000 ha, was also additional land. Thus, we can construct the following figures for the Finnish land market in 1999:

Additional land transfers:			56 000 ha
of which:	*rented*	*39 000 ha*	
	sales	*17 000 ha*	
Whole farm sales:			23 000 ha
Transfers total:			79 000 ha

Although this division is very approximate, it nevertheless gives some picture of the Finnish land market. To be more accurate, especially at the regional level, more data would be needed.

[5] Ryynänen (1978) points out that the role of additional land in Finnish land market has increased in the 1960's. Until then, it was common that a farm was bought to be kept as an independent economic unit.

[6] The proportion of those generation transfers (by sale) on which the successors have received young farmers' aid can be estimated at 50-60%. Based on Pyykkönen's (2001c) study, their average own arable area is about 30 ha. The rest of the generation transfers have taken place on smaller farms. If we assume that the average farm size on these smaller farms has been about 20 ha, it can be estimated that the average area in all generation transfers has been about 25 ha.

In additional land transfers the rental proportion (70%) is much greater, since generation transfers are mainly comprised of sales (according to Pyykkönen (2001c) almost 90%). An obvious reason for the small number of generation changes is the increased uncertainty of the future possibilities of profitable production. Renting has increased partly for the same reason.

The differences in the relationship between renting and sales (on average almost 50/50 as mentioned earlier) were in general not very large between regions. There were a couple of exceptions[7], but in most of the regions the relationship was quite close to the Finnish average.

By contrast, the proportion of generation transfers does vary between regions (Pyykkönen 2001b), but it cannot be calculated exactly. There are also differences in the proportion of the representative sales. However, they are not very systematic when we look at the structural changes occurring in Finland, since the highest proportions of representative sales were in Lapland (22%) and Central Ostrobothnia (17%), whereas the lowest proportions were in Kainuu and Uusimaa (4%).[8] Both of these pairs represent almost the opposite ends of the spectrum of structural change and investment activity (see Pyykkönen 2001b).

Thus, the land market is rather thin market in Finland. Since the transaction of a specific parcel happens very seldom (once in 25-30 years), and due to the special properties of land, it is obvious that the price formation may not be as simple as for other commodities. Potential buyers close to the parcel may well be ready to pay a very high price for this specific parcel. A second implication of the thin market is that the market information may not be perfect. The thin market might also serve as a partial reason for the high transaction costs that may also play an important role in farmland trade. Vice versa, the high transaction costs may lead to a thin market (see Chavas 2003). However, buyers and sellers usually know each other. Thus, at least search costs are not necessarily very expensive, and the role of transaction costs from this point of view may not be very distorting.

[7] Uusimaa and East Uusimaa, where the proportion of renting was much lower (24-36%), and the Åland Islands, South Karelia, and South Savo, where the proportion of renting was much higher (64-78%).

[8] See the map in Appendix 1.

2.1.2 Sales prices in 1991-2003

These regional differences and growth pressures at the farm level have probably affected land prices. They may cause the problem of increasing land prices at least in those areas where there are large numbers of growth-oriented farmers (Pyykkönen 2001b).

The data are again taken from the price statistics of the National Land Survey (NLS). The price analysis must be restricted to the so-called representative transfers, since the complete dataset does not include the price information divided into different property parts. However, we can take more years (1991-2003) under consideration than in the previous chapter's market description.

The median price[9] of additional land is much higher than the price of land in whole farm sales (see e.g. Ylätalo 1991; also Peltola 1997). In this study, we concentrate on additional land. Nevertheless, for comparison it can be estimated that the aforementioned is also very true with these data. For example, in 1999 the average price of additional land was about 3 500 €/ha. The average price in all sales cannot be calculated exactly from the data available, since only the total number of transferred hectares is known, but not how the area is divided into arable land and forestland. However, by assuming the forest land value to be 50% (1 750 €/ha)[10] of the value of the arable land, it can be estimated that the arable land price in other sales has been about 2 700 €/ha. When also taking into account the fact that the other sales included not only land but very often also other property (e.g. buildings), we can estimate that the land price in these other sales has not been more than 50-60% of the price in representative additional land sales. The price variation over time has, however, been considerable during the last decade (Figure 2.2).

At the beginning of the 1990s prices were at very high level, since they had risen almost throughout the 1980s. The prices then fell very dramatically in the early 1990s. The reasons for these changes may be partly found in the general boom and depression of the Finnish economy, but

[9] The median price is widely used by NLS instead of the average price even though they usually do not differ from each other very much.
[10] The price of forestland has been about 40% of the farmland price in price statistics, but the sold forestlands have been a little less woody than the average forestland in Finland (e.g. Hannelius 1998). Thus, the estimate that has been used in this calculation is a little greater.

also in the discussions that started the process leading to Finnish membership of the EU in 1995. Farmers were afraid of the future, and they were uncertain about their abilities to produce at least as profitably as before.

Then, after EU membership, land prices started to rise again. The reasons for this are not very clear. There has been considerable discussion of the capitalization of direct support into land prices. There are probably several other reasons for this rise. This becomes especially clear when we look at the differences in price levels and price changes between regions. Here we start by looking at the differences in price levels (Figure 2.3 and Map 2.1).

One reason for these differences could be differences in the quality of the arable land, while another might be differences in agricultural viability (Pyykkönen 2001b). However, quality differences do not necessarily explain the differences in price changes. The changes over time have been much greater in the high price areas, at least in absolute terms (Figure 2.4).

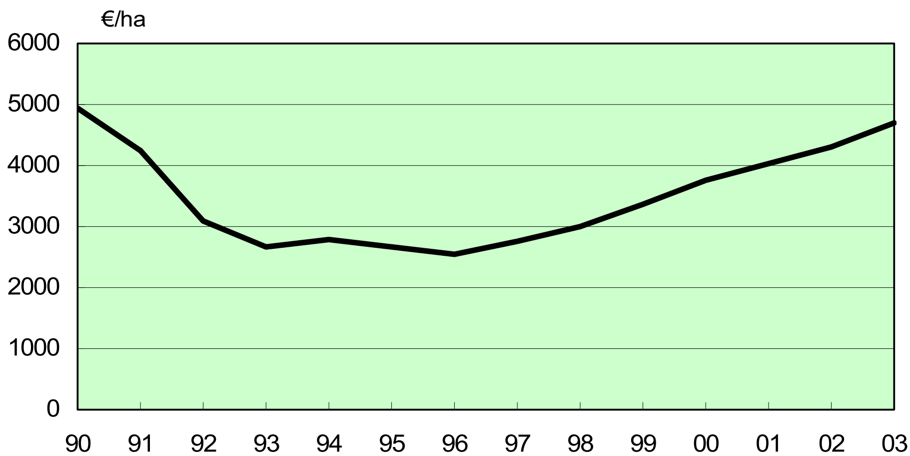


Figure 2.2. *The median price of additional land in 1990-2003.*

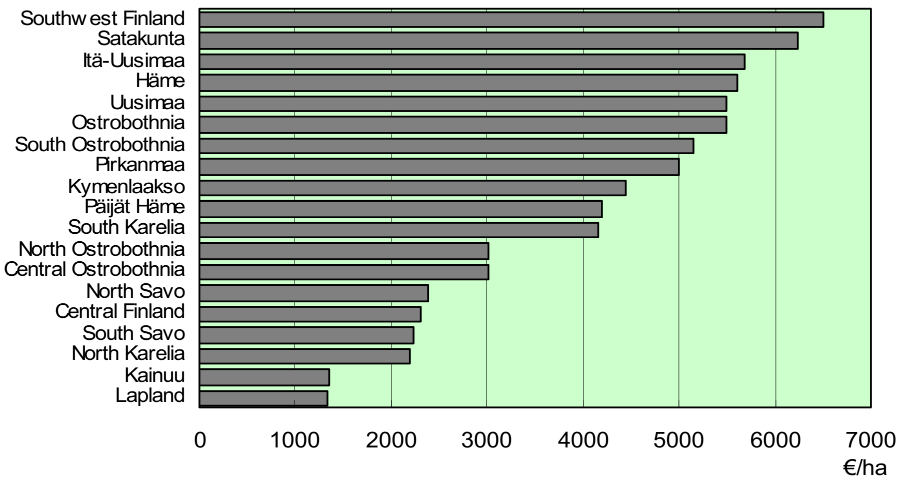


Figure 2.3. *The median price of additional land in different regions of Finland in 2003 (regions defined in Appendix 1).*

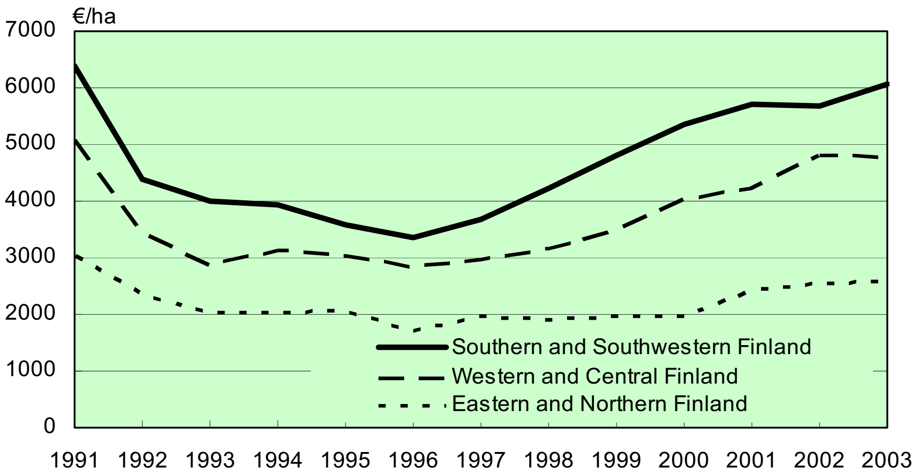
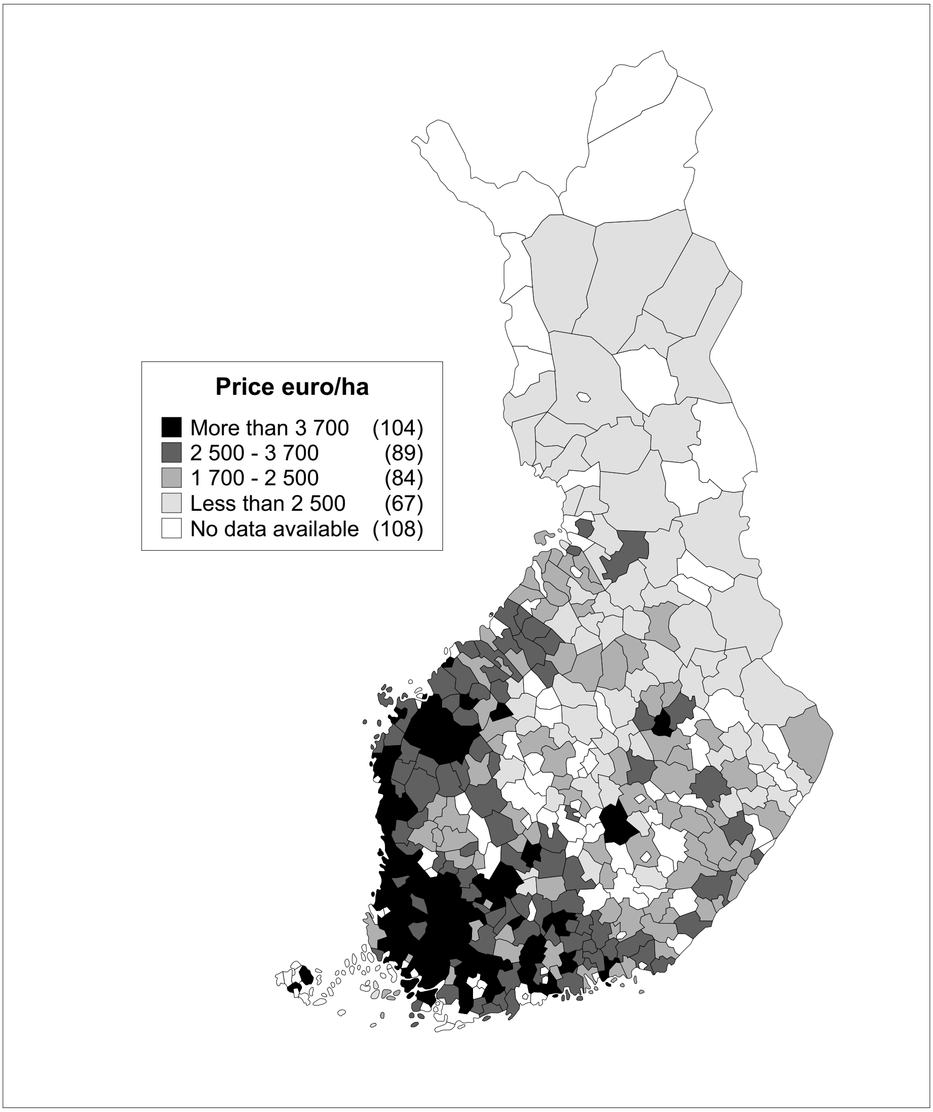


Figure 2.4. *Land price changes in different regions of Finland in 1991-2003.*



Map 2.1. *The price of additional land in Finland in 2000.*

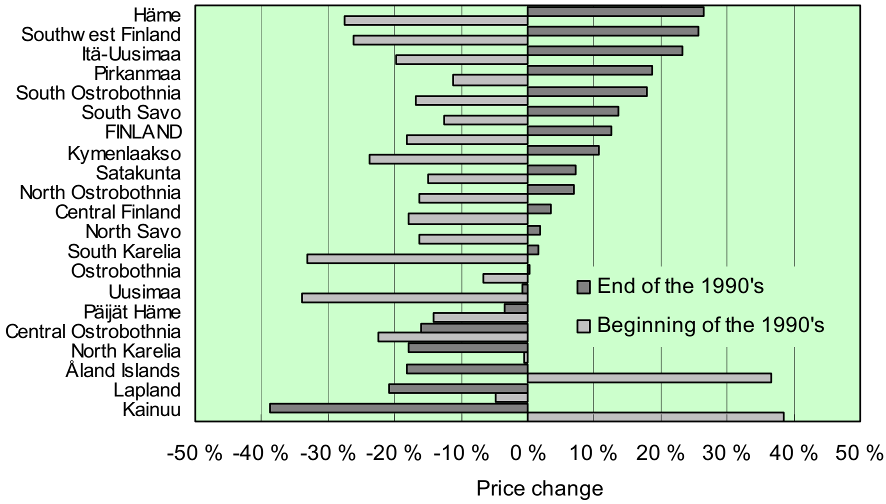


Figure 2.5. *The price changes of additional land in 1991-1995 and 1995-1999 in different regions of Finland.*

The variation is very large in every region and in every year (see Appendix 2). Even if we leave the highest and lowest prices (5% from both ends) outside the analysis, the highest prices are from three to six times higher than the lowest prices. The variation also seems to grow with the price.

It was already mentioned that the price change over time cannot be explained by quality differences. However, they may somehow affect the price changes. Perhaps, farmers' expectations fell the most in the best regions before EU membership. The upcoming producer price reduction was probably expected to hit the hardest those regions where the yield level was highest. However, after membership the expectations also grew the most when farmers noticed that the prospects for farming were not as bad as they had expected due to the compensation based on land-based support. These changes become more obvious when we look at the price changes in more detail (Figure 2.5 and Appendix 3).

The figures and maps are almost mirror images. In general, the changes also seem to have been greatest in the strongest agricultural areas in relative terms.[11] One reason for the price rise is the structural change and quite rapid farm growth in certain areas of Finland. Especially the connection

[11] The relative changes also seem to have been great in the most difficult agricultural areas (Lapland, Kainuu), but this may be due to a very small number of data observations (only few representative sales in most of the years) in these areas.

between husbandry investments (see Pyykkönen 2001b) and land prices seems to be very clear.

The demand for additional land has been higher in certain areas. At the same time, the supply has been just the opposite. The investment activity and the need for additional land have been much higher in southern and western Finland.

There are also differences in the production structure of the areas with volatile prices and those with non-volatile prices. In volatile areas, the production possibilities are more versatile. However, in the non-volatile areas in eastern and northern Finland the structure of agriculture is much more homogeneous, since milk production is almost the only possibility. This may also have had some effect on the different price changes.

One possible reason may also be found in the changed support system. The increased amount of area-based support is suspected to have capitalized into the land prices and increased them. At least this graphical analysis does not make the capitalization effect clear, since the prices have not increased in every region although the support has increased in the same manner.

2.1.3 Rental prices in 1994-2001

The data for rental prices are taken from the taxation statistics of Statistics Finland. These data are very limited and can give only a very approximate picture of the situation. More detailed data based on a survey of Finnish book-keeping farms (603 farms) can be found in Myyrä's (2004) study. In practice, all the leasing in Finland is cash leasing, and no share leasing exists.

The taxation statistics include the rented area and the average rental price. Thus, the data are on a much rougher level than the data for sales prices. Unfortunately, the data could only be examined from 1995 when it became available at the province level.

The rental price differences between regions are quite similar to the sales price differences described in previous chapter. The prices are highest in the best agricultural areas in the southwestern parts of Finland (Figure 2.6, compare to Figure 2.3).

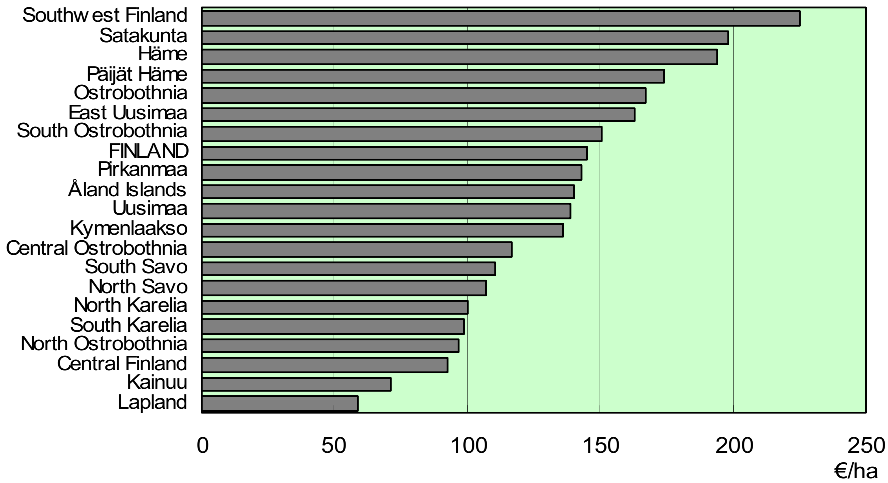


Figure 2.6. *The average rental price in different regions of Finland in 2001 (more recent data at the province level was not available).*

As with sales prices there is marked variance in the rental prices (see Ylätalo and Pyykkönen 1992, and Myyrä 2004).[12] However, as distinct from sales prices, rental prices have not changed in the same way. The rental price changes in the 1990s were much more stable than sales prices (Figures 2.7 and 2.8). However, in recent years the rental prices have probably increased little. Even though the survey results are probably not fully comparable to the taxation information, it is worth mentioning that according to Myyrä (2004) the average rental price in 2003-2004 was 173 €/ha (median 149 €/ha).

Another difference from sales prices is the regional variation in price changes. In contrast to sales prices, there are no differences between regions (Figure 2.8). Compared to Myyrä's (2004) study, rental prices increased in support regions A, B, and C2[13] whereas in the other regions rental prices were still very much at the same level in 2003-2004 as at the end of the 1990s.

[12] Unfortunately, in this study the variance could not be analyzed due to the lack of suitable data.
[13] See the map in Appendix 4.

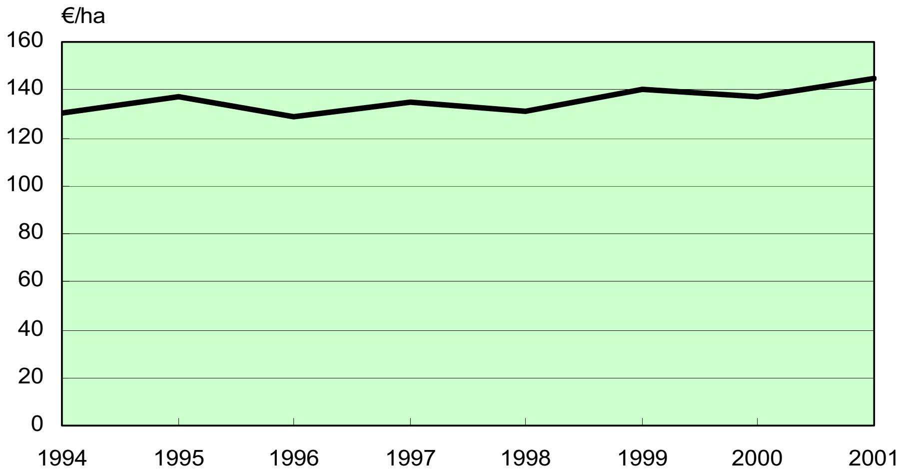


Figure 2.7. *The average rental price in Finland in 1994-2001.*

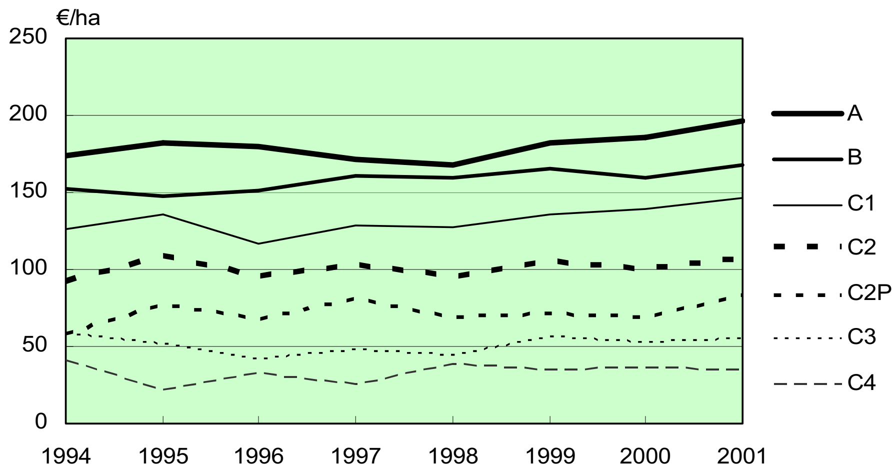


Figure 2.8. *The average rental price in different support regions of Finland in 1994-2001 (support regions defined in Appendix 4).*

A comparison between sales and rental prices may be somewhat misleading, since the rental price statistics include all contracts and not only the new ones, as is the case with the sales price data. If there was an increasing (or decreasing) trend in the prices, the prices of the new contracts could be estimated.[14]

[14] The estimate could be done by assuming the contracts of the previous year to be made at the same price in the next year, when we could calculate an estimate for the rental prices of the new contracts. This would be a very rough procedure and might be

However, there is no trend. This means that if the old contracts have remained at the same level, the new contracts have not been more expensive than the old ones. This result is slightly astonishing, since the general opinion is very different, and rental prices are thought to have developed very similarly to sales prices.

One reason for this may be found in the inaccuracies of the taxation data. Taxation records are made on cash principle, which may cause some problems when rent payment may occur in the year following the actual renting.

Another reason for this can be found from the differences between the databases. The sales price data include only the representative transfers, whereas the rental price data include all transfers. Thus, the data also include contracts between relatives.

However, it is also possible, perhaps even probable, that renting in fact differs from selling. The lessor's aims may be somewhat different from those of the seller. A high price means more for the seller than for the lessor. For the lessor there may be other factors that are more important than the price. Such factors might include good relations with the lessee, security of the land being well taken care of, and the possibility of renting the farm as a whole unit or for some services. These factors belong to the social capital that has proved to be an important factor affecting land prices (Perry and Robison 1999, Robison et al. 1999).

Renting as a transfer also differs in other ways from a sale. Perhaps rental prices are also somehow more related to the production capacity of the lot than sales prices. The ownership of land is also connected to other values than productive capacity. One might expect, for instance, the value of the land to grow for some reason in the future, making it already worth a higher price today. This same effect does not hold for rental prices.

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a little inaccurate, since contracts can be rewritten or they might include price changes. On the other hand, the support system has encouraged farmers to make longer contracts than before.

2.2 Agricultural policy since 1990

2.2.1 Income and price policy[15]

In the first half of the 1990s Finland still had a policy that basically relied on high market support by means of import restrictions. Producer prices were generally fixed and were agreed in annual negotiations between farm producers and the government. When deciding producer price changes, the changes in input prices were taken into account. Thus, there were two matters to be decided in the negotiations: the level of the cost compensation and the increase in the net farm income in order to guarantee a fair income development to farmers when compared to the rest of the labour force.

Even though the main support for farmers had come from market price support, there had been some other support elements based on the number of animals and on the amount of arable land.[16] Due to the increased producer price difference (partly due to the exchange rate and strong FIM) compared to the world market and to the EU in the late 1980s, the emphasis of these other tools was increased. However, the main support was still based on import restrictions, and thus on high market prices.

EU membership in 1995 markedly changed the policy. Producer prices were reduced mainly overnight and the reductions were compensated by direct income support based mainly on the amount of arable land and the number of animals (Figures 2.9 and 2.10). There was a short transition period for grain as well as pork and beef. The only price support after the transition period that was allowed in the membership agreement was milk price support.

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[15] See reviews of the Finnish agricultural policy (e.g. Ihamuotila and Kola 1995; Crommelynck et al. 1998), of the Finnish accession to the EU (e.g. Kola 1993; Kettunen 1993; Kettunen and Niemi 1994; Finnish agriculture… 1996; Latukka et al. 1993; Kola 1998), and of the pressures to change EU policy (e.g. Salonen 2003; Niemi and Kola 2003; The reform of the… 2004).

[16] The support based on the amount of arable land has always been paid to the farmer, not to the landowner.

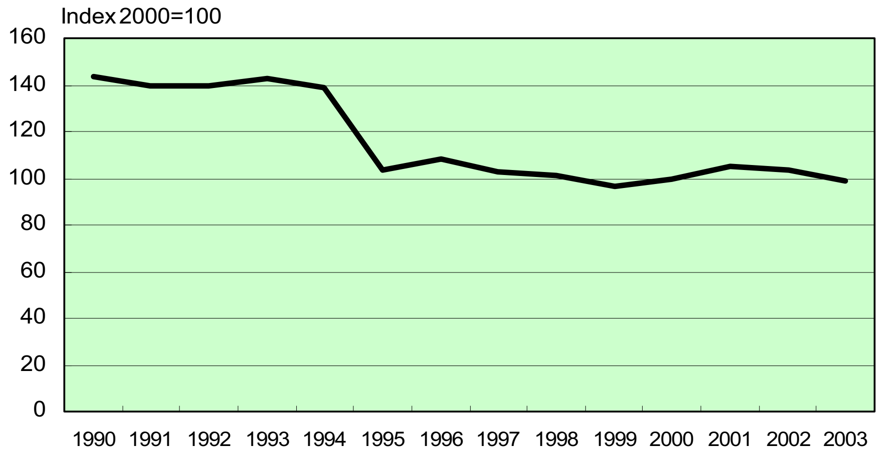

Figure 2.9. *Producer price index of Finnish agriculture from 1990-2003.*

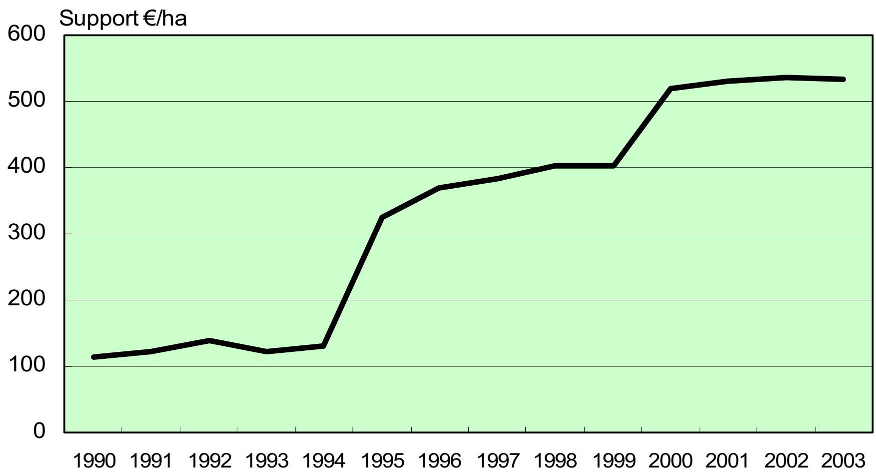

Figure 2.10. *The development of direct land-based support per hectare from 1990-2003.*

The means of the common agricultural policy (CAP support) in accordance with horizontal support (LFA and environmental support) would not have allowed the income level of Finnish farmers to stay at the same level as before membership. Thus, Finland was allowed to pay pure national aid to farmers. This was, however, separated into two different support schemes. The support in northern Finland is based on article 142 of the accession treaty and is long-term support, whereas the support in southern Finland is based on article 141. Finland interprets this as long-term support, but the commission only as short-term support during the transition period.

