A Hedonic Price Model of Self-Assessed Agricultural Land Values

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Abstract

The hedonic price model assumes that land prices contain information in relation to the value that consumers put on characteristics of the land. Variations in prices may then be used to measure the productive value of those characteristics. There is a small literature on hedonic price models of agricultural land, including a study by Kostov (2009). Kostov deals with the impact of land characteristics on price in Northern Ireland and puts the emphasis on solving problems related to spatial dependency which can lead to biased results they are ignored. Latruffe and Le Mouel (2007) studied the capitalization of farm subsidies into higher land prices, while Myles et al. (2008) assess the influence of direct payments on the rental value of the land by. Urbanization can also have an impact on land prices because of an increased expected value of the land due to land use changes as discussed by Cavailhès and Wareski (2003).

The aim of this paper is to understand what drives the farm land market in terms of price making and value of the land and to what extent. The main objective of this study is to evaluate the impact of certain groups of factors on the agricultural land market, namely:

- Policy Capitalisation
- Local Markets
- Environmental and Agronomic Drivers of Land Productivity
- Land Use

In order to estimate a hedonic price model with the four agronomic, market, land use and policy elements, we require a dataset that contains both land values and relevant explanatory variables. In order to capture market capitalization, it requires information on policy changes over time, while capturing local market and agronomic characteriststics requires georeferenced information.

The Teagasc National Farm Survey, which is the Irish component of the EU Farm Accountancy Data Network (FADN) is a detailed farm datasetthat has been conducted annually since 1972.

Given the selection bias associated actual sales or purchases, we have chosen to use self-assessed land prices from the NFS as our dependent variable.

3 Models are estimated of increasing complexity

- Land use
- Land use plus policy plus environment
- Land use plus policy plus environment plus local land market

Key Words: Hedonic Price Index, Agricultural Land

JEL Classification

A Hedonic Price Model of Self-Assessed Agricultural Land Values

1. Introduction

With farmland as its first and most basic means of production, a thorough understanding of the land markets and the factors influencing land prices is necessary to study the agricultural sector. This can be achieved through the use of Hedonic techniques developed by Court (1939) and further extended by Rosen (1974). It is popular among economists for the study of land and housing prices. It is also a powerful model to measure the value of non-market goods like pollution, air quality, or even risk. Examples of empirical applications of property value models include works by Smith and Huang (1993, 1995) and Palmquist and Smith (2002).

The hedonic price model assumes that land prices contain information in relation to the value that consumers put on characteristics of the land. Variations in prices may then be used to measure the productive value of those characteristics. There is a small literature on hedonic price models of agricultural land, including a study by Kostov (2009). Kostov deals with the impact of land characteristics on price in Northern Ireland and puts the emphasis on solving problems related to spatial dependency which can lead to biased results they are ignored. Latruffe and Le Mouel (2007) studied the capitalization of farm subsidies into higher land prices, while Myles et al. (2008) assess the influence of direct payments on the rental value of the land by. Urbanization can also have an impact on land prices because of an increased expected value of the land due to land use changes as discussed by Cavailhès and Wareski (2003).

The main problem in Kostov's study remains the general lack of available data as the agricultural land market registers very few transactions compared to the housing market. Furthermore, the effect of agricultural policy changes and urbanisation on the land market could not be studied for lack of a broader dataset. This paper attempts to extend much of the existing literature by using self-assessed land values rather than market sales data. There is relatively few land sales in most OECD countries. Very often smaller parcels of land are sold for development purposes, rather than for agricultural purposes. As a result agricultural sales price data may over-estimate the value of agricultural land. In this study we compare both sales and self-reported land data.

In this study we focus explicitly on Ireland as its grass based animal systems are so highly dependent upon land availability. Agricultural land comprises around 60% of the country's surface with grass as its main production. Accounting for 7% of Ireland's GDP, 10% of its exports, and almost 10% of the employment, the agri-food sector is one of the major contributors to the national economy (Teagasc, 2013). The study utilizes a long running panel dataset of farms, the Teagasc National Farm Survey from 1984-2012. Use of the latter allows for a much larger sample size and as the dataset has been collected nationally over a period of 30 years, it incorporates both enhanced spatial and temporal variation. This extensive data is also an opportunity to study the effect of policy changes in agriculture through the capitalization of subsidies and land market changes in general. This survey has the advantage that it collects both actual sales data, as well as self-assessed farm land value over the entire period, which spans significant policy and land market changes. Also the fact that the database has been geo-referenced, allows for the integration of GIS based environmental and agronomic characteristics, so that the value of these non-traded characteristics can be assessed.