Agenda 2000 continued the EU policy changes begun with the McSharry reform of 1992. The main element of the Agenda was the reduction of grain and beef prices. The price reductions were partly compensated by support increases. Thus, the effect in Finland was in the same direction as in 1995, but no longer so strong.

The Agenda reform did not seem to adequately take into account the budget pressure caused by EU enlargement into Central and Eastern European (CEE) countries, on the one hand, and the increasing pressure to reduce support due to WTO negotiations on the other. Thus, the EU decided to reform the agricultural policy again. The reform was only intended as a mid-term review (MTR) of the Agenda, but due to increased pressure the review turned out to be the greatest reform in EU agricultural policy of all time. However, the reform is still called a mid-term review.

Again, the policy was changed in the same direction as in the Agenda. Producer prices were reduced and increasing support compensated for at least part of the reductions. The main difference in the support was that it was referred to as totally decoupled in order to better suit WTO demands. The commission's original idea of total decoupling was not accepted in the political process. A part of the support can still be coupled to production.

Nevertheless, for Finnish agriculture the reform was (and still is) very difficult to apply. Even utilizing all possibilities for coupled support, the reform would have meant large income redistribution on Finnish farms (see The reform of the… 2004). Thus, all the other elements of the farm support (LFA, environmental and national support) were also reorganized in 2004 in order to retain the status quo between regions and different production lines that was one of the main goals from the Finnish perspective in applying the reform.

Retaining the status quo is, however, a very problematic matter. A good example of this was the Finnish proposition for the LFA scheme in the autumn of 2004. Finnish authorities as well as the producers themselves would have liked to increase LFA support for animal production, and due to the cutbacks in 141 support a little bit more in southern Finland. However, the EU Commission did not approve this, and thus the status quo is threatened.

2.2.2 Structural policy

Investment policy

Investment aid has a long tradition in Finnish agricultural policy. There have been state loans, in which the principal is given by the government, state subsidized loans and investment allowances. The investment policy has also been one of the means of applying regional policy such that the support has been greater in the agriculturally poorer regions.

One of the consequences of EU membership was the increased pressure for structural change. The means did not change very much, but the level of support actually increased as well as the directing of the support. The supported investments were restricted so that small investments were not eligible for support. Another change was the change in regional aspects of the support. Due to the differences in national income policy the investment support during the years 1997-2002 was much greater in southern than in northern Finland. Today, the support is equal in all the regions but much greater than, for example, before EU membership.

When land purchases are concerned, farmers are nowadays entitled to a state-subsidized loan. The level of support has changed a little in the last 15 years. There have also been differences in the support level depending on whether the land has been purchased in the generation transfer or whether it has been so-called additional land.

The transfers and transfer prices that can be supported have been strongly regulated, especially in generation transfers (Law on inheritance, chapter 25). In the purchase of additional land there is a rule that the price is not allowed to exceed the current land value in the region. If the price paid exceeds the current value, no investment support at all is provided. What is the current land value is not strictly regulated. One reason for this is that the price movements in land prices over time have been so great. Secondly, the local price variation depending on the characteristics of the specific parcel is also great.

Since 2004 a state-subsidized loan can be 50% of the purchase price of the land.[17] In addition, if the purchaser is eligible for subsidized loan he/she

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[17] Nowadays, the standard is that the 50% is calculated from the upper price bound (which is set regionally by state officials). The upper price bound is set so that it is less than the current value in the region. Thus, if the purchase price exceeds this price

also will be relieved from the transfer tax of real property that is 4% of the price. Subsidized interest rate is calculated by subtracting 4%-points from the market rate. However, if the market rate is less than 6%, the farmer will have to pay 2% interest for the loan. Thus, the interest subsidy is 4%-points at maximum.

Retirement policy

In Finland there was a retirement regulation already before EU membership that allowed farmers to retire at the age of 55 (see Wilmi 1994; Pyykkönen 1998; Pietola et al. 2003). The program changed but actually the system remained quite similar after EU accession. Finland has almost fully applied the EU early retirement scheme. The only exception was in the 2000-2002 scheme, where retiring by leasing the land out was not allowed.

During the last decade there have been about 1 000 generation transfers in Finland per year. This is much less than previously, when there were 2 000-3 000 transfers per year (Pyykkönen 2001b).

According to Pyykkönen (2001b), in the 1995-2000 early retirement scheme 31% of the transfers were generation transfers, 52% of attendant's farms went to additional land by sales or leasing, 8% were completely left outside production, and 9% were some kind of combination of additional land and removal from production. The respective proportions in farmland were: 45% generation transfers, 44% additional land, 4% out of production and 7% a combination.

If the generation transfers remain as expected at quite a low level, this means that the supply of additional land remains at some positive level. As mentioned earlier, the majority of the additional land has been leased out. In Pyykkönen's survey (2001b) the proportion was extremely high, 95%, which is, however, probably a slight overestimate.[18]

bound but does not exceed the current value in the region, the actual amount of subsidized loan is less than 50% of the purchase price.

[18] The study concerned mainly those farmers participating the early retirement scheme who had not found a buyer or a lessor without announcing it publicly in the newspaper.

2.2.3 Land policy

In 1979-1998 there was a regulation that gave farmers priority to purchase both farmland and forestland (Law on the right to purchase arable and forestland). Originally, the regulation restricted the land purchase of a non-farmer if there was a farmer who was interested in buying the same lot and who was willing to pay the same price as the non-farmer. This was assumed to decrease the demand for land and thus also the prices.

In the farmland market the effect of the regulation was very small, since non-farmers were probably not very eager to purchase farmland. On the other hand, in the forestland market the effect was suspected to be greater since many non-farmers were eager to purchase forestland.

However, sales between relatives were allowed, and after 1990 the regulation was relieved so that if a purchaser at least practices part-time forestry he/she is allowed to purchase the land. The regions where the regulation was in force were also restricted in the late 1980s to northern Finland. In addition, there was only negligible evidence of the price effect according to Uusivuori and Ylätalo (1993). For these reasons the importance of the regulation was very small and thus the regulation was repealed in 1998.

Another piece of legislation that steers land use is the leasing regulation (Law on land leasing). The maximum duration of lease contracts for pure farmland (without buildings) is restricted to 10 years. When a farmer makes long-term investments this may be a restriction. The results of Myyrä et al. (2005) suggest that land improvements are delayed on leased land. Thus, investors might be eager to purchase land by sales rather than by leasing. However, for liquidity reasons they are often compelled to lease even when there is land for sale in the neighbourhood.

The environmental support scheme may also restrict land use. This is partly connected to whether the land is owned or leased. When a farmer makes a commitment to participate in the environmental scheme the parcel is tied to the scheme for the whole scheme period, whether or not the farmer remains the same during the whole period.

2.3 Changes in infrastructure

Changes in infrastructure also affect agriculture, even though the effects are not direct. Regional infrastructure varies considerably in a country like Finland, where the distances are long (e.g. Huovari et al. 2001). Agriculture affects the vitality of the countryside, but we can also say that the vitality of the countryside affects agriculture. Taking into account the different climatic conditions and the natural restrictions for production, the vitality of the countryside (off-farm job possibilities, access to services etc.) has an important effect on farm structure.

The differences in structural change also mean that possibilities for utilizing technological progress may well differ markedly between regions. This may affect land purchases and land prices as well.

Since Finland is very sparsely populated and the proportion of farmland is very low (about 6%), the demand for farmland for non-farm purposes (housing, industry, forestry) has traditionally been quite low. However, in the most populated areas there is some non-farm demand for farmland. One of the key issues in regional development has been migration. The population has concentrated very much during recent decades, and the concentration is forecast to continue. For example, in the most remote countryside the population is forecast to decrease by more than 40% in the next twenty years. (See Huovari and Volk 2004; Nivalainen and Volk 2002.)

The proportion of agricultural labour decreased below 50% even in the countryside by the 1950s. Today, this proportion is no more than 4%. However, there are regions where the proportion of direct agricultural labour is considerable. For example, in about 30 municipalities the proportion is still more than 30% and in about 100 municipalities the proportion is more than 20%. In addition, the indirect spillover effects of agriculture are noteworthy (e.g. Knuuttila 2004).

All these put pressure on further change in agricultural structure, which is also expected to have important implications for the land market.

3 LITERATURE REVIEW

3.1 Classical theories on land rent[19]

The key issue in determining the value of agricultural land is land rent. The classical explanation for differences in land values relies on David Ricardo's work.[20] The idea of land rent (differential rent, Ricardian rent, economic rent) was introduced in his essay in 1815. According to classical thinking land has special properties possessed by no other production factor. Thus, land has to be treated differently from other production factors. It is a scarce and fixed resource, whereas labour is infinite. In this context, classical economists believed that the labour supply curve was horizontal and thus all payments to labour were economic earnings.[21] Since land is fixed by nature, the land supply curve is vertical, and thus land makes rental earnings.

We can illustrate the classical Ricardian theory of rent by Figure 3.1. We assume that there are only two factors of production: labour (L) and land (A_0). Labour is completely variable but land is fixed. The production function is thus $Y=f(L, A_0)$.

[19] See an excellent review of Hubacek and van den Bergh (2002) that provides the basis for chapters 3.1 and 3.2.

[20] Simultaneously but independently, Thomas Malthus, Robert Torrens and Edward West also introduced similar ideas to Ricardo concerning land rent (Hubacek and van den Bergh 2002).

[21] Economic earning refers to the portion of factor payments by the producer that is necessary and sufficient to employ the particular factor.

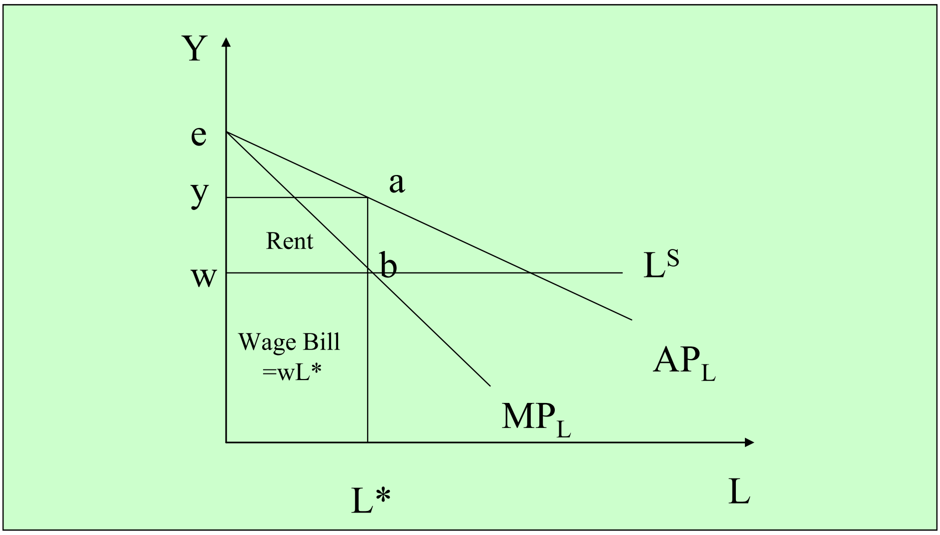

Figure 3.1. *Ricardian land rent.*

The average and marginal products of land are downward sloping due to diminishing returns on labour productivity. This, however, is derived from the idea that the amount of land is fixed and it varies in quality. The most fertile lands are always used first, and the less fertile later.[22] The more land is used the less fertile it becomes. Thus, we can write this mathematically as follows:

(3.1) $R = p*Q - wL$,

where R is land rent, p is producer price, Q is production, w is wage, and L is labour. Land is used until $w=MP_L$. Since the labour cost is the only cost and since it depends on the fertility of the land, we can rewrite equation 3.1. as:

(3.2) $R = p*Q - C(f_i)$,

where C(f) is production cost (labour cost) based on the fertility of the land. Another classical economist who must be mentioned in the land rent context is Heinrich von Thünen. In his famous book "The Isolated State" in 1826 he derived a very similar kind of residual rent to that of Ricardo. In his thinking,

[22] This was later criticized by Carey (see Ylätalo 1991), who claimed that actually the best land is not always taken into use due to higher starting costs than for the poorer land next to it.

instead of land fertility being the primary factor behind differences in land rent, the transportation cost to the central market determined the land rent.

In contrast to Ricardo, von Thünen's model assumed the unit production cost to be the same at every location, i.e. land quality does not differ. Transportation costs, however, differ, and they determine the products and their amounts produced at different locations.

Mathematically we can write the location rent:

(3.3) $R = p*Q - c*Q - t(u)*Q$,

where R is land rent, p is producer price, Q is production, c is unit production cost, and t is unit transport cost, which is a function of distance (u). If land rent was zero at the market (R=p*Q-c*Q since the transportation costs are zero) there would be no production elsewhere. If the amount that can be produced at the market does not respond to demand one should increase the price so much that it covers the transportation costs from a great enough distance to meet the demand. Thus, the price of a product in the city is determined as a sum of the production cost and the transportation cost from the most distant farms that produce that particular product. At the most distant farms the land rent is thus zero, but it increases the closer the farm is to the city (i.e. the lower the transportation costs are).

Since transportation costs differ between products they also allocate the production such that bulky or perishable products are produced closer to the city (central place) and valuable or durable goods are imported from further away. Thus, von Thünen developed a system of concentric circles that are termed von Thünen fringes.[23]

There are many other classical economists who would be worth mentioning. Thomas Malthus tried to demonstrate that rent constitutes a genuine addition to wealth, and not a mere transfer of purchasing power as Ricardo asserted. Ricardo pointed out that "rent is not the result of the generosity of nature but of her niggardliness", whereas Malthus emphasized the productivity explanation. John Stuart Mill took into account the

[23] von Thünen's ideas have also served as a basis for other branches besides agriculture. For example, Weber developed a similar kind of model of optimal location of manufacturing facilities. von Thünen is claimed to be one of the fathers of spatial economics and geography as well as urban economics. These approaches also relate to the non-farm demand of land to be dealt with later in chapter 3.

competing uses of land and also introduced the function of land as a provider of amenity services (see also Oltmer 2003).

Classical economists laid the foundation for modern economics. In their analysis land retained its special role. Thus, the aggregate production function can be represented in the equation: Q=f(A, K, L), where Q is aggregate output, A is land, K is capital, and L is labour. This "classical triad" was developed from the recognition of the three categories in the economic process – landowner, workers, and capitalists – associated with a triad of incomes – rent, wages, and interest (Hubacek and van den Bergh 2002). However, many classical economists concentrated on only one or two production factors, ignoring some of the three.

3.2 Neo-classical approach concerning land rent

The marginalist revolution demolished the classical Ricardian theory in the 1890s. In neo-classical thinking the Ricardian law of rent is applied to all factors, not merely land. The key issue in neo-classical criticism was that in classical thinking there was no alternative use for land, and thus no opportunity cost to be compensated.

The neo-classical approach also brought the idea of factor substitution, and this changed the thinking slightly. However, even though land can be substituted to some degree by other inputs it is still a scarce input. The substitution is very inelastic (Marshall 1920).

According to the classical approach, land rent is a residual. In the neo-classical approach, land is at least partly substitutable, and land rent can be calculated similarly to the marginal product of other factors. This reflects the difference in thinking between classical and neo-classical economists (i.e. economic vs. rental earnings).

Intuition also supports the neoclassical approach, since it is often hard to prioritize some cost over another cost. This is especially true in agriculture, where the cost of a farm family's own labour is a similar kind of residual to land rent (or actually they cannot be properly separated) if all other costs are prioritized.

In production function analysis, all production factors are in principle included in the model. The result concerning land rent is the marginal product of one unit of land. In empirical analysis this is a very reasonable result, but in real life the fixed costs seldom need to be increased very much when only a small addition in land is made. Thus, in the short term, when land is purchased the marginal product may well be slightly larger than the analysis assumes. However, in the long term all costs are variable and adjusted (when acting optimally). This also reflects the difference in the price of additional land and of whole farm sales (e.g. in generation transfers). Thus, the result is again reasonable.

3.3 The capitalizing of land rent (net present value)

According to both classical and neo-classical economists, land rent causes the differences in land values. Land rent must be capitalized in order to obtain the value of land. Therefore, we have to use some interest rate.

In theory, the net present value formula is simple. The net present value is a sum of the future stream of land rent produced by the land. This is shown in equation 3.4.

(3.4) $$V = \frac{R_1}{1+r_1} + \frac{R_2}{(1+r_2)^2} + \ldots + \frac{R_n}{(1+r_n)^n},$$

where V is land value, R is land rent, and r is interest rate. If we assume the land rent and interest rate to be constant over time, and the rent to last indefinitely, we can rewrite the equation:

(3.5) V=R/r.

The net present value formula seems to be simple. However, there are many parameters whose interpretation in empirical analysis is somewhat problematic. Firstly, if the production function approach is applied we obtain the land rent. However, obtaining the land value based on this rent is no longer so simple. There are two important factors that affect the value: the interest rate and the question of the duration of the returns. What is the correct interest rate? In principle, the answer is clear: it is the opportunity cost for capital. The opportunity cost is determined by the second best investment option that is similar in risk and has the same duration and size. In practice, there are hardly any such investment options, and thus there are some problems in determining the correct opportunity cost (i.e. interest rate. Should it be some average loan interest rate? Or should it be higher, since the land increases the farmer's own capital and is not a prioritized claim? (See Ylätalo 1991; Latukka and Pyykkönen 2000.)

In empirical analysis, where the land value is estimated, there are other problems. In net present value models the interest rate is the result of estimation. But what if the rate varies over time or over income sources? How accurate would the estimation then be? (See discussion later in the following chapters.)

There is also the question of the land rent to be capitalized. Land rent as such is hardly ever available. Thus, we have to substitute it. If Ricardian rent were used there would be problems, since the rent would very often be negative. This would restrict, among other things, the choice of functional form and thus cause econometric problems. Usually, a kind of net farm income is used as a proxy for an income stream to be capitalized. Since the prices of other production factors besides family labour and own capital are exogenous the cost of these other production factors should be extracted from total revenue. It then makes sense to use the net farm income.

The situation is more problematic when researchers want to separate different income sources (market returns and support incomes) from each other in order to find out whether they have different effects on farmland prices. The general procedure is to extract the support income from net farm income. But is this correct? The problem is that by doing so we assume that the support income does not need any costs but becomes a "free lunch".[24] Instead, should the net farm income be divided into market and support components according to their share of the total revenue? By doing so, however, we assume that the costs should also be divided into those of market production and public goods. This would be even more incorrect. And how would the division between labour, land and other own capital be correct?

Now we turn to discussion of the categorisation of studies concerning values and prices. If we study values it is probably more correct to use some average income figures as a substitute for land rent, but when prices are concerned the situation is more problematic. The land market is very thin and the operators in the market may substantially diverge from an average farmer. Is it any longer appropriate to use some average net farm income as

[24] The theoretical analysis in chapter 4 makes the same, perhaps incorrect, assumption.

a substitute for land rent? Or should we instead use the purchasers' net income? This also reflects the question of land rent expectations, which should actually be estimated.

Similar questions arise concerning the interest rate. In addition to variation over time, rates can vary over income sources and over individuals. Simple net present value models have been criticized for many other reasons, and attempts to improve the models have been made, for instance, by increasing the number of explanatory variables.[25]

In addition to net present value models, hedonic models are widely used in empirical research. They partly share the same problems as NPV and especially semi-hedonic studies. In hedonic studies we often assume that land rent (R) is a function of soil productivity (Ricardian approach) and location that reflects the transportation cost to the market (Thünenian approach). Taking into account these factors we have a purely agricultural model. However, if we apply the extensions of Thünen's work to more general location theory by taking into account the non-farm demand of land we can generalize the model.

The models used in empirical land analyses are discussed in the next two sub-chapters. A review of previous studies is also presented.

3.4 Empirical modelling of land values and prices

3.4.1 Models explaining regional differences in values or price levels

3.4.1.1 Production function approach

Using the production function one can determine the marginal return of each production factor, including land. The basic formula for the production function f can be expressed as follows:

(3.6) $Q = f(K, L)$,

where Q is production, K is capital, and L is labour. The capital can then be

[25] See more details on the models in the following chapters.

divided into short term capital (variable input) and long term capital (fixed input). Land is a special case of long term capital, and it can be further separated. When land (A) is separated, we can differentiate equation 3.6 by land and thus calculate the marginal return of additional land.

(3.7) $$\frac{\partial Q}{\partial A} = \frac{\partial f(K, L, A)}{\partial A}.$$

When this is multiplied by the output price we get the neo-classical model of land rent in monetary terms. One can obtain this from econometric estimation if one has the relevant farm level data. By capitalizing the marginal product we can get the net present value of additional land.

Moreover, the capitalized value reflects the value of land only in agricultural use, but for several reasons it does not necessarily reflect the actual prices paid for the land. Firstly, the production function gives the average marginal return. However, a very small amount of land is purchased annually, and the buyer's marginal return is probably not the same as the average. Thus, buyers base their decision on their own situation. Secondly, the capitalization ratio (discount rate, opportunity cost) may be very personal depending on the funds with which the purchase is financed. Furthermore the relation to risk may vary among farmers and also among land purchasers. Fourthly, the time period used in capitalization may vary. Fifthly, there are several other reasons (e.g. non farm demand, and expected capital gains) that affect land price in addition to the pure agricultural return. Sixthly, land purchase is usually a once-only opportunity. If you do not use your opportunity when a certain lot is for sale you may lose it forever.

Previous studies

There have been relatively few international studies that have used the production function approach. However, in Finland this approach has been quite widely used. The most important study was that by Ylätalo (1991). He used the Cobb-Douglas production function, and he had a quite large farm-level dataset from Finnish bookkeeping farms (152 farms from 1968-1986).

After making the econometric estimation, he obtained the marginal return of additional land by subtracting those cost that were left outside the econometric model. Thus, Ylätalo’s model can be described as a mixed classical-neoclassical model. The production function part reflects the neo-classical part and the latter subtraction refers to the Ricardian type calculation. This land rent was then capitalized by using different interest rates (3, 5 and 7%) and different time periods (5, 10 and 15 years) for sensitivity reasons.[26] In principle, one could assume the land to last forever, but Ylätalo used shorter-term capitalization periods due to the fact that the farmer’s own active working period and loan payment time is much shorter. As expected, he found the productive value of the land to generally lie at much lower level than the market value. This confirms the fact that there are many other factors besides land rent affecting land prices, as mentioned previously.

Another Finnish study that employed the production function approach was that by Peltola (1996). He utilized a very similar Cobb-Douglas production function to Ylätalo (1991), and had very similar data (637 bookkeeping farms from years 1976-1995). In addition to the basic model, in which the dependent variable is the gross revenue, he utilized the function where the dependent variable is the net revenue after subtracting variable costs.

In contrast to Ylätalo, however, Peltola assumed the land to have some value after the capitalization period. The reported net present values were calculated such that the marginal product was capitalized with a 5% interest rate for ten years, and then the discounted bookkeeping value up to the present was added. Thus, the net present values were considerably greater than in Ylätalo’s study.

Like Ylätalo, Peltola found the net present values of farmland to have been much lower than the market value in the 1980s in southern Finland. After the 1990 peak in market prices, however, the situation changed. Moreover, the market prices in northern Finland seemed to have been lower than the productive value based on Peltola’s analysis. He explains these differences, for example, with the differing supply-demand situation.

Peltola (1996) also tried to apply the pure Ricardian approach, but he found the land rents to be negative or at least much less than the marginal product.

[26] Ryynänen (1967) utilized a 4% interest rate in his study, in which he compared capitalized gross margins to the expropriation prices.

3.4.1.2 Hedonic (semi-hedonic) approach

A much more widely used approach in the international literature concerning land values and land prices is hedonic modelling. The basic hedonic pricing framework that could serve as a basis for empirical work can be found in Rosen (1974). In its purest form, the hedonic pricing method can be used to estimate the economic values of environmental services or amenities that affect the prices of marketed goods. Goods are not valuable as such but because of services they can produce. People value the characteristics of goods, or the services they produce, rather than the goods themselves. Typical examples for hedonic pricing are housing prices and land prices. The empirical literature concerning both of these is very wide.

The basic hedonic formula can be specified (Rosen 1974):

(3.8) $P(z) = P(z_1, z_2, ..., z_n)$,

where P is the price of the marketable good (e.g. land, and P(z) is sales price per hectare), and z_i measures the amount of the ith qualitative characteristics related to the good (i.e. the specific land parcel). The implicit prices of each characteristic can then be calculated by taking the partial derivative:

(3.9) $IMP(z_i) = \frac{\partial P}{\partial z_i}$.

In order to be able to determine the factors that affect supply and demand factors, Rosen proposed a two-stage estimation. The first step would be the basic hedonic regression following from equation 3.8. In the second step, inverse demand or bid functions are estimated by regressing selected implicit prices expressed by equation 3.9 upon the characteristic, income, and other socio-economic factors that are hypothesized to explain the demand for the characteristic. Land price researchers have rarely been interested in this second step. However, the study by Kennedy et al (1997) is an exception.

In the case of land values (or prices), there are characteristics that contribute to returns in agriculture. Typical variables used in the estimation of land values are land characteristics such as land quality (soil type, fertility, irrigation etc.), lot size, latitude or altitude and the length of the growing period. These factors affect the productivity of land and thus the expected returns on cultivation of the land. Thus, using these variables directly reflects the Ricardian approach. The basic formula to be estimated using these variables can be written:

(3.10) $P = \alpha + \beta X + \varepsilon$,

where P is land price, X is matrix of land characteristic variables, α, β are parameters to be estimated, and ε is error term. However, as shown in the previous chapter, there are other factors that affect land prices. von Thünen pointed out the effect of transportation cost. The Thünenian approach is further generalized to capture the effects of location in urban economics. Thus, in order to capture these effects, variables referring to location characteristics are often included in hedonic models. Examples of such variables are the distance from the nearest neighbour and urban area, population density, population growth and housing prices. These factors reflect both the transportation cost and the alternative uses of arable land, for example because of housing pressure. In empirical modelling this means that we add the matrix of these location characteristics variables to the model:

(3.11) $P = \alpha + \beta X + \gamma Z + \varepsilon$,

where Z is matrix of local characteristics variables, and γ is parameter to be estimated. Some empirical analyses ignore the first part of the formula (land characteristics) and concentrate on the latter part of the formula. The main interest in these studies is the effect of urbanization of farmland.

However, agricultural productivity based only on land quality does not necessarily reflect its total capability to produce agricultural incomes, since the agricultural returns are also increasingly affected by policy decisions.

Theoretically, the higher net returns due to direct government payments are at least partially capitalized into cropland values. Since commodity programmes usually produce costs for farmers[27], and the continuation of

[27] EU programmes such as the LFA scheme and environmental scheme are good examples of this. For instance, the environmental scheme sets some requirements

programmes is uncertain, the support is often discounted quite heavily (Barnard et al. 1997).

Recently, increasing effort has been put into trying to find out whether policy-based returns capitalize with different interest rates from market-based returns on land prices. In principle, one can divide the total returns from agriculture into these two parts as follows:

(3.12) $R = MR + GP$,

where R is total return, MR is market return (i.e. price multiplied by amount), and GP is total support. When analysing land prices according to the Ricardian approach we should firstly be able to extract the land rent (i.e. total return minus production cost). Secondly, rent is very difficult to divide into the above-mentioned parts. There are also many problems in defining net rent, since there are many other cost factors (unpaid labour, interest on own capital) that can be defined together with land rent as residuals. This is also one reason why land rent as such is problematic to use in analysis when we are interested in price differences, for instance between regions.

In hedonic analysis, however, we can assume that the market-based return reflects agricultural productivity based on natural conditions. Now, in order to capture the effect of support programmes we add the matrix of support variables to equation 3.11.

(3.13) $P = \alpha + \beta X + \gamma Z + \delta GP + \varepsilon$,

where GP is matrix of support variables, and δ is parameter to be estimated. In practice, many empirical studies can be classified as semi-hedonic models, since the variables in the GP matrix may be expressed in monetary values. Moreover, the variables in the X matrix may not always be purely land characteristic variables (such variables include yield or some kind of net return variable).

The most recent addition to econometric modelling is spatial analysis (see Anselin 1999 and 2002; Pace et al. 1998). This addition is more or less of a technical nature since no new explanatory variables are included in the model but instead the spatial nature of the data is taken into account. As

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that farmers have to obey in order to receive the support. The requirements cause costs to farmers that otherwise would not exist.

Benirschka and Binkley (1994) pointed out, the assumption that the errors for two neighbouring regions are uncorrelated is difficult to justify. If the errors are correlated, the ordinary least squares (OLS) estimation still yields unbiased estimates, but they are no longer best linear unbiased estimators (BLUE). Benirschka and Binkley (1994) continue by suspecting that the spatial nature may cause the OLS-estimated variances to be downward biased.

For this reason the spatial econometric approach should be applied. Once the presence of spatial autocorrelation has been checked, and if it is found, one should decide the specification of the spatial econometric model. In spatial analysis there are two alternative approaches that depend on the nature of the spatial autocorrelation. The first approach is such that the error terms in the model are correlated.

(3.14) $Corr(\varepsilon_i, \varepsilon_j) \neq 0$ for i≠j, and i,j=1,…,n.

When this type of autocorrelation exists it means that some local characteristics that cannot be captured by the variables (matrix Z) but that affect the price level in the region are spatially correlated. Since the error is no longer white noise, one must try to separate the systematic part of the error. In order to do this the spatial error model in which the covariance structure of the error term is re-specified will be needed. In this case, the ordinary least squares (OLS) regression would still give unbiased estimators, but they would no longer be efficient and the estimators for standard errors would be biased. Instead, maximum likelihood (ML) or generalized method of moments (GMM) estimation will be needed (Kelejian and Prucha 1998).

Secondly, correlation may exist in left hand side variables.

(3.15) $Corr(P_i, P_j) \neq 0$.

The interpretation of this type of spatial correlation in the case of the land market is such that when making the trade, trading partners take into account the latest prices paid in the neighbourhood. Thus, one assumes that a purchase is not independent of other purchases. In this case, one can correct the estimation by using a spatial lag model in which the spatial lag variable is included. Thus, the spatial lag model specifies the covariance structure for the dependent variable. This is a more severe type of problem in the OLS estimation since due to the endogeneity in P the estimators are not only inefficient but also biased. Instead, ML or instrumental variable (IV) estimation should be used (Anselin 2002). Whether spatial autocorrelation exists can be tested as well as the appropriate model specification. These are discussed in more detail in chapter 5.

The spatial model requires information on the location. There are modelling techniques that are based on the adjacency of observations and others that are based on more accurate location information (geocoded data). In the former group of techniques the weights are 1 if the observation is adjacent to another. In the latter group of techniques the weights are computed based on actual distances between observations. The nearer the observations are to each other the greater is the weight. Commonly used equations to compute weights are to use the inverse of either the distance as such or the squared distance as a weight.

Previous studies

Peterson (1984; 1986) provided an interesting introduction to the caveats that the production function approach may include when land prices are concerned. He showed how important the measurement of land input is for the coefficients of other inputs. In his theoretical analysis, if land is included in the production function according to its value on the market it leads to upward-biased estimates of land and downward-biased estimates of other inputs that are substitutes for land. He also found clear evidence for this in his empirical Cobb-Douglas production function analysis, where land was measured in three different ways (acres, price index, and quality index based on his own hedonic analysis). The data were, however, highly aggregated (U.S. states). Thus, he pointed out the importance of taking into account non-farm factors in the analysis.

He also built a hedonic analysis on land prices where the independent variables were divided into two components. Farm factors included the proportions of irrigated and non-irrigated land, as well as the proportion of woodland. In addition, he used precipitation as an explanatory variable. Non-farm demand was included in the model as population density. According to his analysis, non-farm factors explained about 70% of the variation in land prices.

Based on this hedonic analysis, Peterson calculated a land quality index for all U.S. states. Furthermore, based on this same U.S. analysis he created similar land quality indices for several other countries. Since the analysis was quite rough he was perhaps generalizing the results a little bit too much.

However, some of the results appeared reasonable. The best land was, according to these calculations, in the rice production countries where the proportion of irrigated land is great and the precipitation is high. Respectively, the poorest land was found in Africa. In the European context, however, the results were somewhat peculiar. The best quality was in Denmark and Norway, and the poorest land was in the U.K. and Ireland. The Finnish land quality was among the highest, being much higher than, for instance, in France, the Netherlands and Belgium. There were probably some measurement problems, but on the other hand these results indicate that there is a continuing need for country-specific analysis of land prices.

Drescher et al. (2001) analysed factors affecting farmland prices in Minnesota in 1996. The data in the pure rural model consisted of 620 arms-length sales.[28] The model specification was semi-logarithmic so that the dependent variable, per-acre sales price, was in a logarithmic form. The explanatory variables were divided into three groups. The first group consisted of parcel-specific variables: the size of the sales, the proportion of arable land and a soil productivity measure (crop equivalent rating). The second set of variables was county-specific in order to capture the local economic structure: land area, the size of the agricultural sector (crop sales and livestock sales), non-farm employment, the natural amenity index, population, population growth, and the loss of farmland to control the urban sprawl. The third set of variables captured the urban effect: the urban access index, adjacency to a metropolitan area, and the number of highways in the neighbourhood.

The model worked quite well. All the statistically significant variables were of the expected sign. The explanatory power in the rural land model was 0.60. Agricultural productivity clearly affected the price. Similar to many other studies, the size effect was negative. The importance of the agricultural sector in the region also seemed to have strong influence on land prices. The greater the importance of agriculture and the more intensive it was, the higher the prices were. The authors also found that the

[28] The total data consisted of 1 699 transactions that were used in the statewide model.

expectations of farmland conversion into non-farm uses were capitalized into land prices. There were many variables that supported this phenomenon.

Kennedy et al. (1997) used a large sales price dataset (948 sales from years 1993-1994) from Louisiana in their analysis of the rural land market. They followed the two-stage estimation method proposed by Rosen (1974).

Firstly, they estimated the parameters from the hedonic model. As explanatory variables they used some continuous variables such as the size of the tract, the proportions of cropland, pasture, and timberland, the value of improvements, road frontage, and distance to the largest parish town. In addition, they had numerous dummy-variables capturing the soil type, the possibility to produce special crops, and reasons for the purchase. As socio-economic variables they used population density and both the net farm income and per capita overall net income in the region.

Secondly, they calculated the implicit marginal prices of each characteristic, and using these as dependent variables estimated the bid function for each characteristic. The purpose of this approach was to incorporate any potential effects of socio-economic variables on the marginal implicit prices of rural real estate characteristics.

Kennedy and co-workers used a semi-log specification in the model. Thus, the dependent variable was in a logarithmic form whereas the right–hand-side variables, with the exception of the size of the tract, were not.[29] The model was regionalized such that a separate model was estimated for each submarket.

Their model worked very well. All the statistically significant coefficients were generally of the expected sign. The coefficient of the size of the tract proved to be negative, as expected, in seven cases out of eight. Special crops that can utilize economies of size to a greater extent probably explain the one exception. The sign of the value of improvements was positive whereas that of the distance to the largest town in the parish was negative. The results also confirmed that land values are strongly influenced by the income-producing potential of the tract. The results of the second-stage estimation were not so promising.

Maddison (1998 and 2000) used hedonic modelling in order to determine the impact of climate change on land prices. The data consisted of almost 500 sales in 1994. Independent variables in his model included some

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[29] The authors hypothesized that the price of land declines as the size of the tract increases. Thus, a non-linear specification for this variable was incorporated.

residential variables, the size of the milk quota sold at the same time, soil classes as dummies, the number of frost days, temperature (30-year averages), wind speed, precipitation, sunshine, and humidity. He firstly utilized a simple linear OLS model and secondly a Box-Cox transformation. The agricultural variables (size and milk quota) as well as housing variables generally gave reasonable and statistically significant results. In contrast, the land quality variables as well as the climate variables that were of primary interest did not generally prove to be significant. Only one climate variable, namely the wind speed, was statistically significant. According to the author, one should perhaps use seasonal averages rather than annual averages. The effect of the climate change on land prices has also been studied by Lang (2003).

Vasquez et al. (2002) studied Idaho farmland prices. They had data on 453 sales from the years 1993-1994 that they firstly divided into two size classes (less than 80 acres and more than 80 acres). The division was based on the Chow test. Thus, they avoided the heteroskedasticity problem in the econometric analysis. The explanatory variables consisted of some parcel specific information (size of the tract, soil class, slope of the tract, and elevation of the tract, as well as distances to the nearest highway and to towns of more than 500 inhabitants and less than 500 inhabitants), and some region-specific data (county population, net farm income in the county, the number of dairy cows in the county). In addition, they used some dummy variables controlling for the location and irrigation possibilities.

Interestingly, they found no evidence in the base analysis of factors other than pure agricultural ones having an impact on land prices. However, they continued their analysis by dividing the total sale value of each tract by the gross rent of the tract and regressing this against the same explanatory variables. In this analysis, they found evidence of the effect of development pressure on land prices.

One of the few European studies has been that by Giuliani (2001), who analysed Swiss land prices. His agricultural data covered the years 1990-1997 and consisted of 167 actual sales. He used OLS regression with several model specifications depending on the proportion of the arable land, and on the other hand on the set of explanatory variables used in the model.

Giuliani divided the explanatory variables into four groups. The first group consisted of parcel-specific variables such as the parcel size, the proportion of arable land, time of the sales, and dummies for whether the sales were arms-length or not or whether the seller was a farmer or not. The agricultural variables (regional) were the average farm size and the proportions of agricultural labour and land. The socio-economic variables (regional) were connected to the income level and the activities of other sectors. The socio-ecological variables included, in addition to population density, some environmental variables that responded to the urbanisation pressure.

The models worked quite well and the explanatory powers varied from 0.33 to 0.71. The coefficients were in general of the expected sign and statistically significant. The importance of the time dummies was quite strong due to the fact that there was a declining trend in the land prices during the research period. Giuliani (2002) also analysed land prices with a very similar model in another kanton in Switzerland (Graubünden), but these results were not so good.

Roka and Palmqvist (1997) analysed farmland prices in the U.S. corn-belt region. The land value, which was used as the dependent variable, was gathered from a large farm survey (more than 6 000 respondents). As independent variables they used: the size of the farm, the SIC code (indicating the land use on the farm), the operator code (sole proprietorship, partnership, hired manager), the proportion of primary land, the proportion of erodible land, population density, the corn yield, and selling experience in recent years (dummy).

They analysed four models, and the model including size, the primary land proportion, corn yield, and population density as explanatory variables was preferred.[30] Thus, the crop yield and proportion of primary land proved to be superior variables compared to other pure hedonic agricultural productivity measures. The explanatory power, however, was quite low (34%). This indicates that there are many other factors (site- or tract-specific) that also explain land value variation.

Boisvert et al. (1997) presented a very similar type of hedonic analysis to Roka and Palmqvist (1997). In addition to land value, they also modelled the land rent. Their special interest was in the environmental effect. As independent variables they used population density, yield, sales/acre, field size, crop use, whether the time operator owned or rented the land,

[30] The dependent variable, land value, was modelled in a logarithmic form whereas the explanatory variables were included as such. The semi-log model (OLS) was chosen since the residual sum of squares was slightly less than in the double log and much less than in the linear specification (a limited Box-Cox analysis).

education, dummies for the conservation plan, and the leaching and runoff potential. They reported firstly the double-log specification, but since the Box-Cox transformation seemed to improve the results they concentrated in the discussion on this model.

Firstly, they calculated that the ratio of the average rental price to market price was only 2%, which they regarded very low. Thus, land values reflect probably much else besides the land's agricultural value (productivity), whereas rental prices more or less reflect only that. This was also confirmed in the econometric analysis, since the elasticities (as well as the t-ratios) of rental rates with respect to yields were higher than those in the land value models. According to the authors, land values include speculative value due to the non-agricultural demand. In other words, spatial orientation is a more important determinant of land value than it is for rent. However, the population density was not significant, and it was not even included in the land rent model. For this reason, Reynolds (1997) questioned this conclusion concerning spatial orientation.

Field size proved to be insignificant in contrast to many other studies that found the effect to be negative. The authors offer a couple of explanations. First, large parcels may be better to farm. Second, the proximity of small parcels may lead to inflated offers. The environmental effect on land prices was not very clear.

Benirschka and Binkley (1994)[31] made a study concerning the factors affecting land price change. They investigated the high rise from 1969 to 1982, and the subsequent decline from 1982 to 1987. Similarly to Finland (see chapter 2.1), the variation was found to differ between regions. Like Falk (1991) they also found that prices are much more volatile than rent movements. They hypothesized that when producer prices increase the net percentage increase is greater in less favourable areas (i.e. more remote areas). If the price rise is capitalized into land values, the land price rise (as a percentage) should also be higher in less favourable areas.

The independent variables in their analysis were the distance to the market (using the basic county loan rate as a proxy), soil classes, corn yield, farm size, population density, and population growth. The change in land

[31] This study is very hard to put in any specific class, since the analysis is purely hedonic in the spirit of Ricardo and von Thűnen. However, the dependent variable is the land price change that will be reviewed in the next chapter. On the other hand, the econometrics is more or less cross-sectional rather than time series. This article has also utilized spatial econometrics, which will be reviewed later in this chapter.

price was calculated between two time points assuming constant growth (decrease). Two periods, one growth and one decline, were analysed. The data were quite aggregated, since they consisted of county averages from five U.S. corn belt states. The total number of counties in the analysis was 495.

The spatial autocorrelation was tested based on the adjacency of counties. The spatial autocorrelation parameter (ρ) was estimated in order to test whether the model was a spatial-error model or not. The coefficient proved to be statistically significant. This means that ignoring spatial autocorrelation the variances of other coefficients are underestimated. The maximum likelihood (ML) estimates (and their significances) where spatial autocorrelation was taken into account were quite similar to ordinary least squares (OLS) estimates (ignoring spatial autocorrelation). The explanatory power seemed to be much smaller, but as Anselin (2002) points out, the R^2 values are not comparable.

The hypothesis (based on historical evidence and theory) that land price variation increases when the distance to the market increases was supported. All of the location variables (loan rate, population density, and population growth) were negative in the growth period and positive in the decline period. With a couple of exceptions they were also significant. According to the authors, this means that boom and bust effects are more harmful in remote areas, since the incentive to expand is greater during good times and respectively the failures are more probable in these areas. As a policy recommendation they proposed the rules for granting loans to differ between areas.

Hardie et al. (2001) simultaneously analysed farm and house prices (see also Hardie et al. 2000). Their main interest was in the non-farm demand on farmland, and thus they followed the models of urban growth. They also tested the existence of spatial autocorrelation in a similar way to Benirschka and Binkley (1994).

Hardie et al. (2001) also used data of a very similar kind to that of Benirschka and Binkley (1994). Their data were on the county level (230 counties) from three years (1982, 1987, and 1992). The years were pooled and year dummies were introduced. Thus, the model was a fixed effect panel model. The dependent variable in the farmland model was the estimated value of farmland (and buildings). The independent variables were the per-acre market value of production, per-acre production expenses, per-acre value of machinery, the median price of residential real estate, and the distance index (the population-weighted distance to New York and to the nearest centre). Thus, taking into account the nature of agricultural variables, the model is merely semi-hedonic.

The spatial autocorrelation coefficient was statistically significant. This indicates that the neighbouring counties' farmland values are positively correlated for reasons the variables included in the model are not able to capture. However, the improvement in the efficiency of the model did not actually change the interpretation of the results.

Interestingly, the change in farm expenditure is capitalized more heavily into land values than the change in revenues. According to the authors, this is due to the fact that revenues are more volatile than expenditures. Thus, the transitory component is smaller in farm expenditures.

Another interesting result was that farmland values were more responsive to non-farm factors than to farm returns. This indicates that farmers are affected more by events that change non-farm income and house prices than by agricultural policy. However, the authors were not necessarily willing to generalize this result outside the mid-Atlantic region.

Plantinga and Miller (2001) used similar county-level data (54 counties in the state of New York) from the same years as Hardie et al. (2001). They developed a model of agricultural land value that combines the approaches of agricultural and developed land values. The independent variables in their model were the per-acre net return from agriculture, the population growth in the closest and the second closest metropolitan area, travel time to the closest and the second closest metropolitan area, and all of their interactions.

The explanatory power of the model was very high (0.83-0.90). The authors pointed out the importance of the non-linear relationship between land value and the explanatory variables, since almost all of the interaction terms were statistically significant. They found a very similar result to Hardie et al. (2001) concerning the importance of the agricultural return on land values.[32] Thus, one can interpret that for the average county in the data, land development was perceived as imminent.

[32] The marginal increase in land values was 5 $/acre when the net return from agriculture increased by 1 $/acre. This is a little higher than in Hardie et al. (2001), but still very low.

Plantinga et al. (2002) analysed land prices and development pressure basically with a quite same kind of model specification to Plantinga and Miller (2001). However, instead of using county level data from only one state, the data in this study covered all counties in the U.S. Another difference in the econometric modelling was that they tested the presence of spatial autocorrelation based on the adjacency of counties. Fairly strong spatial autocorrelation was found, and thus the spatial autoregressive parameter had to be estimated (spatial-error model). They used the feasible GLS estimation.

The model appeared to have a good fit. The partial effects had to be calculated due to the interaction terms in the model. All of the partial effects were significant and, except in one case, of the expected sign. On average, a 1$ increase in agricultural returns increased the land price by 5$. The primary goal of the authors was to separate the effects of agriculture and future development pressure on land prices. As expected, the results showed great differences between states. In the most urbanized states the proportion of agriculture was calculated to be less than 20% of the farmland value. On average, however, the authors estimated the agricultural component to be about 90%, since there are many large agricultural states where the development pressure is very low.

Cavailhès and Wavresky (2003) also analysed the urban influence on farmland prices. They found that farmland prices fall sharply close to the city and then gently further away. Their data consisted of more than 2,000 sales in Dijon and surrounding region in France.

Vandeveer et al. (2001) analysed the rural land market in Louisiana in 1993-1998. They used a hedonic model with a more sophisticated consideration of spatial econometric issues than previously reviewed studies. Instead of land values, their data consisted of 254 actual sales. As independent variables they used the size of the parcel, the proportions of cropland and pasture, the value of improvements, distance to the nearest city, and dummy variables that capture the commercial and residential influence. Their model specification was a mixture of semi-log and double-log models, since the land price and the size of the parcel were in a logarithmic form.[33]

The spatial weight matrices were based on actual distances between the sales, not on their adjacency. They found spatial autocorrelation to exist.

[33] Similar to Kennedy et al (1997) specification.

The testing procedure allowed them to determine whether the spatial-error model or the spatial-lag model was correct. The spatial-error model was preferred. As usual in spatial-error models, the results did not change considerably compared to the original OLS model. However, the spatial model proved to be superior in the efficiency of the estimation compared to the traditional OLS estimation. The explanatory power of their model was 0.46, and all of the coefficients were of the expected sign and statistically significant.

Nickerson and Lynch (2001) analysed the effect of farmland preservation programs on farmland prices in the state of Maryland.[34] They had information on 224 arms-length sales, of which 24 were in the PDR program in 1994-1997.[35] Capital asset pricing (CAP) theory predicts that the market value should be lower, i.e. the PDR/TDR value reflects only its value in agricultural use. The purpose of the study was to investigate whether this was true. Thus, it tested the effect of the development restrictions imposed by the sale of development rights (PDR).

Urban growth pressure increases the demand for land for developed purposes over time and the profitability of converting farmland. Hobby farm demand may also increase the demand for land, but not for developed purposes. The authors thought that this may slightly confuse the models.

The dependent variable was the sales price per acre. As explanatory variables they used parcel size, geographic coordinates, the appraised value of structures, soil quality, land use and distances to various landscape features (e.g. the metropolises of Washington and Baltimore).

Firstly, using a probit model, Nickerson and Lynch (2001) tested the effect of these variables on participation in preservation programmes (PDR). This was done in order to be able to calculate Mills ratios to correct the sample selection bias.

Secondly, three models of sales prices were analyzed. The basic model was

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[34] See also the more recent analysis on the same topic by Lynch and Lovell (2002) where the spatial econometrics is applied.

[35] The background of the study is urban pressure. There are State programmes in the US that have been established in order to prevent agricultural land be converted to non-agricultural uses. The Government (or local officials, since programmes may be assisted by county-level acts) purchases the development rights from farmers (PDR) or rights to transfer these rights (TDR). When the farmer sells the rights to develop the land, he or she retains ownership of the parcel.

$$(3.16)\quad P_i = X_i\beta + \delta_i\gamma + \rho\sigma_\varepsilon\lambda_i + \varepsilon_i\,,$$

where P is sales price, X is vector of parcel characteristic variables, γ is dummy for participation in the PDR program, and λ is inverse Mills ratio. The second model was otherwise similar but the coefficients of parcel characteristics were allowed to vary according to participation in PDR. The third model was based only on unrestricted sales. This procedure allowed the authors to calculate predicted sales values for PDR sales and to compare these values with actual sales values. The model specification was semi-log.

The signs of the coefficients were generally consistent with the authors' expectations. However, the coefficient of participation in a preservation programme was not significant, even if it was negative in the first model. In the second model it was significantly negative, but the Wald test showed that the parcel characteristics did not differ between PDR and non-PDR sales. Thus, the first model in which there was no significance was more appropriate. The results of the third model revealed that no actual sales price on PDR sales was outside the prediction interval. Thus, the authors found no statistically significant evidence that voluntary preservation programmes decreased farmland prices. No evidence of selectivity bias was found.

A possible explanation for this is perhaps that actors in the land market do not expect the restriction to be binding in the future. This indicates that even though the preservation is permanent, actors do not trust in the authorities. Another reason might be found in the increased demand for preserved land among hobby farmers. These buyers value urban amenities but wish to live on a farm.

The only variable related to agricultural returns the authors used was the proportion of prime soils. The sign of the coefficient was positive, as expected, but it was not statistically significant in any of the models. Thus, according to the authors, finding adequate proxies for agricultural returns continues to be a challenge for researchers studying land values in urbanizing areas.

The most recent hedonic studies where the use of spatial econometrics has been quite sophisticated are those by Ciappa (2003) and Soto (2004). Ciappa analysed the effect of farm capital structure on land prices and Soto presented a very thorough spatial analysis of the Louisiana land market.

In Finland, only a few hedonic studies have been conducted. Laurila's (1988) study is worth mentioning. Laurila concentrated only on arable land. Laurila divided the independent variables into two groups. As endogenous[36] variables he used two indices of soil quality, the yield of barley, the temperature sum of the thermic growth period, farm size, price support for milk, regional support per farm, total taxable returns per farm, taxable income per farm, government purchases of farmland, and loans granted for farmland purchases. As exogenous variables he used employment, net migration and the price of services. He had 109 observations of farm purchases from different regions in Finland from the years 1980 and 1982-1985. The explanatory variables were mainly at the municipality level.

Laurila (1988) tried several model specifications, starting from one explanatory variable and ending up with six variables at the same time. The net migration and support variables were not included into the reported models at all due to their small significance. The maximum determination rate was 68%. The most statistically significant variables explaining the land price variation seemed to be soil quality and employment. The yield, total taxable income, and the amount of farm loans were also significant.[37]

Since the main interest in this study is on separating the effect of market-based and policy-based returns (and spatial analysis), I concentrate on these studies at the end of this chapter. Two papers of Goodwin et al. (2003a; 2003b) start the review, since they are the most detailed ones trying to take into account the effects of different kinds of support. The authors concentrate on studying the capitalization effect of the different kinds of support introduced by the FAIR Act in 1996.[38]

According to the authors, the question is very important policy issue, since there are pressures to completely decouple the payments in order not to cause any kind of market distortion. The fear of capitalization also provides the grounds for arguments on limiting total payments both in the

[36] By endogenous variables, Laurila means the factors that are purely agricultural whereas exogenous variables are non-agricultural. Thus, they are not necessarily econometric expressions.
[37] The interpretation of the total taxable income and the amount of farm loans is somewhat problematic. The importance of taxable income may reflect the liquidity constraints of farms. However, the amount of farm loans per municipality does not necessarily tell anything about the livelihood of the land market as intended. It merely tells about the size of the municipality, which is probably quite irrelevant for the land market.
[38] The FAIR Act reformed the agricultural policy in the U.S.A. in 1996.

US and EU. Completely decoupled payment should not have any effect on land values.

However, any factor that raises or smooths the profitability (net income stream) of agricultural production increases the value of agricultural land. Nevertheless, there are caveats in the capitalization process:

1. The uncertainty of the continuation of the support leads to heavier discounting.
2. The share of the benefits between owners and operators

According to the authors, the problem in studies trying to separate the effect of market-based and support-based income on land value or prices is the use of heavily aggregated data. In contrast to many other studies, Goodwin et al. (2003a; 2003b) had the advantage of a unique farm level dataset (survey of 14 000 farmers). The earlier study covered the years 1998-2000, and the later one the years 1998-2001. The authors also attempted to include very careful consideration of the effect of non-agricultural demand on land values.

They started their conceptual framework by following the general line presented in the study of Weersink et al. (1999).[39] Since different sources of income streams may have different uncertainty of future streams, the constant discount rate assumption of the NPV model does not hold. Thus, the discount rate may vary over different sources.

The authors divided income streams into market returns, government payments, and incomes from non-agricultural sources. Government payments were further divided into different kinds of payment according to their nature.

The Goodwin et al. (2003a) model[40] is represented by the following formula:

(3.17) $$V_t = \sum_{i=1}^{\infty} (b_1^i E_t MR_{t+i} + b_2^i H_{t+i} + \sum_{j=1}^{g} b_{3j}^i E_1 GP_{j,t+i}),$$

where V is the land value according to a farm survey (farmers' estimation at the end of the year), b_k is parameter (k=1,2,3), E is the expectation operator, MR represents the expected market returns, H the non-agricultural

[39] Weersink et al. (1999) provided an excellent review of land value studies.
[40] In the 2003b study the model was similar but the independent variables were not lagged.

returns, and GP the government payments from different programmes (j=1,…,g).[41] Expected market returns (MR) were represented by two variables: the county average net return/acre without government payments (productivity difference between counties), and the normalized mean yield (productivity difference between farms). In the 2003 study they added the market price index to the list.

Non-agricultural returns (non-farm demand) (H) were represented by three variables: the total value of housing permits in the county, the urbanization rate, and the population growth rate. In the 2003 study the urbanisation rate was compensated by population density.

Government payments (GP) were divided into four categories in the 2002 study, and into five categories in the 2003 study. In the 2002 study, a similar model was also introduced to study the effects on leasing (i.e. land rents instead of land values).

As expected, the payments were indicated to have a substantial effect on land values. The loan deficiency payments (LDP)[42] appeared to have the greatest effect on land values. An additional dollar in LDP would raise the land value by almost ten dollars in the 2002 study and by almost seven dollars in the 2003 study. The authors considered this to describe the belief in a continuing support stream in the coming years, not only in a given year. The same concerns disaster payments, although the rise is little smaller (less than seven dollars in the 2002 study and less than five dollars in the 2003 study). Thus, it is discounted more heavily than LDP, but anyhow it reflects the trust in some kind of future support.

The flexible production payments (AMTA payments) were analysed using two different approaches. In contrast to previous results, the AMTA payments[43] were not found to affect land values when the joint effect was studied (2002). When years were separated the first year payments were found to have a minor effect on values (additional dollar raised 3$/acre). These results were exactly as expected, since the payment was expected to expire. In the 2003 study, the AMTA payments a little surprisingly had more effect than in the earlier study. The authors believed this to show that

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[41] Note that the model allows each programme benefit to be discounted at a different rate.
[42] Loan deficiency payment (LDP) is a price support.
[43] AMTA programme payment is a flexible production payment introduced in the FAIR Act in 1996. It was planned to expire in 2002, but the Farm Bill in 2002 continued the payments.

farmers relied on the continuation of the payment. The effect of other support was somewhat mixed. The results clearly showed that programmes differ in their effect on land values. Thus, it is important to study the effects separately.

Urbanization also seemed to significantly raise land values, but due to correlations between variables the exact effect of each factor cannot be separated. Similarly, construction pressure seemed to have an effect on land values, as also did the agricultural productivity measures, thus confirming the NPV approach.

The rental regressions carried out in the 2002 study indicated quite similar results. The AMTA payments also showed a rising effect, indicating that landowners were successive in extracting at least a proportion of the support for themselves.[44] The urban effect is somewhat mixed and perhaps the opposite. This may reflect the owner's option value of not yet selling the land if the price is rising. On the other hand, it may reflect the operator's attitude: he benefits only from the agricultural value of the land, not from the non-farm demand.

Barnard et al. (1997) carried out one of the first analyses after the FAIR Act changed U.S. policy considerably. However, their data were from the year 1992, i.e. before the FAIR Act. They used two related, but quite different, regression-based approaches. One was the standard linear (parametric) estimator (OLS) and the other a nonparametric estimator.

In their regression model the dependent variable was land value based on a survey of farmers' evaluations. The data were from different regions and covered the years 1994-1996. As pure hedonic variables they used three variables that served as a proxy for the agricultural productivity value. They were soil quality (soil index), precipitation and temperature (both 30-year averages). In addition, they used county-level averages of government payments in 1992 to represent the policy-based part of the returns.

Furthermore, they used the average farm size, irrigation possibility and special crops (fruits and vegetables) to represent the structure of agriculture in the region.