Section 3 of this paper will outline the general basis for hedonic pricing theory, justify the choices of characteristics which were used in the analysis and lay down work hypotheses. Section 4 will cover the methodology required in this study to use the Hedonic price model, test the aforementioned hypotheses and deal with issues related to spatial dependency, quantile regression and the use of self-reported land price data. The next two sections (5 and 6) present the data and results from the application of the proposed methodology to the Irish land prices obtained through the Teagasc national survey.

2. Context

The aim of this paper is to understand what drives the farm land market in terms of price making and value of the land and to what extent. As mentioned previously, the factors affecting farm land prices can be roughly classified in 4 main categories: agronomic characteristics, policy changes in a European context, and local land market and land use.

Categorizing land market factors in order to understand their impact

As land is the most basic means of production in the agri-food sector, the quality of the land has a sizeable influence on its price. In order to assess this impact, several agronomic factors must be used to cover the number of variables involved in agricultural production from a biological standpoint. Drawing upon Kostov (2009), where land quality is approached through production potential, land drainage potential, and cattle units per hectare, and as grassland is the main agricultural land use in Ireland as well as an important component in cattle farming, several factors can be used to evaluate the influence of land quality on its price. Grass growth can be used along with productive capacity to cover the main aspects of land quality in Irish agriculture. Drainage capacity is also important in that land with low drainage capacity is likely to flood often and cause losses in production.

Other characteristics which may be useful to determining the productive value of land are dairy share (as dairy farms require better quality grass to be efficient with their feeding costs), or tillage share (as land suitable for tillage is likely more productive and allows for high profitability crops).

Policy changes

One of the many concerns of policy makers is the actual effect said policies have on the land market and how farmers react to it. EU farm supports have gradually moved from price supports to payments coupled to production to payments decoupled from production to land based payments, increasing the income from factors associated with production, whether it be animals or land (Swinnen et al., 2008). Relatively inelastic supply of inputs such as land, combined with production and/or demand pressures resulting from farm subsidies can result in upward pressure on input prices (Floyd, 1965; Hertel, 1989; Ciaian and Swinnen, 2006).

Much of the literature relates to the capitalisation of farm subsidies into rental values (See Patton et al., 2008; Breustedt and Habermann, 2011; Ciaian et al., 2011; Ciaian and Kancs, 2012; Guastella et al., 2013; Guastella et al., 2014).

However in Ireland where most land is rented for short periods of time under what is known as the con-acre system and where it is possible to consolidate farm subsidy entitlements onto existing non-rented land rental values are less likely to capitalise the subsidy value than in other EU countries (O'Neill and Hanrahan, 2011). Given this land values may be more appropriately capture this capitalisation.

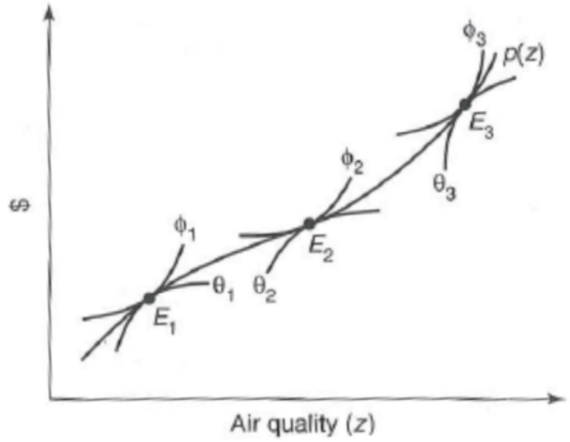
Local land markets and land use changes

One of the main defining aspects of land is the fact that it is not possible to export or otherwise displace it. Acknowledging this, we have to make the assumption that localisation plays a role in the land market and therefore influences the price of land. Factors related to local labour markets, relevant as they may be, are likely to present some redundant information as the local land market can be expected to reflect the average local land quality and mimic the effect observed with agronomic variables. Nevertheless, local land market information may also be used as a proxy for the presence of specific infrastructure from which farmers may benefit in specific areas (easy access to collection points etc.), as well as an interesting proxy for the impact of urbanisation on the market for agricultural land. Indeed, having an urbanised area close to farm land may result in highly profitable opportunities such as the development of an urban organic food market, or a significant increase in land value.