Urban pressure was measured by an index that takes into account the population around the parcel and parcel's distance from a population centre. In addition, recreational demand (per capita payroll for recreation industries) was used, because urban pressure does not necessarily take into account

[44] Compare to the results of Bierlen et al. (2000).

this kind of non-farm demand. In order to separate different years they used dummy variables.

Regression was performed in a log-linear form in order to be able to interpret the parameter estimates directly as elasticities. Compared to the models of Goodwin et al. (2002; 2003), the determination rates were quite high (0.40-0.66 vs. 0.15-0.24). However, the data used are much more aggregated in nature. Urban pressure, government payments and special crop estimates were all of the expected sign (positive) and significant. The elasticity of government payment varied from 0.12 to 0.69. Thus, usually it is very inelastic as expected.

The authors concluded their study by expecting the fear of decreasing land values due to the FAIR Act and declining subsidies to be exaggerated. This is due to the fact that farmers expect the support to continue at least in some form in the future. Other factors having an effect in the same direction include increased productivity due to greater flexibility granted by the FAIR Act ("freedom to farm"). Continuing urbanization and strong export demand also support the land values and offset otherwise potential reductions.

In a more recent analysis based on hedonic pricing, Barnard et al. (2001) calculated that at maximum the government payments account for 24% of the market value of farmland. The smallest effect was in the most urbanized states where the government payments account for only 8% of the farmland value. The authors also emphasized that programmes differ from each other considerably such that the loan deficiency payments (LDP) that are tied to production affect farmland values less than those tied to the land. They also noted that landowners are able to capture all the value of future commodity programmes through appreciation in the land value.

Gardner (2002) found very weak evidence, if any at all, of a positive effect of U.S. commodity programmes on land prices. He analysed the growth in land prices between 1950 and 1992, using county-level data in his hedonic analysis based on OLS regression. The independent variables were the proportion of cropland under programme crop cultivation, government payments per acre, the initial land value in 1950, farm sales per acre, the relative proportion of the rural population, population growth, property taxes per acre and multifactor productivity growth.

The strongest factors affecting the growth in land value were population and productivity growth. Gardner (2002) saw the scope of the programme and benefits going to the commodity buyers in the long term as reasons for the weak effect of commodity programmes.

Roberts et al. (2003) published one of the few studies where the lease prices are used instead of sales prices or land values. The reason for this was that land values, more than rents, encapsulate intangible beliefs in the future that are difficult to measure and may show misleading statistical associations. The chosen approach also meant that the importance of non-farm factors was probably small.

The authors concentrated on the incidence of government payments on land rents. Thus, they only reported the coefficient concerning this. They had very large farm level data (census data covering about 60 000 farms) from two years, 1992 and 1997, of which the former was before the FAIR Act was introduced and the latter after. As an explanatory variable in their linear OLS model they used paid cash rent. In addition to government payments, explanatory variables included, crop sales, total sales, costs, land area, the proportion of irrigated land, some acreage controls, and region dummies.[45]

Their strongest estimates implied an incidence of government payments on land rents of between 34 and 41 cents for each government payment dollar. If the policy makers had targeted the benefits at farmers they were at least 60% successful in this. However, the authors emphasized that the effect of government payments may have been captured by other input factors, or alternatively, in the long term, the incidence will be larger.

Patton and McErlean (2003) offered the most detailed spatial land price analysis thus far. Their data were based on 1 314 transactions in Northern Ireland from the years 1996 to 1999. They also sent questionnaires to the purchasers, but only 395 were returned and from these only 197 could be used in the analysis. In addition to transaction information concerning the price and the size, they included several other variables in the hedonic model. These were the land quality score, conacre rent (one season lease price), distance to the nearest urban area, and a dummy indicating whether there was a potential building site on the purchased land.

The authors firstly estimated the traditional single market hedonic function by OLS. The coefficients were, as expected, statistically significant and of the expected sign. They then continued the analysis by dividing the

[45] Thus, the model is not actually a hedonic model, not even a semi-hedonic model. However, it is worth being referred to in the context of other studies concerning the separation of market incomes and government payments.

transactions into sub-markets. Their spatial regime model covered four LFA submarkets and three non-LFA submarkets. The results were somewhat mixed. It seemed that the spatial regime model was superior to the single market model based on explanatory power and the log-likelihood ratio. However, the Aiken (AIC) and Schwartz (SC) information criteria[46] suggested just the opposite. In addition, many of the coefficients were not statistically significant. The Chow test, however, indicated that coefficients were different in different regions. Thus, according to the authors it is appropriate to use the spatial regime model.

Thirdly, they tested whether the appropriate spatial model should be a spatial-lag or spatial-error model. In order to build the weight matrix they used the GIS coordinates to compute the distance from each transferred parcel to the other parcels in the data. The weight was the inverse squared distance. The testing procedure showed firstly that there were spatial autocorrelations and secondly that the appropriate model should be a spatial-lag model. The presence of spatial dependence means that the traditional hedonic models are mis-specified and the results are biased. Thus, they re-estimated the previous models.

Again, the spatial regime model was, according to the authors, more appropriate. The spatial dependence was also stronger in the spatial regime model. They concluded that incorporation of a spatially-lagged dependent variable better captured the price determination process, since more variables were statistically significant. In the single market model the differences between traditional and spatial models were smaller. Thus, the authors pointed out the importance of taking into account both spatial heterogeneity and spatial dependence in modelling land prices.

Katchova et al. (2002) applied semi-hedonic spatial analysis in order to test whether differences in production risk affected farmland prices. They started the theoretical framework with a basic capitalization formula, but added a risk component to it. The risk was measured as the variability in land rent, using data from 82 counties in Illinois. The dependent variable they used was the average transaction price in the county in 1995-1999. As independent variables they used the land rent (based on actual paid cash rents and the landlord's share of share leases), and its variability over time as a risk variable, farm size, soil productivity, economic productivity, and population density as a proxy for non-farm demand.

[46] These information criteria take into account the loss of freedom.

In the basic OLS regressions Katchova et al. (2002) observed the expected result that riskier production conditions reduce the land price. The non-farm demand controlled by population density also seemed to have significance in determining the land price. The spatial analysis showed that there were spatial autocorrelations. The authors estimated both spatial error and spatial lag models. Interestingly, the spatial error model did not change the results considerably, whereas the spatial lag model did. According to the spatial lag model, the coefficients of neither the rent nor the risk proved to be statistically significant. Thus, the spatial autocorrelation between neighbouring counties dominated the effects of rents and risk on farmland prices.

Janssen and Button (2004) used county level data (54 counties) from South Dakota for the years 1991-2001.[47] They compared the results by dividing the research period into pre-Farm Act (1996) and post-Farm Act periods. As the dependent variable they used both land value and cash rental rate. As explanatory variables they used the soil productivity index, government payments, dummy variables to capture socio-economic effects, and the time trend.

Differences in cropland productivity and socio-economic factors proved to be major factors explaining variation between regions for both basic models (value and rent). The R^2 values were 0.85-0.89. The authors used both linear and logarithmic model specifications. The coefficients of government payments were positive and highly significant, but a $1.00 dollar increase in payments increased the land value by only $1.18 and the rent by $0.08. There was no difference between the two time periods in the relation between land values and government payments. However, the effect on rental rates declined after the Farm Act was introduced. The authors calculated that without government programmes both land values and cash rental rates would have been about 5% lower. They also noticed that rental rates did not increase at the same speed as land values, and explained this by means of socio-economic factors.

[47] Actually, this is a panel data, but they used it in econometrics partly like cross sectional data. They removed inflation with the GDP deflator and in addition they used a time trend.

3.4.2 Models explaining differences in price movements over time

Movements in land prices have been widely studied in the economic literature.[48] The modelling theory has a very similar basis to the literature concerning factors affecting price levels. The basis is in the capitalizing of expected land rents as shown in chapter 3.2. The underlying theory behind the models is the net present value model (NPV) and capital asset pricing (CAP).

Falk (1991) saw the fundamental economic questions to be:

1. How much of an asset's price movement is caused by factors that determine the fundamental value of the asset (current and expected future returns and discount rate)?
2. Do these factors account for asset price movements in a rational manner?

The simplest version of CAP theory assumes that land buyers are risk neutral, discount the future at a constant discount rate r, act competitively, and value land only for its economic return (Falk 1991).

If it is assumed that the discount rate is constant, that agents are risk neutral, and differential taxes on capital gains and rents are ignored, and also that the residual rent is constant over time, the capitalization formula (the traditional one) is

(3.18) $V=R/r$,

where V is land value, R is a constant annual return, and r is a constant real discount rate. However, before long researchers noticed that land prices and farm income series diverged, and thus they were forced to examine the validity of this formula. A number of alternative explanations have been proposed, starting from productivity increases, government programmes and urban pressure.

In the 1960s researchers tried to include these variables in a supply and demand framework. They worked quite well at that time, but when re-estimated in the 1970s the validity disappeared. One reason for this was, according to Burt (1986), the highly inelastic nature of the quantity of

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[48] This short overview of the development of movement literature is largely based on the excellent review of Weersink et al. (1999).

farmland and thus the supply curve does not actually exist. Actually, Burt (1986) pointed out that when the quantity of farmland is fixed the demand equation entirely determines the land price. This is why recent studies have focused on the demand side.

Melichar (1979) pointed out one of the restrictive assumptions of the formula, namely the ability of net farm income to measure the land rent.[49] History had shown that current returns on assets grew rapidly over time. This resulted in the large annual real capital gains and low real rate of current return on assets actually experienced by farmers. Thus, Melichar (1979) modified the formula as follows:

(3.19) $V=(1+g)R/r-g$,

where g is the growth rate. This can be included in the traditional formula as follows:

(3.20) $V_t=E(V_{t+1}+R_t)/1+r$.

Thus, the capital gains can be explained in theory as the capitalization of expected future rent (see Falk (1991)). Castle and Hoch (1982) estimated that only about half of real estate values are explained by capitalized rent, whereas the other half is explained by capital gains. Alston (1986) included inflation in the model, and Burt (1986) added lags to the model. Their model specification and lag structure, however, differed. Later, Just and Miranowski (1993) criticized the use of complicated lag structures. Alston (1986) found that an increase in expected inflation had a negative effect on real land prices, but the effect was very small.

Shalit and Schmitz (1982) were the first to include credit rationing forces in the model. They also found evidence for this relationship, since according to them higher prices provide more collateral and thus lead the

[49] In empirical work we seldom obtain data on land rent as such. Thus, we have to use a proxy for this. Often, researchers have used some kind of net income data instead of land rent. This perhaps may be even more appropriate, since the question of privileged cost can thus be set aside. Alston (1986) points out that usually in farm accounts the proportion of unpaid labour and the interest on own capital are hard to define as well as land rent. If we use, for instance, net profit we can assume that they each get same share of the profit and none of them is privileged. Even if we could obtain data on land rent it would often be negative and thus impossible to use in econometric analysis. Sometimes, cash rents are used in order to describe land rent (e.g. Burt (1986), Alston (1986)).

farmer to purchase more land. However, when tested by Burt (1986), very little evidence for this was found. Weisensel et al. (1988), on the contrary, suggested that increased land values lead to increased credit.

Featherstone and Baker (1987) tested an asset price bubble by simultaneously estimating interest rates, returns on assets and the price of land by vector autoregression (VAR). Indeed, they also found evidence of the considerable effect of speculative forces on land prices.

Just and Miranowski (1993) also criticized the approaches that concentrate on one factor at time (farm returns, capital gains, credit market conditions, explosive expectations, risk changes, non-farm demand, etc.), since they have been used in isolation rather than taking into account all factors simultaneously. According to Just and Miranowski (1993), many of the factors thought to affect land prices and their changes correlate with each other, which weakens the validity of the results obtained by using only one of the factors as an explanatory variable. This also explains why the results in ad hoc and partial analysis have been conflicting.

In their own model, Just and Miranowski (1993) simultaneously estimated the effect of many factors. Firstly, they offered a descriptive (graphic) analysis of different factors and their contribution to land prices. This graphic analysis pointed out, for example, that real returns do not closely parallel land prices and nor do they seem to affect the price changes. They started the modelling by taking the accumulation of wealth as the driving force.

In the econometric estimation they used land price change as the dependent variable. Independent variables were land price expectations, return expectations, government payment expectations, risk, capital gain taxes, the opportunity cost of savings and debt, land tax, the credit limit and the inflation rate. Thus, they were also one of the first in trying to separate the effect of market returns from governmental payments. In modelling the expectations they used naïve expectations (i.e. the change in expectations for period t is explained by changes in previous prices and thus, indirectly, by previous changes in other variables). The data were panel data concerning U.S. states for the period from 1963 to 1986.

They noted that contrary to other findings the changes in returns were only one of three main factors affecting land price fluctuation. Land price expectations had the most important explanatory force. However, taking into account the naive expectations they are indirectly explained by other variables. Of the other variables, inflation and the opportunity cost of capital are roughly as important as returns.

Government payments do not seem to explain the changes in land prices over time, although they may account for roughly 15 to 25% of the capitalized value of land. The reason for this was, according to authors, the stabilizing nature of the payments.

This means that a simple net present value model is probably not appropriate in investigating land prices and their changes. However, there is another reason why the net present value model may not be appropriate. Previous literature in support of the net present value model relied on traditional time series regressions. If the data are characterized by non-stationarity, the regression may suffer from spurious regression (see Granger and Newbold 1974; Engle and Granger 1987).

Campbell and Schiller (1987) firstly showed that if the net present value model were correct, net rents and land prices should have same time series properties, and past values of the spread between land prices and rents would add useful information in forecasting future changes in rents given past changes in net rents. The second criterion imposes co-integration, Granger-causality and cross-equation restrictions on the vector-autoregressive representation of the changes in rents and the spread between rents and land prices (Falk 1991; Clark et al. 1993a).

For this reason, the researchers started to question the appropriateness of the traditional NPV approach (Falk 1991; Clark et al. 1993a; Baffes and Chambers 1989; Tegene and Kuchler 1993; Hanson and Myers 1995). All of them rejected the traditional NPV, at least for the second criterion. Another study of Clark et al. (1993b), however, found some evidence for the traditional NPV formula.

The purpose of the Falk's (1991) study was to test the validity of the constant discount rate version of the present value model. If the present value model were correct and if net returns evolved as a difference stationary process, then it can be shown that the land price series is also a difference stationary process.

Falk (1991) used both land prices and actually paid cash rents as land rent.[50] The series were found to have similar time series properties.

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[50] This is quite an exception compared to other studies so far. An obvious question is how well the cash rent is related to returns on land? Or is it only a reflection of the land sales market?

However, casual observation (graphic analysis) already suggests that price movements are more volatile than rent movements. Testing the VAR restrictions showed that NPV model must be rejected. The correlation between series was 0.90 and the coefficient was 17.75, indicating discounting at an annual real interest rate of 5.6%. One possible reason for this behaviour might be rational bubbles.[51] Another explanation might be that the discount rate varies over time.

In a more recent study, Falk and Lee (1998) deepened the analysis in trying to decompose the farmland price movements into a component driven by fundamental forces (returns to asset) and a component driven by speculative forces. They found that in the short term the two components are equally important in explaining the year-to-year movements in land prices. However, in the long term the importance of non-fundamental shocks disappears and the main reason for land price movements is the change in returns on assets.

Roche and McQuinn (2001) also investigated rational bubbles. They had a long time series (1911-1995) from Irish land prices. The unit root test showed that land price and land rent as well as farm output and output price series were non-stationary. By using a general regime-switching model they found that the partially collapsing bubbles model provides a reasonable description of the dynamic movements of Irish land prices over the research period.

Clark et al. (1993a) discussed the relationships between farm income, land values and capital asset pricing theory. It was shown that land prices and land rents do not have the same time series properties, which is a necessary condition for the simple capital asset pricing theory to hold. Thus, rethinking of land value models is needed. Proper models might include rational bubbles, government policy shifts or producer price shifts.

Clark et al. (1993b) tested the time series properties of three data sets and found in each case that the land value series included one unit root less than the land rent series. Thus, the simple asset pricing theory does not hold. It also means that the second criterion cannot be tested. This result is in contrast to that of Falk (1991), but similar to the results of Baffes and

[51] Rational bubble means the tendency for the price to deviate from its fundamental value in a non-stationary manner as a result of a self-fulfilling belief that the price depends on a variable(s) that may be intrinsically irrelevant with respect to the asset's fundamental value.

Chambers (1989). The reason for this might be that the land market differs between different parts of the U.S.

The result also means that cross sectional studies are needed in order to shed light on the factors affecting land prices and generating the differences in time series properties. Possible factors mentioned by Clark et al. (1993a) include interest rates, taxes and risk aversion. The authors strongly support the re-thinking of land price modelling in such a way that the methodology should follow unit root testing.

According to Tegene and Kuchler (1993), possible reasons for rejection of the traditional net present value formula are: speculative bubbles, time varying discount rates and non-monetary returns on farmland. One reason for time varying discount rates might be found in the different sources of incomes. The market return may be discounted differently from government payments. Thus, the separation of these income sources in the analysis and allowing the discount rates to be different may add knowledge in this matter.

Chavas and Thomas (1999) developed a dynamic model of land prices. Their main point was that CAP models may be inappropriate to model land prices properly, since the transaction costs are not included in the model. Transaction costs arise since the capital market is segmented, hence leading to costly arbitrage process between farm and non-farm equities. In their time series analysis (system equation) carried out at the U.S. aggregate level for the years 1950-1996, they found strong evidence for the effect of transaction costs on land prices. They also found that market participants are risk averse. Later, Lence (2001) criticized the authors for, among other things, ignoring the non-stationarity in their analysis (and Just and Miranowski (1993) for the same reason).

Turvey et al. (1995) carried out one of the first studies allowing the discount rate to vary between income sources that utilized modern econometric methods. The authors developed an enlarged present value model that allowed the discount rate to differ for various sources of returns and also to vary over time. In addition to land values, they also studied the quota values.

Similarly to Weersink et al. (1999), they started their work with a present value model without government payments. They then modified it by allowing the discount rate to vary over income sources and over time. Since it is well known that most economic time series are not stationary in their levels (i.e. both the mean and variance change over time), some modifications are needed. In the past, differencing and time trend removal have been used to make series stationary. In modern econometrics, co-integration analysis is necessary. The authors pointed out that if the economic rent and land value have a different number of unit roots the NPV approach is not valid. In order to be valid, NPV claims stationarity.

Turvey et al. (1995) used Canadian data from Ontario for the years 1947-1993 and Saskatchewan for 1949-1993. Since the preliminary analysis indicated the presence of unit root non-stationarity in each of the time series, they used canonical co-integration analysis. Discount factors were found to be different in Ontario but not in Saskatchewan. Government payments discounted less than market-based returns. The reason was the nature of the support. In Ontario, subsidies are more stable than in Saskatchewan where the support is generally ad hoc in nature, and thus farmers cannot count on subsidies as much as in Ontario. The results suggest that land values are more responsive to government payments when these payments are perceived to be permanent. Turvey et al. (1995) also formed a structural model that gave quite similar results. In addition to land value models they applied a similar approach to milk quotas.

Weersink et al. (1999) summarized their literature review by dividing the land value studies into two groups, namely those that rely on the NPV model represented by traditional time series and those that use co-integration analysis. What was not considered in the latter group of studies was the fact that land rent is derived from two different sources: the market and government. This was the reasoning for their study.

The discounting effect of government payments (GP) depends on the nature of the support programme. Support that is ad hoc or transitory might be discounted more heavily, whereas support that is long term and has a stabilizing nature may be discounted even less than market returns (MR).

The purpose of Weersink et al. (1999) was to estimate the separate effects of market returns and government payment on land values and to determine whether the GP are discounted more heavily than MR. This is one of the first studies that has tried to separate the effects of market returns and support benefits. The authors developed a present value model that allowed the discount rate to be different for various sources of returns.

Weersink et al. (1999) referred to quite many studies that have examined the capitalization of support into land values. In every cited study the capitalization effect was clear, indicating that support is not decoupled from the land rent. Some studies showed that the support was almost fully capitalized into asset values (Traill 1985). Cited studies were by Featherstone and Baker (1988), Veeman et al. (1993), Clark et al. (1993b), Just and Miranowski (1993) Goodwin and Ortalo-Magne (1992).

The authors started their conceptual framework with a present value model without government payments.

(3.21) $P_t = \sum_{j=1}^{\infty} b^j E_t R_{t+j}$,

where P is the current nominal land price, b is the nominal discount factor, and R is the nominal net cash rental income of land as expected on the basis of information available in period t-1. The nominal discount factor b can be decomposed into

(3.22) b=1/(1+i+c),

where i is the nominal interest rate, and c is the nominal risk premium.[52]

If the stochastic process driving nominal rents is known we can write:

(3.23) $R_t = (1+\pi)R_{t-1} + w_t$,

where π is the expected growth rate of nominal cash rent, and w is a white noise error term. This leads to the following specification of the present value model:

(3.24) $P_t = \frac{E_t R_{t+1}}{(i+c-\pi)}$.

This can be interpreted as a short run equilibrium formula. Remembering the purpose of the study, two modifications are needed. Firstly, land rent must be divided into two sources, and secondly, the discount rate should be allowed to vary between these sources. Thus, the equation will have the following form:

[52] A real version of the formula could be obtained by subtracting the expected growth rate in nominal cash rent from interest rate i and taking the value and rent in real terms.

$$(3.25)\quad P_t = \sum_{j=1}^{\infty} (b_1^j E_t MR_{t+j} + b_2^j E_t GP_{t+j}) \ ,$$

where R=MR+GP, where MR is the market returns, and GP is government payments. And further

$$(3.26)\quad P_t = \frac{E_t MR_{t+1}}{(i_{MRt} + c_{MRt} - p_t)} + \frac{E_t GP_{t+1}}{(i_{GPt} + c_{GPt} - g_t)},$$

where the i_{MR} , i_{GP} , c_{MR} and c_{GP} refer to the respective interest rates and risk premiums, and p and g are the expected growth rates in market returns and government payments. The hypothesis that market income is discounted less heavily than income from government programmes can now be tested. Behind this is the assumption that government payments are more likely to be transitory. Finally, Weersink et al. (1999) calculated both the short term and the long term elasticities, which are as follows (in the case of market returns):

$$(3.27)\quad \xi_P^{LR} = \frac{b_1}{(1-b_1)} \frac{MR^B}{V^B} \text{, and}$$

$$(3.28)\quad \xi_P^{SR} = \frac{b_1 MR^B}{V^B} = (1-b_1)\xi_P^{LR} \ ,$$

where MR^B, and V^B denote the respective means. In order to be able to adopt a consistent econometric approach they used the rational expectations theory. They firstly supposed that both market returns MR and government payments GP can be described by a stochastic process that can be represented by a first order autoregressive trend stationary series. Thus:

$$(3.29)\quad MR_t = \alpha_0 + \alpha_1 t + \alpha_2 MR_{t-1} + v_{1t} \ ,$$

and respectively

$$(3.30)\quad GP_t = \beta_0 + \beta_1 t + \beta_2 GP_{t-1} + v_{2t} \ ,$$

where α and β are parameters to be estimated, and v is the error term. By using the Wiener/Kolmogorov prediction formula the land value equation can be written as follows:

$$(3.31)\ P_t = \gamma_0 + \gamma_1 t + \gamma_2 MR_{t-1} + \gamma_3 GP_{t-1} + v_{3t}\ .$$

Now they formulated the SUR system consisting of three equations, MR, GP, and P. The cross-equation restrictions were introduced in order to test the system. They estimated their model with the same Canadian time series data from Ontario 1947-1993 as Turvey et al. (1995). They divided the land rent into two sources by subtracting the support from net farm income.

The land price and the government payments were found to be trend stationary. The income series seemed to be difference stationary, but the DF test result was not very strong. Thus, the approach presented is relevant. The cross-equation restrictions were rejected. The discount factors for the market income and support income were found to be different such that government payments discounted less than market-based returns. Thus, the results were the same as those of Turvey et al. (1995), in spite of the slightly different econometric estimation.

This result for Ontario contradicted Schmitz's (1995) Saskatchewan results, according to which government payments were discounted more heavily. The reason is the nature of the support. In Ontario the subsidies are considered to be provided on a more stable basis. In Saskatchewan they are generally ad hoc, and thus farmers cannot count on them as much as in Ontario.

Both short term and long term elasticities were very low. However, government payments were even more inelastic than market returns. The results suggest that land values are more responsive to government payments, especially when these payments are perceived to be permanent.

In a more recent study concerning land prices in Ontario and Saskatchewan, Clark et al. (2002) found no significant evidence of different capitalization of market incomes and government payments. They used a time series from 1949 to 1996, and co-integration analysis in which the stochastic and deterministic co-integration were separated. The authors concluded that definitive statements in this matter await further theoretical refinements and empirical verification.

Oltmer and Florax (2001) had a very different approach to the topic. They offered a meta-analysis ("analysis of analyses") on the effect of support on land values. They regressed the elasticity of income[53] on land prices against region, production, model properties and so on. They found evidence that pure income support results in substantially lower capitalization in land values than mixed price and income support. This result was based on differences in elasticities between studies. The elasticities have been lowest in those studies where the government payments were separated from market incomes.

Recently, panel data analyses have also been increasingly applied in modern econometrics. One of the first panel analyses concerning land prices was that by Chavas and Shumway (1982). They built a fixed effect model for Iowa land prices using data from five regions from the years 1967-1977. As explanatory variables they used the prices of soybean, corn, and hog. In addition, the mean yield of corn and inflation (consumer price index) were included in the model. The fixed effect was introduced into the model by regional dummies. They applied simple adaptive expectations (one-year lag for yield and inflation variables, two years for price variables). The explanatory power of the model was very high (99%), and all the coefficients were statistically significant and of the expected sign. Rising producer prices were found to be an important factor increasing land prices. Technology change as well as general inflation was also found to have clear effect on land prices.

Vukina and Wossink (2000) rejected the usual approaches (proximity to market and non-farm demand) in order to take into account location as a factor affecting land prices. They saw that both of these traditional approaches were irrelevant in a country like the Netherlands.[54] Instead, they introduced an alternative explanation based on environment policies. In the Netherlands, manure production rights regulate animal production. There are two quotas: land-based and animal-based. They estimated an inverse land demand model by using panel data from years 1988-1996 and from nine

[53] The problem in this kind of analysis is that data is very heterogeneous. The variables are of a different kind and not measured in a similar manner. The elasticities used in the study are also the results of different kinds of model. Thus, there is considerable room for criticism in this kind of meta-analysis. The authors themselves admitted the possible (obvious) problem of sampling error. This can also be criticized based on the fact that the nature of support varies a lot between (and within) countries.

[54] The Netherlands is one of the most densely populated countries in the world. Therefore, the importance of the distance between farmland and urban area probably differs from the situation in Finland.

provinces.[55] The manure right policy changed during the research period from a very limiting policy to a policy that allowed freer trade of quotas.

As explanatory variables they used the land acreage in the province, farm income, total manure output, the cost of waste management (different for surplus and deficit regions), and the mortgage rate. The model was estimated by generalized least squares (GLS). All the variables were statistically significant and were of the expected sign. The hypotheses of the authors were confirmed. The passive policy at the beginning of the research period kept the price gap between surplus and deficit regions high, and respectively the price gap was reduced at the end of the research period. The reason for this was that it became profitable for farmers to sell their animal-based rights in the surplus region and move to the deficit region and start production there. However, the migration from surplus to deficit region was not very large, probably due to social and cultural reasons.

Lence and Mishra (2003) provided a panel model that also took into account spatial dependence. Instead of land prices or values, they studied the factors affecting cash rental rates. This is reasonable, since the cash rental rate can be considered as representative of the observed price of land as an input in the production process. Thus, the non-farm factors usually included in land price models were not needed. They also provided a theoretical basis for incorporating government payments into the model.

In the econometric analysis they divided the government payments into four categories depending on the nature of the support. The market returns were included in the model as acreage-weighted corn and soybean revenues. Their county-level data were from Iowa from the years 1996-2000. The spatial autocorrelation was based on a matrix that included distances from each county to every other county in the study (total 93 counties).

The presence of spatial autocorrelation was clear. They used spatial-error-specification in their spatial model. As expected, both market revenue variables were positive and highly statistically significant. A one-dollar increase in market revenues increased the cash rent by 35-38 cents. As expected, the coefficients of both the market loss assistance payment (MLA) and the FAIR Act production flexibility contract payment (PFC) were positive and statistically significant. They also seemed to discount less than market revenues, since a one-dollar increase increased the cash rent by 85 cents. The coefficient of the conservation reserve program was positive but

[55] They ignore the supply side since the supply of land is more or less price inelastic.

statistically insignificant. The sign of the loan deficiency payment (LDP) was unexpectedly negative, which was difficult to explain.

The authors also estimated a model in which all the government payments were aggregated. The market effect remained very similar to the disaggregated model. The coefficient of government support was positive and statistically significant, but rather small, indicating that a one-dollar increase in support would increase the cash rent by only 13 cents. For comparison purposes they also estimated the model without spatial parameters, and the results were quite different. According to the authors, this provided strong evidence of misspecification problems when spatial autocorrelation was ignored.

Lambert and Griffin (2004) used firstly quite a similar model specification to Lence and Mishra (2003), and secondly a fixed-effect, distributed lag model in order to analyse the role of government payments on cash rental rates. They used county-level data from 74 counties in Illinois for the years 1996-2001 in their analysis.

Similarly to Lence and Mishra (2003), they used spatial error specification in the first analysis. They built two spatial weight matrices, the first of which took into account the observations in the same county (farm-farm effect), and the second in adjacent counties (farm-county effect). The presence of spatial autocorrelation was detected. In addition to two government payment variables (AMTA and LDP), corn and soybean revenues were included in the model as explanatory variables.

The coefficients of both payment and soybean revenues were statistically significant. Otherwise, the results were quite similar to those of Lence and Mishra (2003). In the second model, they added variables that capture the soil productivity, the acres owned, rented, and share leasing. The fixed effect model was found to be the proper specification. Again, a positive connection between payment variables and cash rental rates was found, but the results were not statistically significant in all specifications.

Mishra et al. (2004) analysed the effect of debt solvency on farmland values with a panel co-integration model. They used state level data for 46 states from 1960 to 2002. Explanatory variables were returns to farmland, the real interest rate, the debt to asset ratio and government payments. Like many other studies, they found that the standard asset pricing model was inappropriate to explain variation in farmland values. The standard asset pricing model suggests the coefficient of farmland returns to be one.

However, the authors found it to be less than one. The riskiness of the business may explain this.

The coefficients of government payments were in general negative and statistically significant. The negativity meant that when the share of government payments in the farmland returns increased the value decreased. Since government payments were included in the returns on farmland this result was consistent with the authors' expectations.

Awokuse and Duke (2004) concentrated on the contradictions persisting in literature explaining the relative and absolute importance of the various causes of farmland price changes. They first analysed the causal structure of the determinants of fluctuations in farmland price changes. They built their model on the same determinants and basically on the same data as Just and Miranowski (1993) in their structural model.

By using analysis termed directed acyclic graphs (DAG), based on the contemporaneous causal relationship among the determinants, they found that the only causes for land price changes were capital gains and real estate debt. Inflation and returns from agriculture only indirectly affected the land price fluctuation. The analysis was continued by co-integrated vector autoregression analysis (VAR). This analysis strengthened the authors' opinion of the adequacy of a very simple model in which macroeconomic variables cause land price changes. However, they emphasized the need to test the causal effects with a larger dataset, since the DAG is sensitive to small samples.

Ryan (2002) carried out a simple but interesting analysis on the effect of government payments on land values. He analysed land prices during the period from 1970-2001 in 13 southern U.S. states. He simply divided the net income by the land price in order to obtain the implicit discount rate for each year. Then he subtracted the government payments from the net income and using these implicit discount rates calculated the land prices without government payments. He concluded that without government payments the land prices would have been substantially lower, especially at the end of the research period.

However, he admitted that there are many caveats in this kind of analysis. Firstly, the net income does not entirely belong to the land. Secondly, expectations are not properly taken into account. Thirdly, the same discount rate for market incomes and government payments is assumed. And perhaps most importantly, this simple model assumes that land has value only in agricultural use.

The most recent panel data analyses concerning land prices are those of Gutierrez et al. (2005) and Duvivier et al. (2005). The analysis of Gutierrez et al. (2005) covered 31 US states from 1960 to 2000. Assuming a constant discount rate present value model they found that farmland prices and cash rents are non-stationary and non-cointegrating. However, they showed that if there is a regime shift representing a time-varying discount rate the non-cointegration must be rejected. Thus, when allowing a time-varying discount rate the present value model cannot be rejected in contrast to the case assuming a constant discount rate. Duvivier et al. (2005) analysed land prices in Belgium using panel data from 1993 to 2001. They demonstrated that the introduction of the CAP reform in 1992 exerted a positive effect on farmland prices.

4 THEORETICAL ANALYSIS OF THE CAPITALIZATION OF MARKET RETURNS AND SUPPORT RETURNS

4.1 Introduction

As has been shown earlier, the basic theories rely on the capitalizing of land rent. Recently, increasing emphasis has been placed on trying to analyse the policy effects on land prices. This is due to the fact that policy instruments increasingly affect land rent. The WTO negotiations and the general goal of freer trade and smaller subsidies (at least support that distorts markets, so called amber box) have been the driving forces for the latest changes in agricultural policy. In the most recent CAP reform, support was decoupled from production. However, the support still remains even more tightly coupled to the land. This means that the questions of the effect of support on land prices are increasingly important.

Thus far, the interest has been mainly in analysing whether market-based returns capitalize differently from policy-based returns. By means of empirical models we can determine whether the discount rate of market-based returns and support-based returns differ from each other. The possible differences are based on different expectations of:

- the volatility of the market-based returns,
- the permanence of the support (i.e. trust in the policy),
- the level of the support.

Thus, the risk concerning different income sources can be different. Many of these studies have already been referred to in the previous chapters of this thesis.

This is of course a matter of great importance but, actually, it is only one side of the problem. The other side is that recent policy changes have usually included producer price reductions that have been fully or partially compensated by increasing support. This certainly does have some effect on the behaviour of the farmers, and thus also on the land rent and furthermore on land prices. Therefore, some basic results will be sought by very simple theoretical consideration.[56]

4.2 Effect of compensating producer price reductions by increasing support

4.2.1 Full compensation at present input/output ratio

Let us first consider the situation where the policy-based support is increased so much that it fully compensates the producer price reduction, even when there are no changes in farmers' production behaviour.[57] This means that we assume the input/output-ratio to be unchanged. The starting point for this mathematical analysis is the traditional profit maximization approach, normalizing the model per one hectare of land. The profit to be maximized can be written as the difference:

(4.1) $\pi = TR - C$,

where TR is total return from production and support payments, and C is total cost. In order to analyse the effects of market-based returns versus policy-based returns to land price we have to split the TR and C into parts. Thus, TR can be written:

(4.2) $TR = pf(x) + g$,

where p is producer price, x is input use, f(x) is produced amount (production function), and g is policy-based payments (for simplicity we assume here that they are area-based). There is a slightly restricting assumption in the analysis made for simplicity reasons. It is assumed that the amount of land is fixed, and it also stays unchanged. The land is thus not

[56] See also Ciaian and Swinnen's (2003) theoretical analysis on the effect of CAP support on land prices in new member states as well as the analyses of Lence and Mishra (2003), Schmitz and Just (2003), and Guyomard et al. (2004).

[57] In the 1992 CAP reform, this kind of compensation was basically made. This was also the Finnish goal in EU membership negotiations in 1995. Of the recent reforms in the Agenda 2000 reform, the compensation was not generally full. In Finland, however, drying aid was introduced that actually meant full compensation for grain producers.

included in the production function input bundle. The profit function is thus a kind of a per hectare profit function. This can be judged by the fact that, for example, in the latest EU policy reform the land is supposed to be kept in good condition in order to receive the support. Due to the quite considerable support, the land is thus not assumed to go out of production in large amounts.

C can respectively be written:

(4.3) $C = wx + r$,

where w is input price, and r is land rent. In this analysis, a very simplifying assumption of area-based support being totally without costs has been made, i.e. the marginal product is same at all production levels. This is probably not the case when the area-based support is linked to production. However, the marginal product curve of support certainly is more linear than the marginal product curve of market returns (via production function). Moreover, decoupling the support from production, as in the latest EU policy reform, makes the marginal product curve of support even more linear.[58] The situation is essentially as if the payment is made only for owning (or actually controlling or cultivating) the land.

Now we can rewrite the equation 4.1:

(4.4) $\pi = pf(x) + g - wx - r$.

When assuming the profit to be 0 (perfect competition assumption) we can obtain the equation for land rent:

(4.5) $r = pf(x) + g - wx$.

[58] The decoupling from production actually eases the extension of production (i.e. the effect described in the examples) compared to previous situation when the set-aside was only allowed to reach 50% of each farmer’s total arable land area. When continuing production the input decreases have actually been very low, even when they would have been highly recommended. Perhaps farmers have not actually been producing at an optimal level? This also has something to do with the structural change. There also might have been economies of scope between agricultural output and environmental services or eligibility in the direct income support schemes has imposed “Kuhn-Tucker” type restrictions on production (e.g. enforcement to harvest on maintaining good agricultural practice).

Now, let us assume that the producer price is reduced, and the policy-based support (g) is increased in order to compensate for the reduction. Thus, we can write the land rent before the policy change as:

(4.6.a) $r_0 = p_0 f(x_0) + g_0 - wx_0$, and respectively after the policy change:

(4.6.b) $r_1 = p_1 f(x_1) + g_1 - wx_1$.

If we now assume that the policy-maker makes the decision to decrease output prices and increase support based on the assumption of an unchanged input/output ratio (x_1=$x_{0,}$ i.e. the producer price reduction is fully compensated for even if the farmer do not change his production behaviour), we can write:

(4.7) $g_1 = g_0 + \left[p_0 f(x_0) - p_1 f(x_0)\right]$.

Now, we are interested in how the land rent changes when we take into account the change in production behaviour (i.e. $x_1 \neq x_0$). This analysis has been made for simplicity reasons by differentials rather than by properly differentiating the basic equations. However, for illustrative purposes the chosen procedure suits much better. Thus, subtracting 4.6.a from 4.6.b and joining 4.7 we can write:

(4.8)
$$\begin{aligned} r_1 - r_0 = \Delta r = p_1 f(x_1) + g_0 + \left[p_0 f(x_0) - p_1 f(x_0)\right] \\ - wx_1 - \left[p_0 f(x_0) + g_0 - wx_0\right] \end{aligned}.$$

Rearranging equation 4.8 we can write:

(4.9) $\Delta r = \left[p_1 f(x_1) - wx_1\right] - \left[p_1 f(x_0) - wx_0\right]$.

Since we assume the producer to act rationally, we know that given the input/output price (w/p_1) using x_1 is the profit maximizing production level. Thus, increasing x (as well as decreasing) to x_0 decreases the profit. Looking at the latter part of the equation we can therefore conclude that it must be less than the first part of the equation, and thus the result of the equation is positive, i.e. land rent increases. Another effect when land values or prices are concerned is that the proportion of support-based (i.e. land-based) income has increased.

4.2.2 Full compensation at an adjusted input/output ratio

However, the policy maker certainly knows that farmers react to the lower producer prices in order to reach a new profit maximising point. Thus, if the policy maker wants to avoid overcompensation the new support should be cut compared to the analysis in the previous chapter.

The following analysis is based on the situation where the compensation is calculated at the adjusted profit maximisation level (i.e. taking into account the dynamic effect of the changing input-output price ratio and farmers' adjustment to the new situation). Thus, it is lower than in the example presented in the previous chapter.

The analysis is analogous to that in the previous chapter. The only difference is in the manner in which the change in support is calculated (compare to equation 4.7):

(4.10) $$g_1 = g_0 + \left[p_0 f(x_1) - p_1 f(x_1)\right].$$

This means that the equation that describes the change in land rent will also change:

(4.11) $$\begin{aligned} r_1 - r_0 = \Delta r = p_1 f(x_1) + g_0 + \left[p_0 f(x_1) - p_1 f(x_1)\right] \\ - wx_1 - \left[p_0 f(x_0) + g_0 - wx_0\right] \end{aligned}.$$

Rearranging equation 4.11 we get:

(4.12) $$\Delta r = \left[p_0 f(x_1) - wx_1\right] - \left[p_0 f(x_0) - wx_0\right].$$

Now, with a similar assumption to that in the previous chapter concerning farmers' rationality, we see that the Δr is certainly negative. Thus, the compensation is not enough to keep farmers' net incomes at the level they were before the policy change.

If a policy maker would like to decide the compensation level in this manner he/she should be very well aware of the nature of the production function and the farmers' reactions. Even if the farmers' precise reactions are known in the short term, the policy maker should know the possible market reactions due to possible price changes, and thus he/she should know how these changes would affect farmers' behaviour in the long term. This would not be an easy task. Deciding the compensation level based on the unchanged input/output ratio is a much easier task.

4.3 Joint effect of the changes in capitalization rates and production behaviour

As mentioned earlier, the differences in capitalization rates (i.e. differences in risk) can be studied empirically. Thus, the two factors, behavioural effect and discounting effect, are at least qualitatively combined in order to derive some picture of the joint effect of policy change on land prices. The direction and the magnitude of the effect are shown in the following Table 4.1.

Table 4.1. *The expected effect of policy change on land prices conditional on the riskiness of market returns and support returns.*

		Riskiness		
		Similar risk	Market returns riskier	Support returns riskier
Compensation	Full	+	++	?
	Full (after adj.)	-	?	--

As such, it seems simple to judge whether the land prices rise or decrease due to policy change. Lagerqvist (2005) points out that the uncertainty of timing of the future policy change and of the level of the payment will disturb the land market. However, there are many other factors that affect land prices. Moreover, if the compensation level is not full (before behavioural adjustment) the magnitude of the partiality is a difficult empirical issue to define.

The discounting effect is in principle an easier task to define. But only in principle, since the discount rates may change due to policy change. It is quite obvious that a reduction in producer prices may change the discount rate of the market return. If producer prices are reduced one may easily think that at least the risk of further reductions is lower than before. Another factor affecting this is the possible market effect on production.[59] Thus, the expectations are merely positive concerning price movements in the future, and the discount rate of the market return should be lower. However, the discount rate may not be fixed over time. If the producer price increases the risk may again rise.

Similarly, the discount rate of the support may change, too. The situation is a kind of mirror image to the risk changes in market returns. If the support is increased the risk of some decreases in the future is greater, especially if there is some positive development in the market. When we think about the risk of support return the situation is, however, more complicated. The basic assumption based on previous research is that when the support is on a long-term basis the risk is lower. There are also other reasons that decrease the risk, namely the bona fide attitude of politicians towards ensuring the family farmers' future. If the support programme is more ad hoc in nature the risk of its disappearing is greater. There are several reasons for this increased risk:

- budget pressure due to increased support (tax-payers view),
- whether the farmers rely on politicians,
- the question of how long is long-term.

These findings hold only if the situation is examined from the perspective of crop production. However, when the most recent policy change is considered from the husbandry farmers' point of view, the situation is a little simpler. If we assume a simple situation that previous support based on the number of animals is changed to area-based support, and if we furthermore assume that a farmer uses the land only for intermediate consumption, we can easily conclude that the marginal product of the land increases compared to the previous policy. This means that husbandry farmers are willing to pay more for additional farmland than previously. Even if the compensation is not full at the whole farm level the conclusion of a higher marginal product of land holds.

To sum up, it is a very complicated matter to define the precise effect of a policy change on land prices, and an even more complicated matter to identify the policy that has the least harmful effects on the land market.

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[59] For example, one of the goals of the recent EU policy reform is to increase market prices by reducing production.

5 EMPIRICAL MODELS OF FINNISH LAND MARKET

5.1 Introduction

Traditionally, land prices are explained to be an outcome of the expected future incomes (land rent). In this simple net present value model (NPV), the future land rents are capitalized into land prices. In the purest form, only the agricultural earnings are taken into account. However, as we have seen in the previous chapters there are many other factors affecting the prices. To put it briefly in the form of a simple figure, we can divide the factors into two subcategories: the internal factors and the external factors. In the real world the connections are not necessarily straightforward. However, the figure provides an overall picture of the factors involved in the problem (Figure 5.1).

Both time series and cross-sectional data have been used in land price analysis. In time series studies the focus is on the price fluctuation and in cross-sectional studies on the price level.

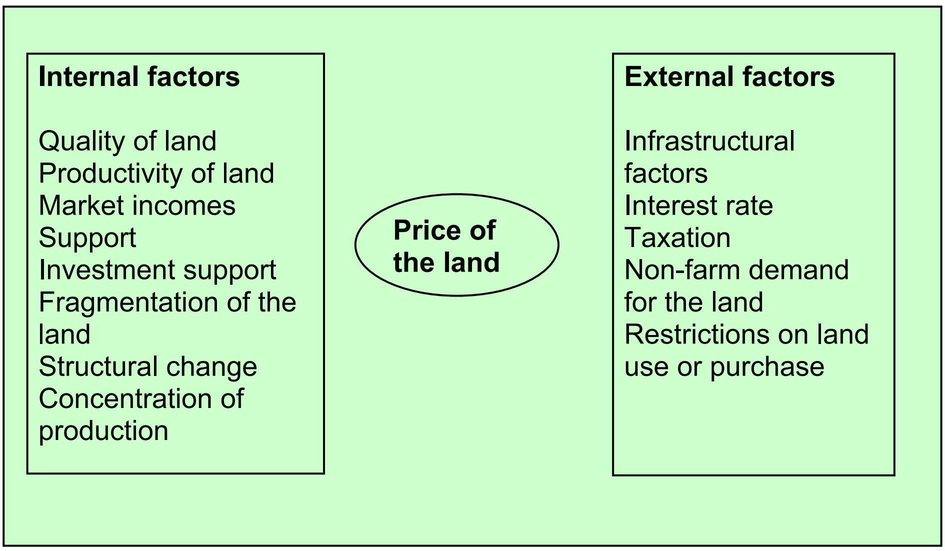

Figure 5.1. *Internal and external factors affecting land prices.*

Unfortunately, insufficient long time series data are available in Finland for a proper time series analysis. The time series starts from the year 1982, but the early observations are not necessarily consistent with the later observations. Thus, the proper time series does not actually start until 1991. Another reason for not applying modern time series analysis based on co-integration is the much-regulated agricultural market in Finland. It does not necessary allow a proper construction of co-integration vectors and testing (Ryhänen 1994; Siitonen 1999).

However, the graphical analysis of time series including the calculation of imputed land values (chapter 5.2) as well as panel analysis (chapter 5.3) is used instead. In addition to land prices, the cash rental rates are explored in both of these approaches. The use of the panel analysis is also reasonable in the sense that only very few studies have sought to analyse both the fluctuation and the level at the same time. The panel data to be used in this study allow these both approaches to be simultaneously taken into account. The aim of this approach is to determine whether market returns and government payments affect land price fluctuation, and if they do, whether the effect is similar.

Traditionally, farmland prices have varied greatly between different regions in Finland. Joining the European Union in 1995 meant a considerable change in Finnish agricultural policy. The previous support, which mostly consisted of price support, was reduced and area-based support measures were introduced. These support measures do not necessarily take into account differences in land quality; hence, one might expect price differences between good and poor land to have decreased (see the theoretical analysis in chapter 4). However, land price differences between regions seem to have increased in recent years.

Taking into account the rapid structural change that is going on in Finnish agriculture, the issues of how and at what price resources, especially land, are transferred to continuing farmers are very important.

The purpose of the hedonic analysis in chapter 5.4 is to determine the factors that affect land prices and how these factors cause regional land price differences. Unlike other land value studies, the interpretation of infrastructure effects here concentrates on the non-farm job opportunities of farm families rather than on the non-farm demand for farmland. The spatial aspects of the econometrics will also be analysed.

5.2 Imputed land values from 1982-2003

In order to compare the market values of arable land to the capitalized values, we firstly construct the land rent series to be capitalized. The actual land rent based on farm accounts indicates that land rent would very often be negative when the cost of the farmer's own labour and the interest on his or her own capital are privileged. Thus, there exists no positive capitalized value for farmland, or alternatively, it would be very low. There are many reasons for this not being a proper procedure for measuring land rent (see discussion in chapter 3).

Instead, we firstly attempt to construct the capitalized value by using farm family income (FFI) as a substitute for land rent. Actually, we use the estimated share of the interest of the arable land. The share is estimated to be 15% of the FFI[60] (hereafter referred as FFI-land). Secondly, in addition to the FFI-land we also use the cash lease, which can be argued to be the short term land rent. The market value, FFI-land/ha, and cash lease per ha are presented in Figure 5.2.

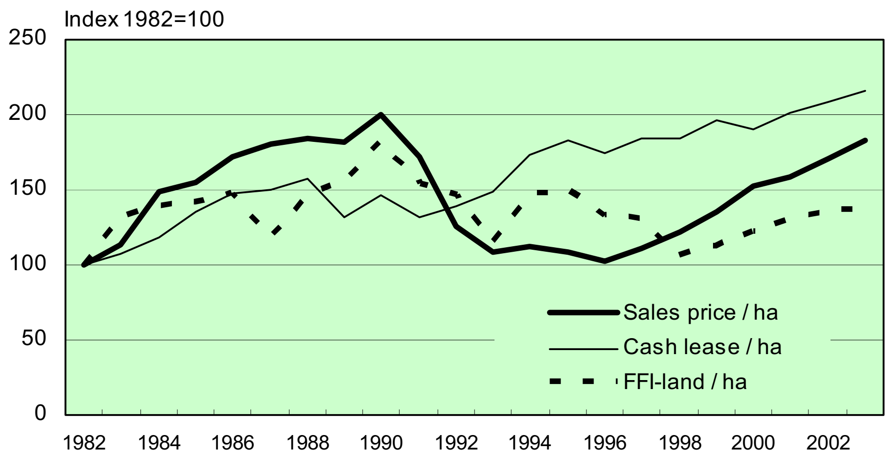

Figure 5.2. *The market value of farmland (median sales price), lease price (average cash lease), and family farm income (FFI-land) per ha in 1982-2003.*

[60] This figure is based on the average from years 1997-2003 calculated at PTT. The share of the non-salaried farm family's labour cost is about 77%, and the share of the rest of the family's own capital about 8%. The remaining 15% belongs to land.

The choice of the interest rate to be used for capitalization is also a difficult task. If the investor makes the investment entirely using his or her own capital, the starting point for the reference rate could be the risk free interest rate. As such, we have used the interest of government bond (maturity five years). If the land is purchased by foreign capital the reference rate could be the average loan rate in agriculture. However, land purchases have always been supported by investment grant schemes in Finland. The conditions for loans have, however, changed over time. The proportion that has been financed by a state-subsidized loan has varied from 50 to 80%. The amount of interest subsidy has also varied greatly. Roughly, the interest subsidy has been about 50% of the general loan interest rate in the last 20 years. Since not all sales have been entitled to support, the "subsidized loan rate" has been calculated by assuming 50% of the purchase to be financed by a subsidized loan and the rest by a normal bank loan. The interest rates are presented in Figure 5.3.

In the next step the imputed values of farmland are calculated by dividing the FFI-land and the cash lease by different interest rates (see equation 3.16 in chapter 3). The results are then compared to the actual market values. The capitalized values are presented in Figure 5.4.

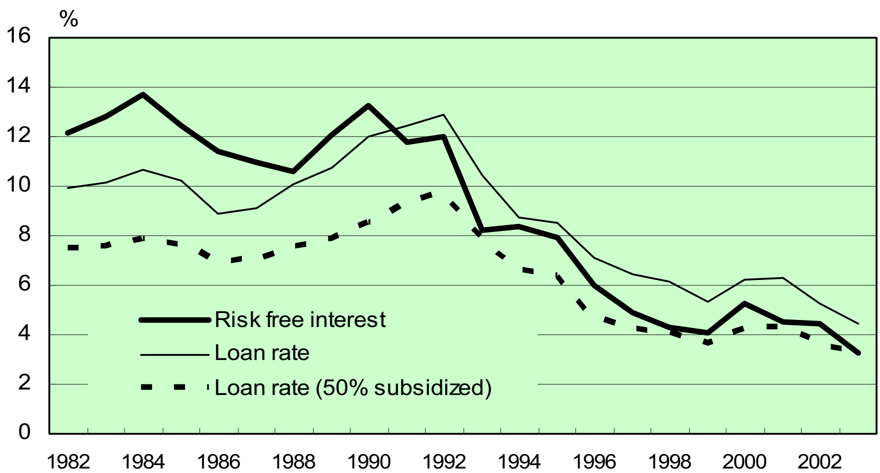

Figure 5.3. *Interest rates from 1982-2003.*

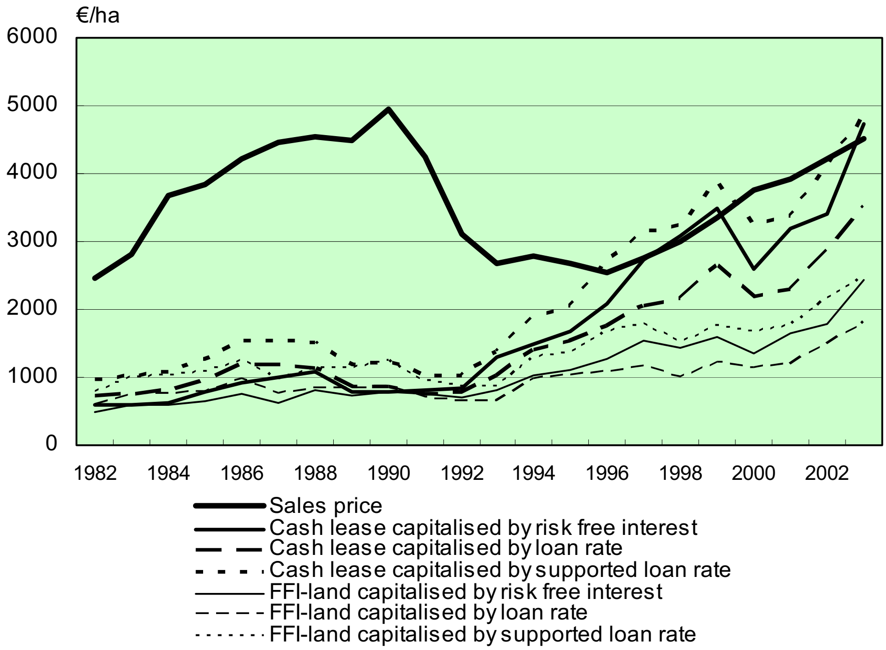

Figure 5.4. *Imputed values of farmland and the actual market price from 1982-2003.*

It is clear that the market values were at a very different level in the 1980s and furthermore in the first half of the 1990s. There seems to be some correlation between imputed values for FFI-land and the market value (0.08-0.22), but not very strong.[61] Compared to the cash-lease-imputed values, the correlations (0.02-0.08) seem to be even weaker. The lower capitalized price with the FFI-land approach was expected, since it can be assumed to be more or less an image of the average value of the farmland, whereas the cash lease as well as market price describes the value of the additional land.

If we assume that cash leases can only be affected by the agricultural productivity of the land, we may easily conclude that the market values are affected by many other factors besides pure agricultural productivity. However, if cash lease really is affected only by agricultural productivity the FFI-land and the cash lease should correlate more than they seem to do. One reason for this could be the change in the role of leasing and in the expectations. In the 1980s the proportion of leased land was much smaller

[61] The low correlation is partly based on the fact that interest rates do not seem to correlate at all with the market value. The correlation between the FFI-land and the market value is 0.51.

and the contracts may well have been based more on other factors than agricultural productivity. The factors unrelated to agricultural productivity, however, were probably not the same non-productivity factors that affect market prices.

Another interesting issue from these figures that can be calculated is to compare the ratio of the cash lease to market value with the interest rates. If the market value only reflected agricultural productivity the first-mentioned ratio should provide some estimate of the risky interest rate. The risky rate should be higher than the risk-free interest rate. However, the result is far from this (Figure 5.5).

There may be many explanations for this. Firstly, non-agricultural factors may have a large role in determining the land price. Secondly, the expected rates for capital gains are much greater than the risk premium, so that they cover the expected reduction due to the risk. Thirdly, the role of leasing has changed, and only the most recent observations are at least somehow comparable from this point of view. If we accept the third point we can see that the cash lease and the market price reflect each other fairly well.

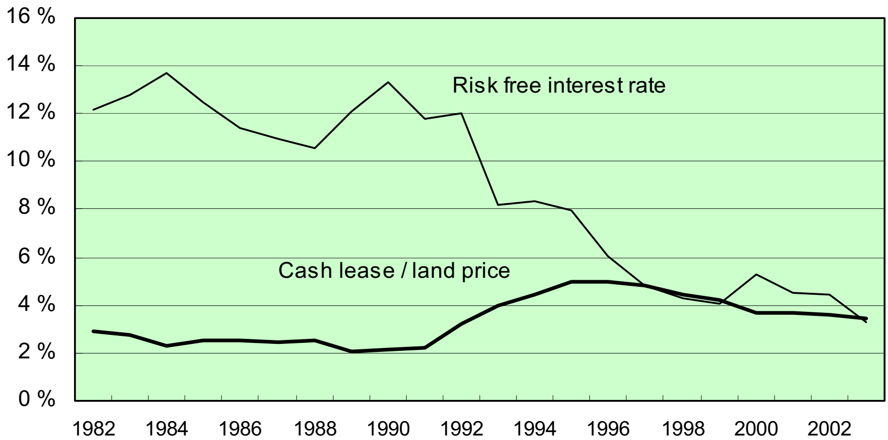

Figure 5.5. *Cash lease to land price ratio compared to the risk-free interest rate in 1983-2003.*

However, this approximate and generally graphical analysis shows that the use of proper time series analysis is, if not impossible, at least very difficult in Finnish conditions. Thus, we move on to the panel analysis in chapter 5.3 and to the hedonic analysis in chapter 5.4.

5.3 Time series (panel) model for 1995-2002

5.3.1 Model and econometric issues

The net present value model serves as the basis for this first empirical application in this study. The conceptual framework follows the principles presented, for example, by Weersink et al. (1999) and Goodwin et al. (2002) (see chapter 3.4).

The value of the land is given by the capitalized value of current and expected future streams of net income generated by the land. Assuming risk neutrality and a constant interest rate (r), land value (V) can be expressed as follows:

(5.1) $$V_t = \sum_{i=1}^{\infty} \frac{E_t(R_{t+i})}{(1+r)^i},$$

where R represents net returns to the land. In the case where net returns are constant over time we can rewrite the equation simply as:

(5.2) $$V = \frac{R}{r} = bR,$$

where b is the implied discount factor. As mentioned, there is an increasing interest in determining whether returns from different income sources differently affect land prices. The main interest has been in separating market returns and government payments.

(5.3) R=MR+GP,

where MR is market income (i.e. family farm income minus government payments), and GP are government payments. By incorporating this formula into the capitalization formula we get:

(5.4) $$V_t = \sum_{i=1}^{\infty} [b_{MR}^{i} E_t (MR_{t+i}) + b_{GP}^{i} E_t (GP_{t+i})],$$

where b represents the annual discount factor (1/1+r) for the respective income source. One could further decompose the equation by adding non-farm components and dividing market income as well government payments into more detailed parts. This study, however, concentrates on this aggregated level. This framework suggests an empirical model that will be discussed next.

Two model specifications will be estimated. In order to take into account the true nature of the theoretical model (i.e. capitalizing the expected future rents) the expectations (rational expectations) were first modelled. In an attempt to avoid the problem of a diminishing number of degrees of freedom, only the static (naïve) expectations have been modelled where the values for explanatory variables (market income MR and government payments GP) in the previous period have been used as an expectation for the current period.

In order to save the data even further, an alternative model without lags will also be estimated. The reason for this is that government payments are relatively well known at the beginning of the year. Moreover, the majority of land sales take place during the second half of the year when the market incomes are also known. Thus, this latter model lies very much on the same theoretical basis as the lagged model.

Since we are interested in both the fluctuation over time and the regional variability, the two-way fixed effect model is a relevant starting point. The estimated two panel models are:

(5.5) $$P_{it} = \beta MR_{it-1} + \gamma GP_{it-1} + \alpha_i + \lambda_t + \mu_{it}, \text{ and}$$

(5.6) $$P_{it} = \beta MR_{it} + \gamma GP_{it} + \alpha_i + \lambda_t + \mu_{it},$$

where P is land price (sales or lease), α is fixed individual (regional) effect, λ is fixed time effect, β, γ are parameters to be estimated, and μ is error term. The models are fixed effect models, since region and time both correlate with government payments and farm income. The sample is also balanced and very small. Region obviously correlates with government payments, since the support region where a province is located determines the payments in a province. The production structure, which strongly affects the family farm income FFI (and thus MR), also varies between regions. Time also correlates with both variables, since the payments have differed between years. It is also very clear that MR varies with time due to differences in weather conditions and prices. Thus, the random effect model does not need to be considered at all.

The estimation will be made for both sales prices and cash rental rates. Most previous studies have concentrated on land values or prices, but as Lence and Mishra (2003) pointed out, the cash rental rate better represents the land price as an input in the production process. The individual (region) and the time effect are tested with the F test (see Hsiao 2003; Baltagi 1995).

5.3.2 Data

The land price data were collected from the price statistics of the National Land Survey (NLS). The data consist of representative[62] transfers of arable land lots during 1995-2002. In this study, the original data were aggregated at the province level, and the median price[63] (denoted by LP) in each year was used. Thus, we use a kind of pseudo panel in which the region is the

[62] The properties of a representative transfer are:

- the transfer is a sale (not a gift, an exchange, or some other arrangement),
- the transfer is not between relatives,
- the lot is sold without buildings or other property,
- the lot covers more than 2 hectares, of which at least 95% should be arable land,
- the lot is located in an agricultural area (not in an area under or planned for development),
- the transfer is made without restricting conditions,
- the lot is bought for agricultural use and is sold as a whole (not some proportion of it).

[63] In some provinces there are some exceptionally high or low prices that may make the averages strongly misleading. The problem is especially bad if the number of observations is small. Thus, the median price is a more accurate measure than the average price.

common factor. The 19 provinces and eight years make a total of 152 observations.

Cash rental rate data were collected from taxation statistics (Statistics Finland). Data at the province level were not published, but were obtained with the help of statistical authorities. However, the data only covered the years from 1995 to 2001. Thus, the total number of observations in this analysis will be 133.

The division of land rent into market-based and government-based shares is a very tricky question. The common procedure in this type of study has been for family farm income (FFI) to be used to represent the total land rent. Government payments (GP) have then been subtracted from the total land rent in order to obtain market-based returns (MR). In contrast to most of the other studies (see chapter 3.4), the share of support is so great in Finnish conditions that by following the previous procedure the market-based return would be negative in many cases, which does not sound very realistic. However, in the absence of better ways to separate the effects of the two income sources we also followed the same procedure.

The statistical source for the family farm income data is taxation data collected by Statistics Finland. The data were provided at the municipality level, and then it was aggregated to the province level. The government payment data were received from the Ministry of Agriculture and Forestry. The original data were collected at the municipality level and were then aggregated to the province level, respectively. Unfortunately, we were obliged to carry out this rough aggregation since there were so few observations at the municipality level in the land price data that the province level was the most accurate.

5.3.3 Results

The research period covers the first five years of Finnish EU membership. During the years 1998 and 1999, Finnish farmers experienced crop failures that decreased the farm family income. Furthermore, the land prices increased throughout the period (see chapter 2.1). Thus, the period is somewhat exceptional, which should be kept in mind when interpreting the results. Summary statistics of the variables are presented in Table 5.1.

At first, the models included two fixed effects, region and time. However, the results obtained from these estimations including the time effect (λ_t) were neither significant nor realistic. This is probably due to the fairly short time period and small number of observations. In the discussion section this problem will be more thoroughly addressed. Therefore, only the results of the one-way fixed effect and pooled models are reported (Table 5.2 and 5.3).

Table 5.1. *Summary statistics (mean €/ha) of the variables in the models.*

	Sales price	Lease price	Government payments	Market income
1995	2 461	121	374	151
1996	2 374	118	371	115
1997	2 516	126	374	104
1998	2 555	120	377	74
1999	2 915	127	388	57
2000	3 201	126	498	-31
2001	3 441	134	505	-40
2002	3 716		513	-69

Table 5.2. *The estimation results of fixed effect and pooled models. The dependent variable is land price.*

	Model 5.5		Model 5.6	
	FE	Pooled	FE	Pooled
Intercept	3 330 ***	3 128 ***	2 392***	2 959 ***
Market income	-6.78 ***	-7.77 ***	-4.35 ***	-7.06 ***
Gov. payments	-0.28 -	0.75 -	2.00 -	0.60 -
Adjusted R^2	0.89	0.53	0.88	0.53
F-test FE vs. Pooled	24.58 ***		25.76***	

The FE models are estimated with dummy variables for N-1 regions.

Table 5.3. *The estimation results of fixed effect and pooled models. The dependent variable is land lease price.*

	Model 5.5		Model 5.6	
	FE	Pooled	FE	Pooled
Intercept	128 ***	-166 ***	121 ***	192 ***
Market income	-0.05 *	-0.26 ***	-0.01 -	-0.26 ***
Gov. payments	0.02 -	-0.05 -	0.05 -	-0.12 -
Adjusted R^2	0.96	0.38	0.95	0.37
F-test FE vs. Pooled	81.08 ***		82.30***	
The FE models are estimated with dummy variables for N-1 regions.				

According to the results, the fixed effect models proved to be superior to pooled models for both land sales and lease prices. The hypothesis to be tested was $H_0: \alpha_1 = \alpha_2 = \alpha_3 = \ldots = \alpha_{19}$. F-test values (24.58 and 25.76 in sales price models; 81.08 and 82.30 in lease price models) were highly significant, thus leading to the rejection of H_0. The values of the adjusted coefficient of determination (R^2) in sales price models were 0.89 and 0.88, (0.96 and 0.95 in lease price models), so the regressions provide a very good overall fit.

However, the results yielded by all of the models are somewhat peculiar. The results obtained showed that the coefficient of market income was statistically significant in three of the four fixed effect models.[64] The sign was, however, negative in all of the models. In contrast, the government payments were insignificant in all of the models (and the sign varied). This requires some further explanation.

The relatively high R^2 values in both of the fixed effect models probably reflect multicollinearity problems. We are mainly concerned about MI (FFI), since it is highly dependent on the production structure, and thus it probably correlates with regional dummies. The correlation is the reason why we should use a fixed effect model, but too much correlation causes estimation problems in the form of multicollinearity.[65]

[64] The results of the pooled models were, in principle, the same.
[65] The fixed effect estimation can be performed as within-groups estimation without dummies (Hsiao 2003). This estimation requires the calculation of individual (in this case regional) means that are then subtracted from the original observations. The OLS

The fluctuation over time is not very well explained by these models. There are probably other reasons for the fluctuation. Furthermore, an eight-year period is quite short, especially considering that several shocks in policy (1995 and 2000) and the market environment occurred during this period. Moreover, fluctuations in harvest during a short time period may cause a biased market condition. During the years 1998-1999, Finnish farmers suffered from crop failure and a consequent reduction in farm family income. However, land prices kept rising, which explains the ambiguity in the results of the models. It is quite clear that the negative value of the market income grows in the lagged model and the coefficient of the government payments also increase.

Another reason behind the problems in the estimation is the policy change in 2000. Producer prices were reduced and government payments were increased. Thus, the market income and the government payment have a tied connection that affects the estimation.

5.3.4 Conclusions

It is quite clear that none of the models presented above is perfect for land price modelling. Thus, the analysis confirms the need to modify the basic net present value approach in order to gain an accurate picture of the factors affecting land prices. However, the modelling framework clarifies some aspects in the Finnish land market.

The negativity of the market income parameter estimate as well as the great differences between the two models in both of the income estimates indicate that there are many other factors that affect land prices and their fluctuation over time. However, this probably does not contradict the result in this study, because government payments and market income may well affect land price levels but not necessarily their fluctuation over time (see Just and Miranowski 1993, Chavas and Thomas 1999, Clark et al. 1993b, Falk 1991). In this study, much of the explanation of differences in the price levels is hidden in the shadows of regional dummies.

Another reason for the unexpected results may be the shortness of the time period available. Due to this and the small sample dataset, the two-way

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estimation can now be performed with these subtracted observations, and there is no need for dummies. The coefficients and the statistical significances remain the same.

fixed effect model framework was not a relevant choice in this study. Another problem connected to the short time period is the proper modelling of expectations. A very simple model was used with only one lag. In order to be able to use more sophisticated expectation models, more data is required.

One matter that needs very careful consideration is the appropriateness of farm family income as a substitute for land rent. There is a very probable endogeneity problem. Unfortunately, potential instruments such as output prices (or output price indices) are unavailable at the regional level. FFI as such is not a good measure for land rent for many reasons. In addition to the land rent, FFI includes compensation for many other production factors. However, if we assume that changes in FFI reflect the changes in land rent we can use FFI as a substitute. There are regional differences in production structure, but fortunately, the regional dummies largely capture these differences. Another problem may arise with time series data, since regional dummies do not capture the changing production structure or changing technology. One problem concerning FFI is its division into two income sources: market income and government payments. How fair is it in Finnish conditions to simply subtract the government payments in order to obtain the market income? However, FFI is the best available substitute, and it is also widely used elsewhere (see e.g. Oltmer and Florax 2001).

Due to many shortcomings (incl. probably poor identification of the model), the analysis is continued in a more detailed way in the next chapter by incorporating other variables into the model that are not so closely connected to agricultural production.

5.4 Hedonic (spatial) model for 1995-2002

5.4.1 Model

The second approach in this study applies a hedonic pricing model. Typical variables used in the estimation of land prices are land characteristics such as quality, parcel size and the length of the growing period. These affect the productivity of land, and thus the expected land rent, but do not reflect the total capability of land to produce income, since agricultural returns are increasingly affected by policy decisions. Thus, support measures are often included in the models.

Moreover, agricultural productivity models are inappropriate in capturing all the factors that affect land prices. This proved to be especially clear in Finnish conditions based on the estimations made in the previous chapter. Another important factor usually included in the models is non-farm demand. Hedonic models have therefore usually been extended by including such non-farm factors as distance to the nearest urban area, population density, population growth, housing and recreational values (see chapter 3.4.1.2).

Thus, the basic model applied in this study is based on the following formula.

(5.7) $P = \alpha + \beta X + \gamma Z + \delta GP + \varepsilon$,

where P is vector of land prices, X is matrix of agricultural characteristics variables, Z is matrix of non-farm characteristics variables, GP is matrix of support variables, α, β, γ, and δ are parameters to be estimated, and ε is error term.

The model applied in this study is quite similar to those of Goodwin et al. (2003a; 2003b).[66] In addition to their models, the spatial autocorrelation will be tested.

5.4.2 Spatial econometric issues[67]

Because of the spatial nature of land sales, the effect of local factors may not have been taken into account accurately enough in the basic hedonic model. The assumption that the errors for two neighbouring sales (or regions) are uncorrelated is difficult to justify. If the errors are correlated, OLS does not yield efficient estimates. Moreover, if the left hand side variables themselves are correlated, the OLS will also give biased estimates. Thus, spatial analysis is worth attempting (see chapter 3.4.1.2).

[66] Phipps (2003) also suggested this in his comment on the study by Goodwin et al. (2003b).
[67] See Anselin 1999 and 2002; LeSage 1999; Pace et al. 1998.

As already mentioned in chapter 3.4.1.2, there are two alternatives for spatial modelling: the spatial lag model and the spatial error model.[68] The spatial lag model corrects the estimation in the case where the dependent variables are correlated with each other, whereas the spatial error model corrects the possible correlation in error terms.

The spatial lag model looks like an autoregressive model that takes into account the possible autocorrelation in time series analysis. Thus, the spatial model can be written:

(5.8) $P = \alpha + \rho WP + \beta X + \gamma Z + \delta GP + \varepsilon$,

where W is the spatial weight matrix, and ρ the parameter to be estimated.[69,70] In this study it was possible to use the exact location based on Geographical Information System (GIS) coordinates when building the weight matrix instead of the adjacency approach employed in most other spatial studies concerning land prices. This means that we can create a weight matrix that includes more accurate weights than only 1 or 0. The building of the weight matrix starts with counting an n*n matrix that includes the distances from each sale to each other sale. In order to build a real weight matrix, we have to modify the matrix structure so that the nearest sales are given the largest weights. A very common practice is to take the inverse of the distance, or the inverse of the squared distance as a weight. When the distances are long (as is the case in Finland) a large proportion of weights will be very small. Thus, it is perhaps not necessary to count every weight but, for instance, take into account only the K nearest sales, or only the sales inside some precise radius. However, this is more or less an empirical matter. An example of building the weight matrix is presented in Appendix 5.

The intuition behind the spatial lag specification is that when a land sale occurs the trading partners' knowledge of other sales in the neighbourhood may affect the price. The spatial lag term is correlated with disturbances.

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[68] Actually there is a third alternative (general spatial model) that combines the spatial lag and the spatial error models (LeSage 1999). However, the estimation would require the use of two different weight matrices, and it is rarely used in practice (Dubin 2004).

[69] This means that a spatial lag for y at i is expressed as $\lfloor Wy \rfloor_i = \sum_{j=1,\dots,N} w_{ij} * y_j$

[70] Note that the diagonal of the weight matrix is 0 since $w_{ii}=0$, i.e. the observation cannot correlate with itself.

Consequently, this means that the spatial lag term must be treated as an endogenous variable and OLS is no longer an unbiased and consistent estimator. Instead, ML or some other proper estimation method that takes into account this endogeneity has to be used.

The spatial error model is a special case of regression with a non-spherical error term, in which the off-diagonal elements of the covariance matrix express the structure of spatial dependence. This being the case, the OLS results are still unbiased but no more efficient. If there is spatial correlation in the error this means that the disturbance term is actually:

(5.9) $\varepsilon = \lambda W \varepsilon + u$,

where the u is white noise. Modifying this slightly we get:

(5.10) $\varepsilon = (I - \lambda W)^{-1} u$.

Substituting (5.10) for ε in the basic model (5.7) and multiplying both sides by (I-λW) results in the spatial error model as follows:

(5.11) $P = \alpha + \lambda WP + \beta X - \lambda W \beta X + \gamma Z - \lambda W \gamma Z + \delta GP - \lambda W \delta GP + u$.

where λ is parameter to be estimated. Thus, the model is actually a spatial lag model with an additional set of spatially lagged exogenous variables (WX, WZ, WGP) and a set of k non-linear constraints on the coefficient. The intuitive interpretation for the spatial error model is that there are some local characteristics that cannot be captured by the explanatory variables but that affect the price level.

Specification tests

The most commonly used specification test for spatial autocorrelation is Moran's (1948) I-test. In matrix notation Moran's I statistic is:

(5.12) $I = (N / S_0)(e'We / e'e)$,

where e is a vector of OLS residuals, and $S_0 = \sum_i \sum_j w_{ij}$, a standardisation factor that corresponds to the sum of the weights for the non-zero cross-products. Moran's I is similar but not equivalent to a correlation coefficient and is not centred around 0. Inference is based on a standardized z-value that follows a normal distribution. However, Moran's I is not a very strong test. In principle, it tests the spatial error, but according to Anselin and Rey (1991) it picks up a range of misspecification errors such as non-normality and heteroskedasticity of residuals, as well as spatial lag dependence. When spatial regressions are estimated by maximum likelihood (ML), the Lagrange Multiplier (LM) test can be used. This is an asymptotic test that follows a X^2 distribution with one degree of freedom. Both types of spatial model have their own LM test. Burridge (1980) presented the test for spatial error, and Anselin (1988) for the spatial lag. The joint use of these tests also provides the best guidance with respect to the choice of the proper alternative (Anselin and Rey 1991).[71] The formal expressions for the LM test are as follows:

(5.13) $$LM(error) = (e'We/s^2)^2 / tr(W'W + W^2),$$

where tr is trace operator, and s^2 is e'e/N (ML estimate for error variance).

(5.14) $$LM(lag) = (e'Wy/s^2)^2 / [(WXb)'MWXb/s^2 + tr(W'W + W^2)],$$

where y is dependent variable, M is $I-X(X'X)^{-1}X'$, and b is OLS coefficient vector. All these tests assume the normality and homoskedasticity of the residuals. If these assumptions are violated the tests are not valid or at least one should be cautious when interpreting the results. Since diagnostic problems are very common with spatial data of this type there are some other tests that are not so sensitive to these assumptions.

Firstly, in order to be able to decide which spatial specification would be the correct one, robust versions of the LM tests have also been developed (Anselin et al. 1996). This means that the robust LM lag test is robust to spatial error and vice versa. Anselin (2005) suggests the following testing procedure for choosing the correct model: firstly perform the non-robust LM tests, and if only one of them is statistically significant choose it. However, if

[71] If the test proposes the spatial lag model we can further test the presence of spatial error dependence using the LM test in order to decide whether the joint model of lag and error is needed (LeSage 1999).

both are significant, continue with robust LM tests. Then choose the one that is more significant.

Secondly, Kelejian and Robinson (1992) proposed a robust test that tells whether there is spatial autocorrelation in the error. This statistic is obtained from an auxiliary regression of cross products of residuals and cross products of the explanatory variables (collected in a matrix M with L columns). The cross products are for all pairs of observations for which a nonzero correlation is postulated (each pair only once, total number of pairs h_N). Using γ for the coefficient vector and α for the resulting residual vector we can write the statistic:

(5.15) $KR = (\gamma' M' M\gamma)/(\alpha'\alpha / h_N)$.

This test is a large sample test and follows a X^2 distribution with L degrees of freedom.

5.4.3 Data

The land price data were collected from the price statistics of the National Land Survey (NLS). They are published at the regional level twice a year, but for this study the original data were obtained for each land transfer.

The original data received from the NLS consisted of 6 511 arms-length transfers[72] of arable land from 1995 to 2002. After removing duplicates (20) and the observations with some missing data on other variables (66), the data consisted of 6 425 observations. In addition, in the preliminary hedonic regressions 144 more observations were removed, since they were deemed to be clear outliers.[73] The outliers were mainly sales that were either very low priced (usually less than 500 €/ha) or very high priced (more than 10 000 €/ha). Thus, the final data used in the further analysis consisted of 6 281 observations.

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[72] To be accurate, the coverage of the data in this study was slightly larger (19.7%) than in the published data of the NLS. This was due to the fact that the sales where the proportion of arable land was more than 95% and that were larger than 1.5 ha were included in the data, whereas in the published data the criteria were tighter, i.e. only lots of more than 2 ha and only arable land were included.

[73] The criterion for detecting an observation outside the final data was that the residual was more than three times the standard deviation of the disturbance term (e.g. Osborne and Overbay 2004).

In addition to the sales price (PRICE), the data include information about the parcel size (SIZE), and whether a lake, river or sea borders the parcel (DWATER). In order to be able to apply the spatial econometric technique, the GIS coordinates of each land sale were also obtained, allowing the building of a spatial weight matrix based on actual distances.

A possible problem with this dataset is that it covers only a small proportion of the transfers of arable land in Finland (see chapter 2.2). Firstly, a considerable proportion of the transfers take place in generation changes. Another reason for the small coverage is that transfers often include forest or buildings. Nevertheless, the data is quite large, as can be seen in Table 5.4.

Incorporating municipality level data from different sources extended these price data. The variables that try to capture the effect of differences in land quality (in addition to DWATER) are the average yield in the region (YIELD). Since the production conditions vary considerably between regions in Finland and not all crops are suitable for production everywhere, the barley yield is chosen to represent the yield potential. Barley can be grown almost everywhere, and it is the most common grain in Finland. Unfortunately, the data were available only at the province level. The average yield of the years 1995-2000 was used as a proxy for this land quality measure. The third variable capturing the land quality differences was the length of the thermic growth period (number of days when the temperature is more than 5 °C) (THERMIC). The value of the nearest meteorological station (of the 63 stations) was taken to represent the

Table 5.4. *The number of representative sales and the amount of transferred land in different years.*

	Number of sales	Total area, ha	Average size of the sale, ha
1995	666	4 047	6.08
1996	656	4 050	6.17
1997	704	4 707	6.69
1998	912	5 665	6.21
1999	873	5 851	6.70
2000	741	4 556	6.15
2001	893	5 727	6.41
2002	836	5 593	6.69

variable in each municipality. The average distance to the nearest station was 31 kilometres.

The support variables were gathered from the IACS register.[74] Only land-based support was included in the analysis. The support was divided into four groups. The first covered crop support based on the EU's common agricultural policy (CAP). The second group was the support for less favourable areas (LFA). The third was based on the environmental scheme in which about 95% of farmers participate in Finland (ENV). The fourth group consisted of purely national land-based support based on articles 141 and 142 in the Finnish Accession Treaty (NAT). All the variables were calculated by dividing the total amount of the named support (paid in each municipality) by the total area of arable land (in each municipality) in each of the years in the research period.

The third set of variables was connected to the farm structure in the region. The first variable was the farm density (FARMDEN), which was calculated by dividing the number of farms in each municipality in each of the years by the total land area of the municipality. This variable reflects the number of potential land purchasers in the neighbourhood. The second variable tries to capture the effect of structural change in agriculture. Since the environmental scheme and other forms of support regulate the land area needed for manure management in animal husbandry, a variable termed manure density (MANDEN) was calculated (see also Vukina and Wossink 2000). The calculation was based on the numbers of different animals in each municipality. The manure each animal group produces was calculated based on normative values. The amount of phosphorous (P_2O_5)[75] in each of the manure groups was then calculated, again based on normative values. After this, the phosphorous amounts were summed to obtain an aggregate measure of manure density in each municipality. The third structural variable was the proportion of agricultural income in farm households (PARTTIME). The data were obtained from taxation statistics and the variable was calculated for every municipality. The last structural variable was the proportion of special crops (SPECROP) in the region. This was calculated as the relative share of the potato and sugar beet area from the total area under cultivation. Potatoes and sugar beet are very intensive crops, and they

[74] The IACS register is the integrated administrative control system of the Ministry of Agriculture and Forestry.
[75] The amount of phosphorous was chosen as the indicator of manure density since it is the most restricting nutrient according to the environmental scheme.

have special criteria for the land for cultivation. The data source was the IACS register.

The fourth set of variables[76] covered the non-farm factors that may affect land prices. Variables such as population density (POPDENS) are usually included in land value models to indicate the urban pressure and the non-farm demand for land. Nevertheless, as Finland is a large and generally sparsely populated country, the urban pressure as such may not be a very relevant factor. Furthermore, the proportion of agricultural land is indeed very small compared to other EU countries. Hence, the non-farm demand for farmland for future development cannot be very large. However, the population density, together with the unemployment factor (UNEMPL) and the proportion of agricultural labour from the total labour (AGRLAB), works as a proxy for the job opportunities and availability of services in the neighbouring area. This is a very relevant factor considering the part-time nature of Finnish family farms, since less than half of their net income is derived from agriculture. The better the non-farm job opportunities are, the more reliably the farm family can regard the future of their agricultural production. Hence, the willingness to pay more for the additional land is greater. These three variables were calculated based on municipal statistics (Statistical Centre).

5.4.4 Results

The dependent variable in the applied model in this study is the sales price of land (€/ha). Summary statistics and the expected signs of the independent variables are presented in Table 5.5.[77]

Based on a Box-Cox analysis the semi-log specification was chosen for the analysis.[78] This analysis was performed as a maximum likelihood

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[76] The variables in the fourth set as well as in the third set above are calculated at municipality level.

[77] Some other explanatory variables (distance to the regional centre, proportion of agricultural land area, buyer's age, proportion of young farmers, proportion of leased land and average farm size) were also modelled in the initial estimations. However, they were excluded from the final model, either due to multicollinearity or their small importance.

[78] The Box-Cox analysis (Box and Cox 1964) is used in order to improve the homoskedasticity and the normality of residuals. The analysis is based on a transformation function $T(Y)=(Y^{\lambda}-1)/\lambda$. If $\lambda=0$ a proper transformation for Y is lnY. In estimation the value of λ is determined so that the correlation with a normal

estimation of the total data (6 281 observations) with the whole set of independent variables described in Table 5.5. Thus, unlike the independent variables the sales price is transformed into a logarithmic form in further analyses.

The analyses begin with the basic OLS estimation using the total data. In addition to the independent variables shown in Table 5.5, the year dummies were included in the model. This was done in order to capture a possible trend in the land prices.[79] The results of this estimation are presented in the first column of Table 5.6.

Table 5.5. *Descriptive statistics for the variables, and the expected signs of the explanatory variables in the estimation.*

	1995-1999		2000-2002		
	Mean	St. deviation	Mean	St. deviation	Expected sign
PRICE	3131.771	1721.563	4229.588	2347.046	
SIZE	6.381	5.704	6.427	6.313	-
DWATER	0.078	0.269	0.104	0.305	+
YIELD	3276.694	212.499	3284.664	201.935	+
THERMIC	159.645	8.906	159.647	8.648	+
CAP	101.290	42.367	153.103	48.136	+
LFA	136.668	50.956	192.765	19.616	+
ENV	99.768	32.093	113.451	7.901	+
NAT	44.760	15.320	54.672	21.949	+
FARMDEN	0.703	0.366	0.606	0.314	+
MANDEN	5.780	2.362	5.381	2.459	+
PARTTIME	0.384	0.093	0.406	0.095	-
SPECCROP	0.029	0.056	0.028	0.056	+
AGRLAB	0.184	0.091	0.149	0.079	-
POPDENS	20.007	37.394	19.722	34.741	+
UNEMPL	0.168	0.047	0.129	0.042	-

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distribution is at a maximum (see e.g. Greene 1993 or Pindyck and Rubinfeld 1991).The lambda (λ) in the analysis was 0.138 and did not deviate significantly from 0. Thus, the semi-log specification (λ=0) was the appropriate specification. The double-log specification was also tried, but it did not prove to be any better than the semi-log specification.

[79] Another possibility would be to deflate the land price and the support variables. The choice of the deflator is, however, a difficult task. Using the cost of living index would change the values somewhat, even though the inflation rate has been quite low during the research period. Instead, we could use the producer price index of agriculture. The change in this index has been even much smaller than in overall inflation. Thus, deflating the named variables would have little effect on the results.

In the next step, the analysis was continued by testing the effect of changing policy regime in 2000. This involved a Chow test, which allows us to decide whether the structural change in the data leads to different coefficients (Greene 1993).[80] In this case, the data were divided into two sub datasets: the first covered the years 1995-1999 (3 811 observations) and the latter the Agenda years 2000-2002 (2 740 observations). The value of the Chow test, 6.34 (with 16, 6249 degrees of freedom), was highly significant, indicating that the coefficients differ in the different policy regimes. The results of this analysis are presented in Table 5.6.

The overall fit seems to be quite good. However, there also seem to be considerable diagnostic problems. Firstly, the normality assumption of the disturbance does not hold (Jarque-Bera test). Compared to the preliminary analyses the situation has improved[81] but still one has to be cautious when interpreting the results of other diagnostic tests. More diagnostic problems may arise when we look at the multicollinearity condition number[82] and the heteroskedasticity test.[83]

Based on similar analysis of tolerances to that in panel analyses in chapter 5.2, the multicollinearity problems are mainly associated with support variables CAP and LFA. This is quite natural, since by definition CAP support is based on yield levels but at much rougher level than the variable YIELD, which is also used in the analysis. Similarly, LFA is collinear with YIELD and both of them are collinear with some infrastructure variables as well as with the thermic growth period (THERMIC).

As a consequence of the heteroskedasticity, the diagnostics in the OLS regression (R^2, F, t) may be misleading. In order to correct the effect of

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[80] A Chow test (Chow 1960) is a standard F test for the equality of two sets of coefficients in linear regression models. It is a particular test for structural change; an econometric test to determine whether the coefficients in a regression model are the same in separate subsamples. It follows an F distribution with (k, n-2k) degrees of freedom where n is the number of observations and k the number of parameters that have been estimated.

[81] Removing the outliers and taking the logarithm of the dependent variable clearly decreased the non-normality.

[82] There is no accurate test for multicollinearity. In Table 5.6 the multicollinearity condition number is presented. The condition number is calculated by taking the square root of the ratio of the largest to the smallest eigenvalue of the matrix X'X. The rule of thumb says that if it is more than 20 (or 30) there are problems.

[83] Heteroskedasticity is tested by Koenker-Basset test, which is a robust test. The default specification of the SpaceStat with random coefficient variation was used. The test relates the error variance to the squares of explanatory variables. The test follows a X^2 distribution with P degrees of freedom, where P is the number of explanatory variables.

heteroskedasticity we should count the corrected variances for coefficients by, for instance, White's (1980) method. However, the heteroskedasticity tests are also sensitive to factors such as spatial dependence. Hence, no correction to the model diagnostics is made at this stage of the analysis, but we will return to this as well as to the multicollinearity problem in the further analyses.

Table 5.6. *Regression results of the estimated semi-log models stratified according to the policy regime. The dependent variable is the logarithm of the sales price.*[84] [85]

	1995-2002			1995-1999			2000-2002		
	Coeff.	t-value	p	Coeff.	t-value	p	Coeff.	t-value	p
Intercept	4.34698	19.09	***	4.34327	14.51	***	3.22844	7.18	***
SIZE	-0.00649	-7.16	***	-0.006950	-5.74	***	-0.005571	-4.11	***
DWATER	0.085143	4.51	***	0.081190	3.19	**	0.090135	3.22	**
YIELD	0.000332	8.63	***	0.000310	5.92	***	0.000275	4.28	***
THERMIC	0.009176	8.38	***	0.011520	7.26	***	0.010990	6.61	***
CAP	0.003885	9.50	***	0.003077	5.66	***	0.005297	7.86	***
LFA	0.002392	6.19	***	0.001536	3.01	**	0.006073	7.59	***
ENV	0.001447	2.76	**	0.000395	0.53	-	-0.000518	-0.29	-
NAT	0.000119	0.26	-	0.001241	1.85	-	0.000810	1.09	-
FARMDEN	0.391603	14.89	***	0.370316	11.46	***	0.452809	9.76	***
MANDEN	0.037746	10.48	***	0.031550	6.49	***	0.044050	7.22	***
PARTTIME	-0.11427	-1.32	-	-0.230009	-2.12	*	0.174225	1.20	-
SPECROP	1.0455	8.71	***	0.812302	5.23	***	1.44159	7.43	***
AGRLAB	-0.45449	-5.49	***	-0.351191	-3.49	***	-0.632613	-4.38	***
POPDENS	0.001274	7.72	***	0.001094	5.31	***	0.001576	5.77	***
UNEMPL	-1.69213	-10.14	***	-1.54876	-7.44	***	-1.88321	-6.64	***
Adj. R^2	0.505			0.449			0.526		
F	292.01		***	164.18		***	162.12		***
Likelihood	-3450.34			-2072.90			-1337.83		
Multicollinearity	177.75			183.718			211.90		
Jarque-Bera	63.98		***	30.51		***	28.22		***
Koenker-Basset	116.74		***	70.20		***	89.80		***

[84] Time dummies are not reported. In the regime models all the dummies were positive, and increased in time in general (the only exception being the dummy for the year 1997). Dummies for the years 1998, 1999, and 2002 were also statistically significant.

[85] In this and the following tables, p denotes the statistical significance so that *** refers to more than 99.9% probability that the coefficient deviates from zero, ** more than 99% probability, and * more than 95% probability.

In the next step we check if there is spatial dependence in the data. Based on the Chow test, the data are divided into two sub datasets in further analyses. In order to be able to test the spatial dependence, we have to create a weight matrix for spatial weights. In this study, we restrict the spatial dependence to extend only to a distance of 100 kilometres. In order to weight the nearest observation more, we use the inverse of the squared distance as a spatial weight. After calculating these weights they are row-standardized (see Appendix 5).

The results of the spatial dependence tests are presented in Table 5.7. Following Anselin's (2005) suggestion, since both of the non-robust LM tests were highly significant in both of the periods, the robust versions of LM tests were used in the choice of the correct model specification. Thus, only the robust versions of LM tests are presented.

The tests clearly indicate that there is spatial dependence in the data in both periods. The LM tests also clearly suggest that the spatial lag specification is the correct model specification.[86] This means that left hand side variables (i.e. land prices) are correlated with each other. This causes a severe econometric problem that must be taken into account. On the other hand, this means that the characteristics variables, even though many of them are not at farm level, seem to capture quite well the differences in local characteristics that cause price differences.

Thus, in the next step the spatial lag specification of the model is used. Now, the OLS is no longer a consistent estimation method since there is a spatially-lagged variable on the right hand side of the model (i.e. endogenous variable). Instead, we can use the maximum likelihood estimation method or the instrumental variables. The results of the spatial models based on maximum likelihood estimation are presented in Table 5.8.

[86] Fortunately, the data were divided into two subsets (based on the Chow test on policy regimes), since the computation of these models was very demanding. The processing time grows much faster than the size of the dataset. The processing time for the first period (1995-1999) was 64 hours, but for the latter period (2000-2002) only 40 minutes. We tried the analysis with all 6 281 observations, but the program collapsed after three days. Thus, the analysis would not have even succeeded with the total data. Another positive side of dividing the data is the more reliable consideration of the time-spatial dependence. The ideal situation would have been that we could have created the spatial lags so that only those sales that are close enough in space and in addition, traded before (or within certain time) affect another sale. Unfortunately, this was not possible. However, dividing the data allows us to take the time dependence at least a little bit more properly into account.

Table 5.7. *Spatial dependence tests in the models.*

	1995-1999			2000-2002		
	MI/df	value	prob.	MI/df	value	prob.
Moran's I (error)	0.193	17.55	0.000	0.170	12.55	0.000
KR (error)	20	223.01	0.000	20	309.87	0.000
LM (error)	1	0.23	0.634	1	9.70	0.002
LM (lag)	1	14.38	0.000	1	49.87	0.000

Table 5.8. *The results of the spatial models stratified according to the policy regime.[87] ML estimation.*

	1995-1999			2000-2002		
	Coeff.	z-value	p	Coeff.	z-value	P
Intercept	2.94219	10.00	***	1.96264	4.51	***
SIZE	-0.006462	-5.65	***	-0.005373	-4.19	***
DWATER	0.082648	3.45	***	0.094218	3.56	***
YIELD	0.000167	3.35	***	0.000149	2.42	*
THERMIC	0.00630213	4.16	***	0.006933	4.34	***
CAP	0.002148	4.16	***	0.003931	6.09	***
LFA	0.001232	2.55	*	0.004334	5.68	***
ENV	0.000684	0.98	-	0.000328	0.20	-
NAT	0.000383	0.61	-	0.000603	0.86	-
FARMDEN	0.25983	8.37	***	0.310971	6.95	***
MANDEN	0.022251	4.81	***	0.030390	5.21	***
PARTTIME	-0.128898	-1.26	-	0.198938	1.44	-
SPEC	0.56067	3.81	***	1.02946	5.55	***
AGRLAB	-0.261276	-2.75	**	-0.426853	-3.11	**
POPDENS	0.000908	4.66	***	0.001341	5.18	***
UNEMPL	-1.17317	-5.93	***	-1.30035	-4.81	***
P	0.362542	18.83	***	0.344618	14.51	***
Likelihood	-1923.79			-1247.78		
Breusch-Pagan	78.88		***	119.21		***
LM test for remaining spatial error	1.25		-	1.85		-

[87] Instead of the Student's t-distribution a standard normal distribution is used in evaluating the significance of the model coefficients. Thus, z-values are counterparts to the t-values in the OLS regression.

The likelihood ratios are clearly greater than in the analyses ignoring the spatial effect.[88] This and the great significance of the ρ parameter confirm the need to use spatial specification. Moreover, the small values of LM tests for the remaining spatial dependence in the error term (1.25 for 1995-1999 and 1.85 for 2000-2002) indicate that the spatial lag specification properly takes the spatial dependence into account.[89]

Since there is a possible problem with non-normality of the errors (and with the heteroskedasticity, even though the spatial dependency has been taken into account), the same analysis was estimated by using instrumental variables, which provide a more robust estimation method.[90] The results of this estimation are presented in Table 5.9.

In general, the results remain very much the same as in the ML estimation. The signs and significances of the parameters do not change. However, there are some changes in the magnitude of the parameters. In the 1995-1999 subset the changes are very small. The values of the significant coefficients do not generally differ by more than 6% from each other. The significances also remain very much the same.

However, in the 2000-2002 subset the values of the significant coefficients are considerably (from 2% up to 37%) smaller. The value of the ρ parameter increases respectively. Thus, we can suspect that due to the diagnostic problems (especially heteroskedasticity) the spatial dependency is underestimated in the ML estimation. The remaining spatial dependence in the error term also suggests that the spatial lag model does not necessarily take into account all the spatial dependence. Instead, a general spatial model should, perhaps, be used. Unfortunately, the program used in the analyses allows only a rough estimation of general spatial model proposed

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[88] We must use the likelihood ratios for comparison of the models, since the R^2 values of the ML estimations are not comparable to those of the OLS estimations. This is the reason why the likelihood ratios are also presented in Table 5.6 for policy regime models.

[89] The likelihood ratio test value for the spatial lag dependence is 297.82 for 1995-1999 data, and 180.09 for 2000-2002 data. The Wald test statistics (squared z(ρ)) are, respectively, 354.44 and 210.60. Compared to the LM statistics presented in Table 5.7 these values are in proper order: Wald>LR>LM (Anselin 1992). If they were not in this order it would indicate either diagnostic problems or misspecification of the model.

[90] The principle of instrumental variables estimation is based on the existence of a set of instruments that are strongly correlated with the original variables, but asymptotically uncorrelated with the error term. Kelejian and Robinson (1992) have shown that a series of spatially lagged exogenous variables are the proper set in spatial models. This set was also used in this study in the two-stage least-squares analysis.

by Kelejian and Prucha (1998). Furthermore, the application of a general model (i.e. including spatial error in the spatial lag model in question) would probably not considerably affect the levels of coefficient estimates (see chapter 5.4.2).

In the last stage, an attempt was made to drop some of the most correlating variables. As mentioned before, the multicollinearity is mostly associated with the support variables. Dropping these variables had little effect on the results. The multicollinearity considerably decreased, but measured in terms of condition number (still over 100) there are still some

Table 5.9. *The results of the spatial models stratified according to the policy regime. Instrument variable estimation (2SLS).*

	1995-1999			2000-2002		
	Coeff.	z-value	p	Coeff.	z-value	P
Intercept	2.852840	6.70	***	1.161060	2.34	*
SIZE	-0.006431	-5.59	***	-0.005248	-4.12	***
DWATER	0.082741	3.45	***	0.096804	3.68	***
YIELD	0.000158	2.66	**	0.000068	1.04	-
THERMIC	0.005969	3.12	**	0.004364	2.47	*
CAP	0.002089	3.76	***	0.003066	4.43	***
LFA	0.001212	2.49	*	0.003233	3.89	***
ENV	0.000703	1.00	-	0.000864	0.52	-
NAT	0.000328	0.50	-	0.000471	0.67	-
FARMDEN	0.252784	6.40	***	0.221151	4.22	***
MANDEN	0.021658	4.28	***	0.021739	3.41	***
PARTTIME	-0.122449	-1.17	-	0.214588	1.57	-
SPEC	0.544623	3.46	***	0.768487	3.83	***
AGRLAB	-0.255541	-2.63	**	-0.296554	-2.08	*
POPDENS	0.000896	4.50	***	0.001192	4.56	***
UNEMPL	-1.149220	-5.36	***	-0.931254	-3.19	***
P	0.385662	4.68	***	0.562848	7.98	***
LM test for remaining spatial error	0.032		-	11.25		***

problems. Dropping the time dummies further decreased the multicollinearity, but not much. However, the results of the other parameters seemed to remain quite robust. Looking at the log-likelihood values as well as information criteria (Aiken and Schwartz) also suggests a preference for the original analysis with support variables and time dummies included in the model.

Now, we turn to interpreting the results. The interpretation is mainly based on the instrumental variable estimation presented in Table 5.8. The negative coefficient of the sales size (SIZE) in both periods confirms the common result of a lower land price for larger sales sizes, which is usually connected to lower transaction costs. However, the economic meaning of this result is quite small, since we can calculate that at the mean level a one hectare increase in the sales size would decrease the price per hectare by only about 20€. The dummy variable (DWATER) indicates that the irrigation possibility (or some recreational value)[91] increases the land price by nearly 10% at the mean level. In the earlier period (1995-1999) the effect seems to be about 260€, and in the latter period 410€ at mean level.

The two variables controlling the productivity effects (yield level and length of thermic growth period) are both positive and statistically significant with the exception of yield in the latter period. The YIELD variable correlates with the support variables, and dropping the support variables makes these pure hedonic variables statistically more significant. The implicit price of the length of the growing period seems to be about 20€/ha per one day increase in the length of the growing period.

The interpretation of support variables is somewhat difficult due to the multicollinearity. Moreover, only the CAP and LFA variables are statistically significant. However, the significance in the latter period may be connected to the insignificance of the YIELD variable. Thus, we should be very cautious in interpreting these results. In spite of this, elasticities of support measures (calculated around sample means for the model variables) as well as the yield elasticity are presented in Table 5.10.

When roughly estimating the effect of a 1€ increase in support or in market returns (based on the value of the yield, i.e. 0.11€/kg), the income sources seem to have a slightly different effect on the land price in the 1995-1999 data. The discount rate for market income is 21-22%, and for CAP

[91] This may also be a reflection of the fact that land is usually of better quality by a river than in the middle of a forest.

support around 15%.[92] However, in the 2000-2002 data the discount rates seem to be considerably lower for CAP support, from 6% to 8% depending on the estimation method, whereas the discount rates of market income seem to remain at very high level (17% or 38%). The results for LFA support seem to be quite similar compared to the CAP support.

The next set of variables (farm density, manure density, proportion of special crops, and part-time level) controls the agricultural structure. Farm density is significantly positive, indicating that the greater the number of potential buyers for the specific parcel, the higher the price. Calculated at the mean value this means that doubling the farm density would cause an increase in the land price of about 560€/ha.

The positive and significant sign for manure density reflects structural change and the increased demand for additional land due to environmental pressure. Again, calculated at the mean value, doubling the manure density would increase the land price by 400-500€/ha. The proportion of special crops (sugar beet and potato) in the region also has a very strong effect on land prices. The effect also seems to be growing. The effect of the part-time variable was expected to be negative. However, in the latter period the sign is positive, but the coefficients are not statistically significant in either of the research periods.

The fourth variable set consists of infrastructure variables. They are all significant and of the expected sign. The more urban a region is, the more there are pressures from outside agriculture, and the higher the land prices seem to be. This variable is also correlated with the part-time variable in the previous set, which may explain the non-significance of the part-time variable. An increase in the unemployment rate seems to decrease land prices, but the effect calculated at the mean level is relatively small (a one percentage point increase in the unemployment rate would only decrease the land price by 40€/ha).

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[92] Based in the OLS regression the discount rates would be almost the same for both income sources (11% for market income, and 10% for CAP-support).

Table 5.10. *Elasticities of yield and support variables with respect to sales price (calculated at the mean value level).*

	ML estimation		IV estimation	
	95-99	00-02	95-99	00-02
Yield	0.547	0.489	0.518	0.223
CAP	0.218	0.602	0.212	0.469
LFA	0.168	0.835	0.166	0.623

5.4.5 Conclusions

Firstly, the analysis clearly showed that ignoring the spatial dependence may lead to incorrect results. The general interpretation concerning the signs of the coefficients as well as the significance of the results does not necessarily change very much compared to the OLS estimation, but the spatial analysis estimation is much more efficient. However, the parameter estimates may change considerably. Thus, the need to control for the spatial dependence is, therefore, of crucial importance when modelling land prices.

Secondly, as expected, land quality as well as area-based support measures positively affected land prices. The support clearly affects land prices since it has a major role in creating land rent. Moreover, the very rough analysis on discount rates shows that discount rates for support variables seem to be lower than for market income, especially in the latter period from 2000-2002. However, due to the diagnostic problems one has to be very cautious in interpreting this result. Moreover, dropping the support variables decreases the power of the estimation very little, indicating that the support does not seem to explain very much of the variation in land prices between regions.

Thirdly, structural differences between regions and the structural change in agriculture seemed to have a major affect on land prices. The closer the farms are located to each other in a region the more potential buyers there are, and the land price increases. In addition, investments in animal husbandry and the concentration of production seem to affect land prices. The effect comes from two sources. Growing farms need more land for their manure, and the proportion of retiring farmers may be lower. Thus, there is both increased demand and decreased supply for farmland.

Finally, infrastructure also had a very important role in determining the price level of agricultural land. If other industries are prospering in the surrounding area, agricultural viability also seems to improve. The non-farm opportunities offered to farm families make continuing and developing farming more tempting. The variables used in the analysis usually reflect the non-farm demand for farmland, but in Finnish conditions the importance of this is probably smaller than in countries where the proportion of farmland is much greater. Taking into account the part-time nature of Finnish agriculture, the explanation connected to the off-farm job possibilities is more relevant.

6 DISCUSSION

The factors affecting farmland prices are not easy to determine. In principle, the basic capitalization model in the Ricardian spirit should explain the differences in land values well. However, the model does not seem to work in the real world. There is a wide international literature (reviewed in chapter 3) that supports the view that there are many other factors that affect farmland prices besides pure agricultural returns.

This study does not make an exception to this mass of studies. However, the role of the structural change is more carefully taken into account than in most of the other studies. In addition, the study pointed out the need for national research on this topic. The land market in Finland is very much different from many other countries, as well as the agricultural policy that has an increasingly important role in the price formation of farmland.

When considering land prices, we also have to keep in mind that price statistics on land prices only reflect the minority of land sales. The importance is even greater when we remember that the land market is quite thin market (chapter 2.1). Thus, the data require very careful statistical and economic analysis to make inferences about population phenomena.

When examining the price changes over time, we note that the sales prices have been much more volatile than cash rents as well as agricultural returns (chapter 5.2). This is a quite obvious (and a very common) result. Cash rents more precisely reflect agricultural productivity, and more importantly, the contracts are usually quite long term. This study also indicated that the changes in cash rents and land prices do not follow each other. This gives a basic emphasis on the conclusion that land prices are affected by many other factors besides agricultural returns.

The factors that actually explain the changes in land prices over time were not thoroughly explained since a proper time series analysis was not possible to apply. The support clearly affects land prices, since it has a major role in creating land rent. The question of how much of the price change is due to the policy change and how much is for other reasons is impossible to answer. However, the theoretical consideration made in chapter 4 shows that at least part of the rise that started in the late 1990s is due to the policy change that increased the proportion of area-based support.

Another issue concerning the effect of policy changes (or more precisely area-based support) is whether the support capitalizes differently from market returns into the land prices. The econometric analyses did not give a very clear answer on this. However, rather than assuming the discount rates for support and market returns to be similar, the rough analysis refers to the discount rate for support being a little lower. If this were true it would indicate that farmers rely more on support income than market returns. Compared to CAP and LFA support, the data were not informative enough to identify significant effects of environmental and national support.

The econometric analysis in chapter 5.4 attempted to clarify the role of factors causing differences in price levels between regions. The data were exceptionally large, comprising more than 6 000 observations. Thus, it allowed a thorough econometric estimation including the possibility to take into account the spatial nature of the data.

As expected, the land quality as well as the area-based support measures positively affected land prices. Thus, the common results in this type of study were confirmed.

The role of the structural issues is, however, more rarely studied. An important result of this study was that the structural differences between regions and the structural change in agriculture seemed to have a considerable role in affecting land prices. Firstly, the present structure affects the competition in the land market: the more dense farms are in the region the more there are potential buyers, and the land price increases. Secondly, the change in farm structure (especially in animal husbandry) connected to the policy changes that increase area-based support affects land prices. The effect comes from two sources. Growing farms need more land for the manure, and the proportion of retiring farmers may be lower. The introduction of the manure density variable proved to be an efficient way to aggregate the otherwise very difficult task of taking into account the environmental pressure caused by structural change in animal husbandry.

Finally, the infrastructure also had a very important role in determining the price level of agricultural land. A common interpretation for these infrastructure variables is related to the non-farm demand for farmland. However, in Finland this is probably not so obvious an explanation, since Finland is very sparsely populated. The explanation is merely connected to the vitality of the countryside. If other industries are prospering in the surrounding area, agricultural viability also seems to improve. The non-farm opportunities offered to farm families make continuing and developing farming more tempting. Taking into account the part-time nature of Finnish agriculture, the explanation connected to the off-farm job possibilities is more relevant.

One of the main contributions of this study was that it clearly pointed out the extreme importance of taking into account the possible spatial dependence. Empirical studies that have taken into account the spatial nature have thus far also been quite rare at the international level. In addition, compared to published works, the data in this study were much larger, and this also makes the contribution of this study internationally relevant. This study was also the very first spatial analysis of agricultural economics research in Finland.

Even though the literature concerning land prices and values is extensive, the topic is still valid. The need especially for further policy analysis is obvious. The role of direct income support as a factor affecting land prices, and further the distribution of wealth between farmers and non-farmers needs more research. There are also several other interesting topics that are worth further consideration. Firstly, more precise farm-level data on actual sales instead of aggregate data would probably improve the estimation. Especially, when we are looking at the prices of additional land, it is the buyers' and the sellers' expectations that matter, not the average farmers'. The problems with expectation modelling are probably one of the caveats in analyses like the panel analysis in this study (chapter 5.3). Thus, more precise data could improve expectation modelling.

This need for more precise data is linked to many other interesting questions around the topic that are not studied very widely. For example, the properties of buyers and sellers may have an important effect on land prices (see Ciappa 2003). In addition to these properties, the relationship between them may also have considerable effects on land market. Recently, the role of social capital has become increasingly interesting from the economic point of view. However, the role of social capital has rarely been analysed in an economic context, and the results thus far are not very convincing (Durlauf 2002).

In this context, land transactions might be an especially interesting research object, since trading partners usually know each other. There have been some empirical studies based on a neoclassical model of utility maximization. It is clear that social capital matters in transactions between relatives (Robison 1996, Perry and Robison 2001, Robison et al. 2002). However, it is reasonable to assume that social capital also matters in arms-length trades. Furthermore, the effect of social capital is probably different when only the control of the land is transferred (i.e. leasing). Very often, empirical analyses are based on surveys where respondents have answered questions about their behaviour in hypothetical situations. Thus, there is considerable room for empirical research in which real situations are analysed, i.e. transactions that have actually taken place.

The question of how size affects land prices is also worth deeper analysis. In this study the size variable was the sales size, and the result was the common one. The coefficient was negative, which is interpreted to reflect the lower transaction costs when the sales size grows. However, if the data allows it would be interesting to separate the effect of sales size and the effect of parcel size, since it would be reasonable to assume that a larger parcel size increases the price (i.e. the parcel size is a quality factor).

Furthermore, proper time series modelling was not possible in this study. However, the price fluctuation over time in Finnish conditions would be a possible topic for further research. Perhaps the panel analysis (chapter 5.3) could be elaborated so that it would give some answers to the question of how land prices vary over time.

The theoretical consideration presented in chapter 4 may also work as a basis for empirical research, since changes in production decisions and in the intensity of production due to policy changes are not very widely studied.

7 SUOMENKIELINEN SELOSTUS

Pellon hinnan muodostukseen vaikuttavat tekijät

Tilakoon kasvattamista on pidetty keskeisenä keinona maatalouden kannattavuuden parantamiseksi niin kauan kuin maassamme on maatalouden rakennepolitiikkaa harjoitettu. Kun tarkastellaan viljelijöiden ikärakennetta ja viljelijöille tehtyjä kyselyjä heidän jatkamisaikomuksistaan, on helppoa tehdä johtopäätös, että tilamäärä vähenee jatkossakin selvästi. Näin ollen myös tilakoon kasvu jatkuu, mikäli tuotannon taso säilyy suunnilleen nykyisellään.

Tilakoon kasvun kannalta keskeistä on, miten ja millä hinnalla tuotannosta luopuvien tilojen resurssit saadaan jatkavien tilojen käyttöön. Maataloudessa tuotannontekijät jaetaan perinteisesti kolmeen ryhmään: maa, työ ja pääoma. Maa on erotettu tärkeytensä ja luontosidonnaisuutensa takia muusta pääomasta, josta se luonteeltaan melko tavalla poikkeaakin. Pellon merkittävyyttä lisää myös se, että EU-jäsenyyden myötä maatalouden tuottajahintojen alentumista korvattiin suorien tukien korotuksilla, joista suurin osa maksetaan peltoalaan perustuen. Tukien on pelätty pääomittuvan pellon hintoihin, jolloin hyöty tuista valuisi ainakin osittain maatalouden ulkopuolelle. Tukipolitiikan vaikutus maan hintoihin onkin herättänyt kasvavaa kiinnostusta maatalousekonomistien piirissä viime vuosina.

Pellon hinnanmuodostumisen ja siihen vaikuttavien tekijöiden tunteminen on tärkeää paitsi yksittäisen viljelijän näkökulmasta myös yhteiskunnan kannalta. Maatalouspolitiikkaa suunniteltaessa on hyvä tietää, millaisia vaikutuksia eri politiikoilla on paitsi tilojen talouteen myös esimerkiksi tuotantotapoihin ja tuotannon alueelliseen keskittymiseen. Tutkimuksen ajankohtaisuutta lisää myös se, että vuonna 2006 astuu kokonaisuudessaan voimaan EU:n maatalouspolitiikan uudistus, jossa hehtaariperusteisen tuen osuus edelleen kasvoi.

Tutkimuksen tavoitteena oli selvittää pellon hinnan muodostumiseen vaikuttavia tekijöitä. Tutkimuksessa tarkasteltiin sekä lisäpellon kauppahintoja että vuokrahintoja. Tutkimuksessa haettiin vastauksia seuraaviin kysymyksiin:

* Mitkä tekijät selittävät pellon hinnoissa tapahtuneita muutoksia?
* Mistä johtuvat pellon hintojen alueelliset ja paikalliset erot?
* Miten tukipolitiikan muutos vaikuttaa pellon hintoihin?

* Pääomittuuko suora tuki pellon hintoihin eri tavalla kuin markkinoilta saatavat tulot?
* Miten rakennekehityspaineet vaikuttavat pellon hintoihin?

Laajan kirjallisuuskatsauksen ja teoreettisen tarkastelun lisäksi tutkimuksessa käytettiin moderneja ekonometrisia menetelmiä vastaamaan tutkimuksen tavoitteiksi asetettuihin kysymyksiin. Tutkimuksen empiirisessä osassa käytettiin hyväksi sekä paneelianalyysia että hedonista analyysiä. Paneelianalyysissä yhdistetään poikkileikkaus- ja aikasarja-aineistot.

Hedoninen analyysi perustuu puolestaan siihen, että markkinallisen tuotteen (tässä tapauksessa pelto) hintaan vaikuttavia tekijöitä pystytään analysoimaan sen laadullisten ominaisuuksien, joilla ei ole markkinoita, perusteella. Tällaiset laadulliset muuttujat selittävät tietysti osaltaan pellon tuottokykyä. Hedoniseen analyysiin liitettiin mukaan myös spatiaalinen ulottuvuus, jossa hyödynnettiin paikkatietoa. Spatiaalista analyysiä on syytä käyttää, jos on epäilys, että tavallisen pienimmän neliösumman mukaisen regressioanalyysin virhetermit korreloivat keskenään tai että y-muuttujat korreloivat keskenään. PNS ei ole tällöin enää tehokas eikä y-muuttujien korreloidessa myöskään harhaton estimaattori. Spatiaalinen analyysi on suhteellisen uusi menetelmä, eikä kansainvälisessä kirjallisuudessakaan ole kovin paljon artikkeleita, joissa sitä olisi sovellettu pellon hinnan mallinnukseen, ainakaan yhtä suurella aineistolla kuin tässä tutkimuksessa.

Tutkimuksen keskeisenä aineistona käytettiin Maanmittauslaitoksen keräämää kiinteistöjen kauppahintarekisteriä. Lisäksi tutkimusaineistoa täydennettiin alueittaisella informaatiolla eri lähteistä (mm. maa- ja metsätalousministeriön ja Tilastokeskuksen tilastot). Aikasarjojen graafisessa analyysissä voitiin hyödyntää aineistoa vuosilta 1983–2003. Ekonometrisissa analyyseissä sen sijaan käytettiin yksityiskohtaisempaa aineistoa vuosilta 1995–2002. Paneelianalyysissä käytettiin maakunnittaisia tietoja, kun taas spatiaalisessa analyyseissä käytetyn aineiston muodostivat 6 281 lisäpeltokauppaa vuosilta 1995–2002. Kysymyksessä on siis poikkeuksellisen laaja aineisto.

Kaikki tehdyt analyysit osoittivat, että pellon hintaan (etenkin kauppahintaan mutta myös vuokrahintaan) vaikuttavat monet muut kuin puhtaasti maatalouteen ja pellon tuottokykyyn liittyvät tekijät. Pellon tuottokykyä kuvattiin paneelimallissa markkina- ja tukituotoilla, mutta selkeää yhteyttä yli ajan tapahtuvaan vaihteluun ei löydetty. Se todettiin myös, että pellon vuokrahinnat ja kauppahinnat ovat vaihdelleet yli ajan täysin toisistaan riippumatta. Tämä johtunee siitä, että vuokrahinnat ovat selkeämmin kytköksissä maatalouden tuottoon kuin kauppahinnat, joihin muut tekijät vaikuttavat enemmän.

Tukipolitiikan muutoksen vaikutusta tarkasteltiin teoreettisen kehikon avulla. Siinä todettiin, että tehdyt muutokset ovat pääsääntöisesti sellaisia, että niiden seurauksena pellon hinta nousee. Tehdyt politiikkamuutoksethan ovat olleet pääsääntöisesti sellaisia, että markkinahintoja on laskettu, ja laskua on kompensoitu suoraa hehtaariperusteista tukea korottamalla. Viimeisimmässä uudistuksessa kotieläinperusteista tukea muutettiin myös hehtaariperusteiseksi tueksi, joka analogisesti vastaa em. tilannetta. Uudistus väistämättä laajaperäistää tuotantoa, ja jos kompensaatio on riittävä se myös kohottaa pellon hintaa. Tämä liittyy kotieläintilojen osalta myös rakennekehitykseen siten, että näillä tiloilla pellon rajatuotto kohoaa verrattuna aikaisempaan tukipolitiikkaan, ja pellon hinta nousee.

Hedonisessa mallissa (jossa oli myös spatiaalinen elementti) pellon kauppahintoja selittämään lisättiin pellon tuottokykyä kuvaavien muuttujien lisäksi tukimuuttujia sekä erilaisia infrastruktuuria ja rakennekehitystä kuvaavia muuttujia. Ekonometrinen malli toimi hyvin, sillä suurin osa malliin sisällytetyistä muuttujista oli tilastollisesti merkitseviä ja etumerkit ennakko-odotusten mukaisia.

Analyysi vahvisti sen, että kaupan koon kasvaessa hehtaarihinta alenee. Samoin saatiin odotetut tulokset siitä, että pellon tuottokyvyn parantuessa sen hinta nousee. Tuottokykyyn liittyvinä hedonisina muuttujina käytettiin satotasoa ja termisen kasvukauden pituutta sekä myös rantaan rajoittuvuutta. Tietyllä tavalla laatua kuvaava mittari oli myös erikoiskasvien (peruna ja sokerijuurikas) osuus. Tukimuuttujat saivat myös positiiviset kertoimen, kuten pitikin.

Nämä tulokset olivat lähes itsestäänselvyyksiä, ja sinänsä odotettuja. Tällä kohtaa ehkä mielenkiintoisempi kysymys onkin se, pääomittuuko tuki eri tavalla kuin markkinoilta saatu tulo. Ulkomaisissa tutkimuksissa on todettu, että jos tuki on pysyvää ja pitkäaikaista, se pääomittuu markkinoilta saatuja tuloja alhaisemmalla korolla maan hintaan. Jos se taas on enemmän ad hoc -tyyppistä tukea, se pääomittuu korkeammalla korolla. Tämän tutkimuksen ekonometrisen analyysin (hedoninen malli) perusteella tukena saatu tulo vaikutti pääomittuvan hieman alhaisemmalla korolla kuin markkinoilta saatu tulo, mutta tämä analyysi voitiin tehdä vain hyvin karkealla tasolla. Paneelimallin tulosten perusteella pääomittumisesta ei voitu tehdä kunnon johtopäätöksiä lainkaan.

Hedonisessa mallissa tarkasteltiin lisäksi myös maatalouden rakenteen ja rakennekehityksen vaikutusta pellon hintaan. Tuotannon keskittyneisyys kohottaa selvästi pellon hintaa. Kun potentiaalisten ostajien joukko suurenee, kilpailu kiristyy ja hinta nousee. Rakennemuutoksen, ja erityisesti kotieläintuotannon keskittymisen ja kasvun vaikutus pellon hintaa kohottavana tekijänä näkyi selvästi. Tätä mitattiin lantatiheydellä, joka sai positiivisen ja merkitsevän kertoimen. Osittain tässä ekonometrisen analyysin tuloksessa voi heijastua myös se teoreettisessa tarkastelussa esiin tullut asia, että kotieläintilojen on ollut aikaisempaa kannattavampaa hankkia peltoa, ja tämän seurauksena kotieläinvaltaisilla alueilla, joissa on ollut paljon kasvuhakuisia tiloja, pellon hinta on noussut.

Puhtaasti maataloudellisten tekijöiden lisäksi hedonisessa mallissa oli mukana myös infrastruktuuriin liittyviä muuttujia kuten asukastiheys, työttömyysaste ja maatalouden merkitys alueella. Yleensä tällaisten muuttujien avulla yritetään arvioida sitä, mikä on maatalouden ulkopuolisen kysynnän vaikutus pellon hintaan. Suomi on kuitenkin hyvin harvaanasuttu maa ja pellon osuus maapinta-alasta on hyvin pieni. Siten on luonnollista, että suurimmassa osassa Suomea maatalouden ulkopuolinen (ainakaan hintoja nostava) kysyntä ei olisi kovin suurta. Toisaalta kaava-alueilla tapahtuneet maanostot eivät myöskään kuuluneet aineistoon. Muuttujat saivat kuitenkin analyysissä odotetunmerkkiset ja tilastollisesti merkitsevät kertoimet. Selitys lienee se, että mitä paremmat mahdollisuudet viljelijäperheillä on työllistyä myös tilan ulkopuolella ja mitä paremmin on palveluita saatavilla, sitä houkuttelevampaa on myös tilanpidon jatkaminen ja myös sen kehittäminen lisämaata hankkimalla.

Kun saatuja tuloksia verrataan asetettuihin tavoitteisiin, voidaan sanoa, että kaikkiin löytyi ainakin jotain vastauksia, ja huomattavaan osaan jopa suhteellisen perusteellisia vastauksia. Paljon jää kuitenkin vielä selittämättä. Se on kuitenkin selvää, että paikalliset olot ja erityispiirteet vaikuttavat varmasti pellon hintaan. Tätä tukee myös se, että spatiaalinen analyysi osoittautui oikeaksi mallinnustavaksi.

Tyhjentävää vastausta tavoitteiksi asetettuihin kysymyksiin ei varmasti taloudellisen tutkimuksen perusteella pystytäkään antamaan. Avuksi tarvittaisiin ainakin sosiologista ja psykologista tutkimusta, jos kohta niidenkin mahdollisuudet lienevät rajalliset.

Politiikkavalmistelun kannalta on keskeistä tuntea, kuinka politiikkamuutokset vaikuttavat eri asioihin, mm. peltomaan hintoihin. Kun politiikkariippuvuus on koko ajan kasvanut, myös politiikka-analyysien tarve, erityisesti siitä, miten muutokset vaikuttavat tilatasolla, kasvaa. Vaikka politiikkaa ei voi aina suunnitella siten, että asetetut tavoitteet saavutettaisiin, seuraukset on hyvä kuitenkin tuntea. Tämä tutkimus osaltaan vahvistaa sen, että hehtaariperusteisen tuen lisäyksellä on selkeästi epäsuotuisia vaikutuksia Suomen oloissa. Kun jatkossa mietitään politiikan muutoksia, olisi tärkeää hakea niistä kannustavia elementtejä myös tilatasolle, eikä ajatella pelkästään ulkoisvaikutuksia. Suomen oloissa iso ongelma on EU:n politiikan (ja komission) asettamat reunaehdot.

Tämäkin tutkimus osoitti taas kerran, että Suomessa tarvitaan meille sovellettua tutkimusta. Vaikka ongelmat ja politiikkamuutokset ovat samansuuntaisia, Suomen olosuhteet poikkeavat niin paljon vaikkapa muista EU-maista, puhumattakaan Pohjois-Amerikasta, että meidän omilla aineistoilla tehty empiirinen tutkimus on välttämätöntä. Vaikka osa tuloksistakin on samansuuntaisia kuin muualla, voi tulosten tulkinnassa silti olla eroja.

Tutkimuksella oli merkittävä kontribuutio myös spatiaalisen analyysin tuomisessa ensimmäistä kertaa suomalaiseen maatalousekonomiseen tutkimukseen (kovin montaa muutakaan suomalaista tutkimusta, jossa olisi ko. analyysimenetelmää hyödynnetty, ei liioin ole). Paikkatietoja on hyödynnetty muussa maataloustutkimuksessa, mutta tässä tutkimuksessa tehtiin ensimmäistä kertaa ekonometrinen analyysi niitä hyödyntäen. Analyysi osoitti, että spatiaalisen ulottuvuuden lisäämisellä mallia voitiin parantaa. Kansainvälisenkin mittapuun mukaan tutkimuksessa käytetty aineisto oli laaja ja tehty spatiaalinen malli monipuolinen, joten se on merkittävä lisä tämän alan tutkimukseen.

Tehty tutkimus osoitti myös sen, että spatiaalisen ulottuvuuden lisääminen voisi olla perusteltua myös monen muun tyyppisessä tutkimuksessa kuin tässä. Mitä pellon hintaan tulee, tutkimus jätti edelleen selvittämättömiä kysymyksiä. Analyysi tarkentuisi varmasti, jos hinta-aineistoon voitaisiin liittää tilakohtaisia tekijöitä tätä tutkimusta enemmän. Samoin tiedot ostajien ja myyjien ominaisuuksista voisi tarkentaa analyysiä. Tähän liittyen myös sosiaalisen pääoman vaikutus pellon kauppa- ja erityisesti vuokrahintoihin olisi selvittämisen arvoista. Toisaalta myös esimerkiksi tilusrakenteen vaikutus pellon hintoihin olisi syytä selvittää.

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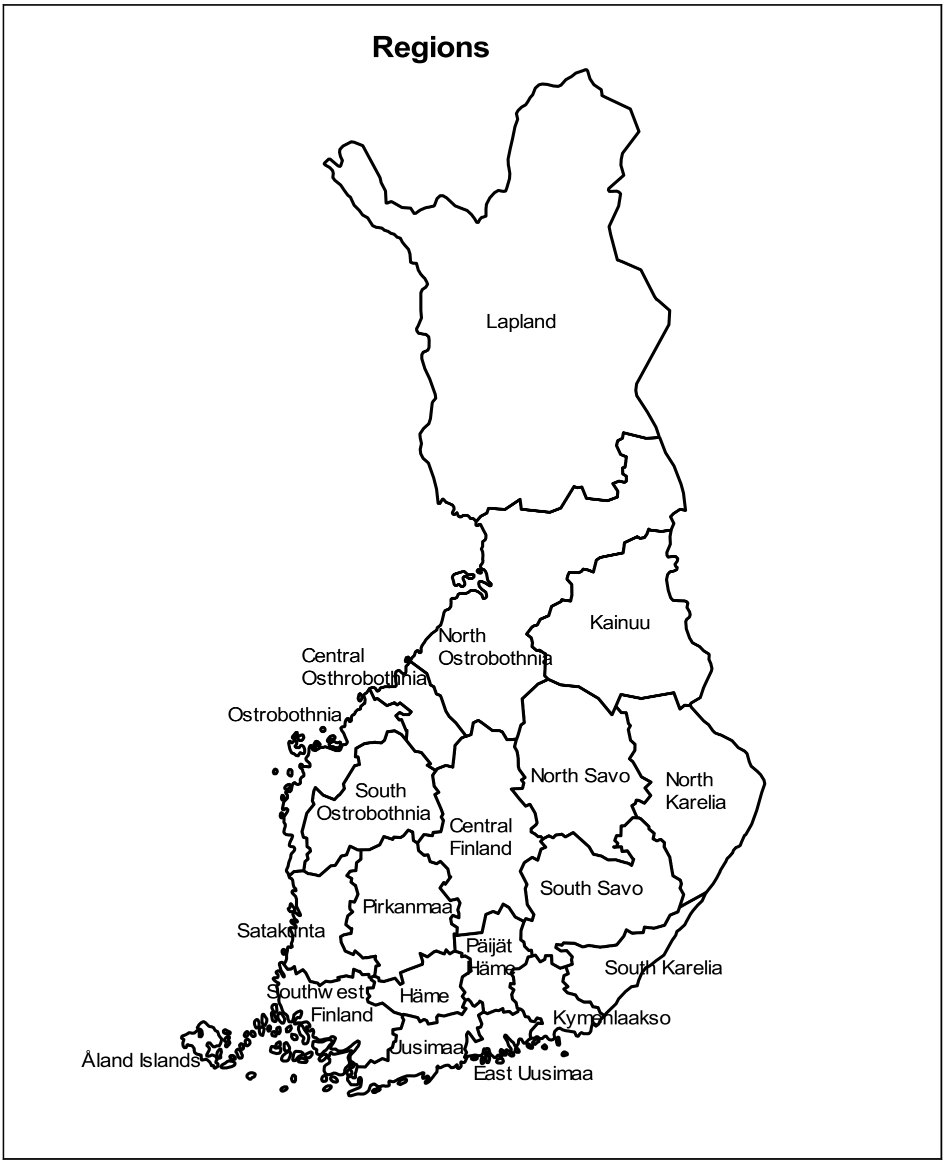
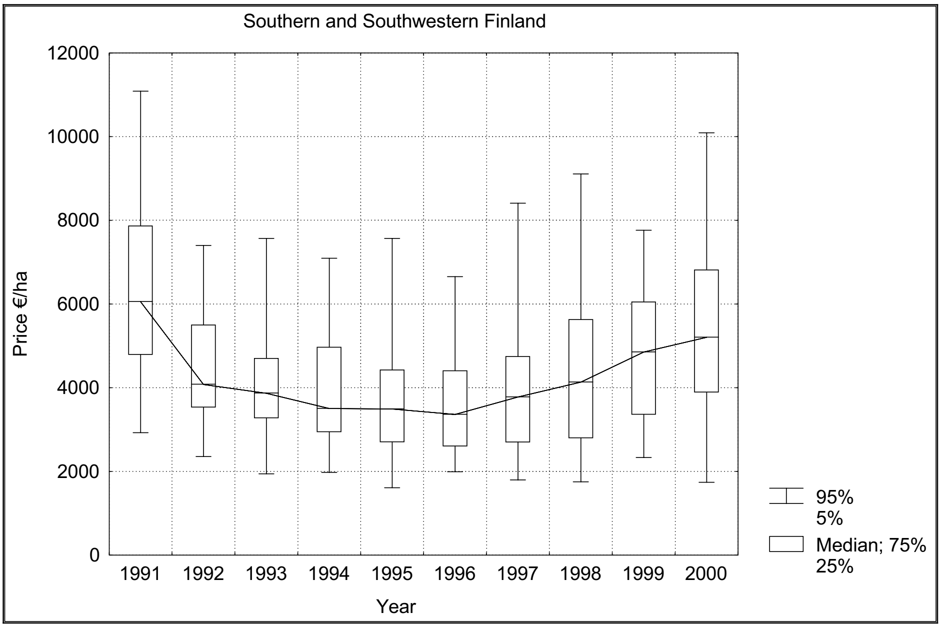
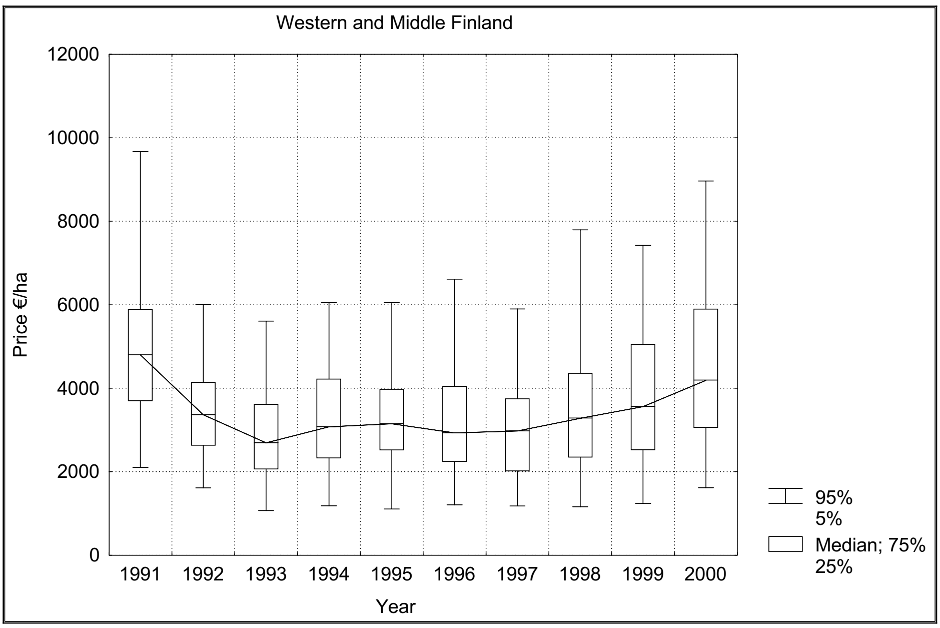
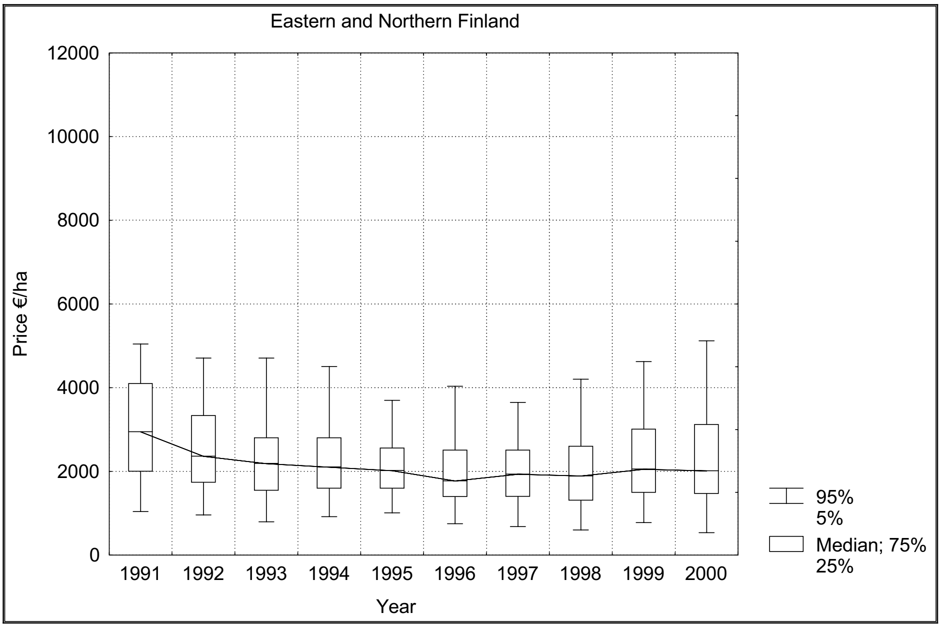
Appendix 1. Map showing the provinces of Finland.



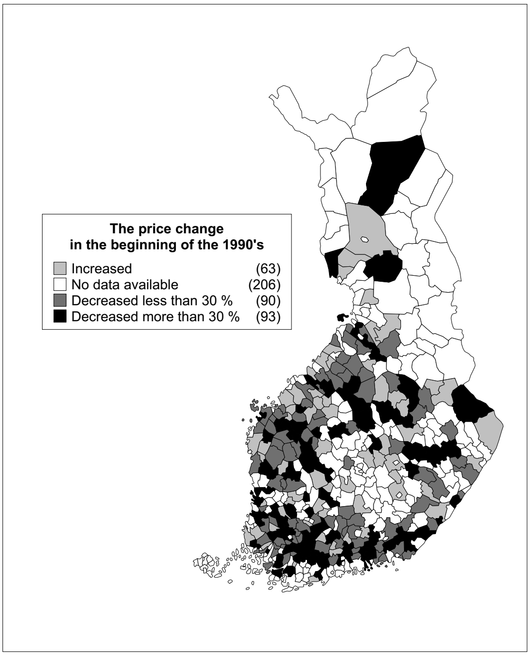
Appendix 2. Land prices and their variation in different regions in Finland.

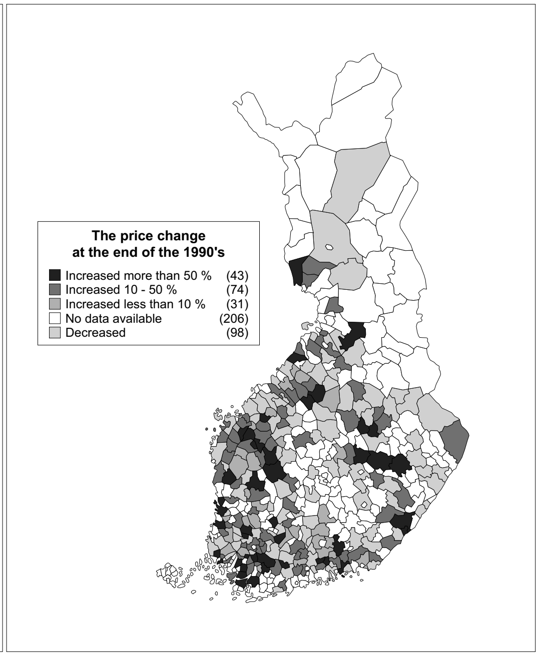




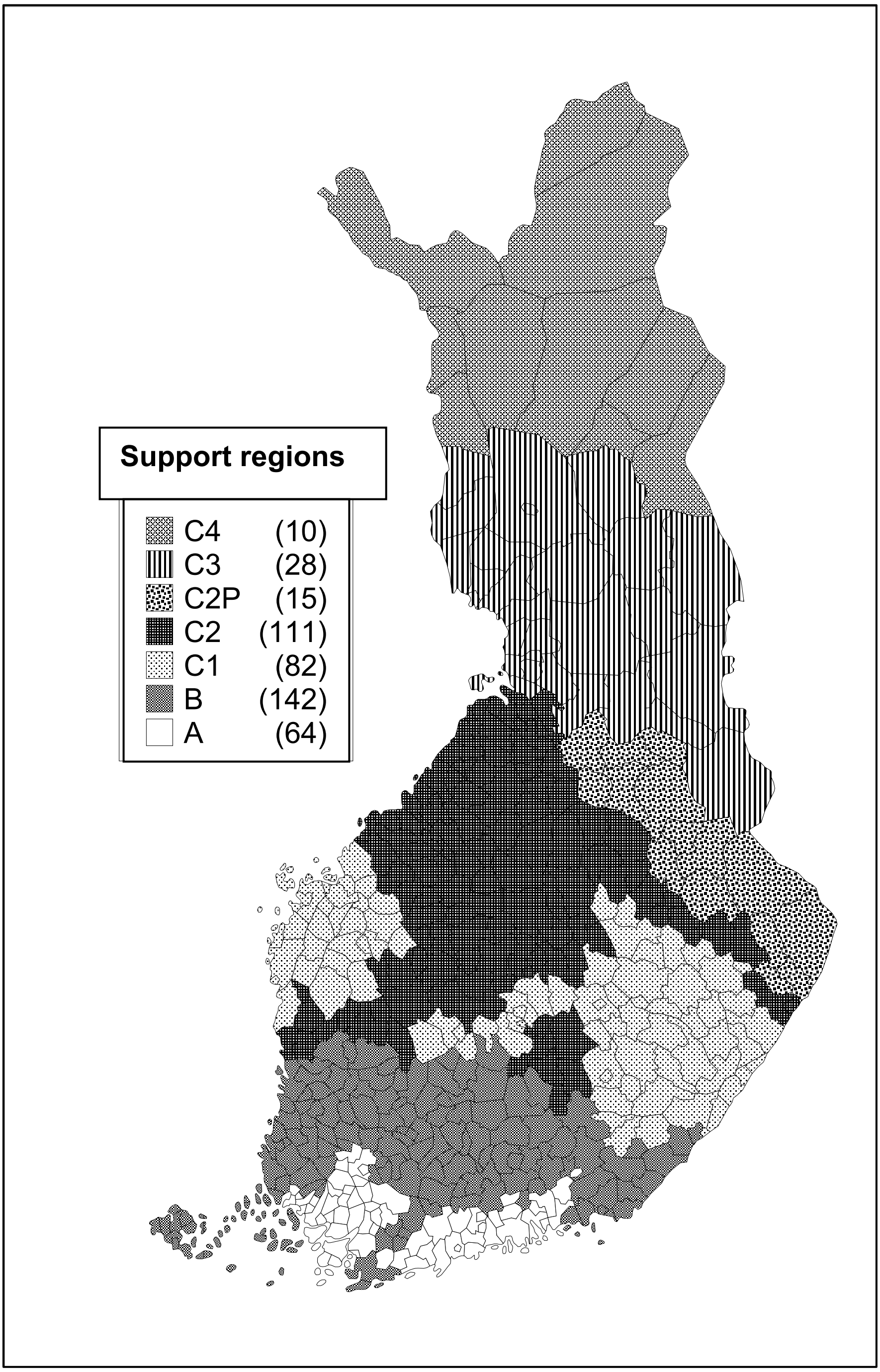

Eastern and Northern Finland
12000
10000
8000
6000
4000
2000
0
Price €/ha
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Year
95%
5%
Median; 75%
25%

Appendix 3. The price changes of additional land in 1991-1995 and in 1995-1999 in different municipalities.





Appendix 4. Map showing the support regions of Finland.



Appendix 5. Construction of a spatial weight matrix.

The great circle distances between centroids of the sold lots are applied in creating the weight matrix.

Distance based weight matrix is defined:

$$
\begin{cases}
w_{ij}^{*} = 0, if \quad i = j \\
w_{ij}^{*} = \dfrac{1}{d_{ij}^{2}}, if \quad d_{ij} \leq 100km \\
w_{ij}^{*} = 0, if \quad d_{ij} > 100km
\end{cases}
$$

In order to operate with relative distances rather than absolute distance the weights are row standardized. The row standardization means that

$$w_{ij} = w_{ij}^{*} / \sum_{j} w_{ij}^{*} \ .$$

The robustness of the results was tested by using 1/d as a weighting factor. The only difference was that the results with squared inverse distance were diagnostically a little better. Moreover, the intuition when using the squared inverse is more natural, since the weight diminishes at increasing speed when the distance increases. The choice of 100km is more or less arbitrary, but again the results are quite robust for the chosen distance. The distances of 20, 50, 200 km were also tried, but the results remained very much the same. Even the full matrix with no distance limitation was applied. However, the process time increased with nonzero elements in the weight matrix by such an amount that it would have been impossible to apply a full-weight matrix to the 1995-1999 sub-sample.

In addition, weight matrices that were based on K (K=20 or K=100) nearest sales were also applied. The results remained very similar, but in order to utilize the whole information in the data the more accurate weighting scheme was chosen.

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