Hedonic pricing theory

The Hedonic price model relies to the assumption that a product's price is made up of the sum of the impact of all its characteristics, the main idea being that the importance of one such characteristic in the price can be derived from the observation of market behaviour. In any case, the idea is to use a hedonic price function which links land prices to the afore-mentioned characteristics. Once this is established the next step is to deduce the marginal value of a change in a specific characteristic. In the case of agricultural land, the hedonic pricing model uses data on land sale prices to link it to characteristics of the aforementioned property. This data is made readily available by the Irish National Farm Survey in the form of self-reported land prices which enables us to observe the impact of land characteristics (noted as "z") on land prices (noted as "p"). The price function p(z) is established by the interaction of supply and demand which results in a unique price of the land for each level of (z). This is done by creating a double envelope curve of the bid function (the demand from individual buyers) and the offer function (supply from sellers).

As illustrated by the following graph which deals with air quality, each point in the hedonic price function is determined by tangency of a bid function and an offer function which represents a particular choice of (z) and a price p(z). In this case, this tangency corresponds to the self-assessed land price, when offer and demand are equal on the market.



Source: Kolstad, C., Environmental Economics: International Edition, Oxford University Press, 2009

3. Methodology and Data

The main objective of this study is to evaluate the impact of certain groups of factors on the agricultural land market, namely:

- Policy Capitalisation
- Local Markets
- Environmental and Agronomic Drivers of Land Productivity
- Land Use

We have developed 4 successive models in order to cover all aspects of land prices. Each model adds more information in order for us to be able to evaluate what each variable groups brings in terms of precision to the final model which will regroup all studied variables.

- Model 1 only considers agronomic and pedo-climatic variables
- Model 2 will use model 1 as a base model and add the local land market component of the analysis.
- Model 3 brings additional data related to farm characteristics and
- Model 4 will conclude the analysis by bringing policy change data in the equation.

Table 1. summary for variables used in each successive model

	model 1	model 2	model 3	model 4
agronomic and pedo-climatic variables	included	included	included	included
local land market variables	x	included	included	included
farm practices variables	x	x	included	included
policy changes variables	x	x	x	included

We use a panel data regression model to understand the correlation between those variables and land prices per hectare. As such, it is necessary to use statistical methods which are adapted to this specific type of data. This regression uses a random effects generalized least squares model which is a technique for estimating the unknown parameters in a linear regression model and when one assumes no fixed effects. Furthermore, generalized least squares also yield better results when there is a certain degree of correlation between variables. Estimating the hedonic function non-parametrically in this way circumvents some of the problems related to spatial autocorrelation.

There are several studies supporting and underlying the strong theoretical basis for a nonlinear hedonic pricing function [Ekeland et al. (2004)]. This is especially important if we take spatial interactions into account as shown by Nesheim (2002) as these interactions may be a source of spatial dependence simply because land owners may independently adopt similar land valuation practices locally leading to a spatial clustering of this behavior rather than a true spatial process [Kostov (2009)]. Another example of a phenomenon which may lead to spatial dependence in terms of farm land analysis would be rainfall. Ignoring these issues of spatial autocorrelation could lead to biased and less accurate estimates than had the samples been independent [Patton and McErlean (2003)].

4. Data

In order to estimate a hedonic price model with the four agronomic, market, land use and policy elements, we require a dataset that contains both land values and relevant explanatory variables. In order to capture market capitalization, it requires information on policy changes over time, while capturing local market and agronomic characteriststics requires georeferenced information.

The Teagasc National Farm Survey, which is the Irish component of the EU Farm Accountancy Data Network (FADN) is a detailed farm datasetthat has been conducted annually since 1972. Each annual sample is comprises between 1000 and 1200 farms, each of which is assigned a weighting factor so that the results of the survey are representative of the national population of farms. The collected data is then compiled on a regular basis throughout the year. The entire process ensures the absolute confidentiality of individual farmer’s data as a unique code is used to identify each farm. Pigs and Poultry systems are not included in the annual samples because the small number of farms is not deemed large enough to be representative of the national agriculture.

We use a dataset consisting of all data collected by the NFS from 1984 to 2012 as well as land sales data and the residential price index from the CSO on the same time window. This corresponds to over 16000 observations for the NFS part of the data alone.

The collected data includes multiple key indicators, both financial and physical such as yields, assets, liabilities, purchases, sales, subsidies, liabilities etc… With the recent emphasis on rural development and viability of rural communities, the NFS has been extended to include additional data regarding farm households such as off-farm employment and income, farm inheritance, household composition, structure age…

Dependent Variable

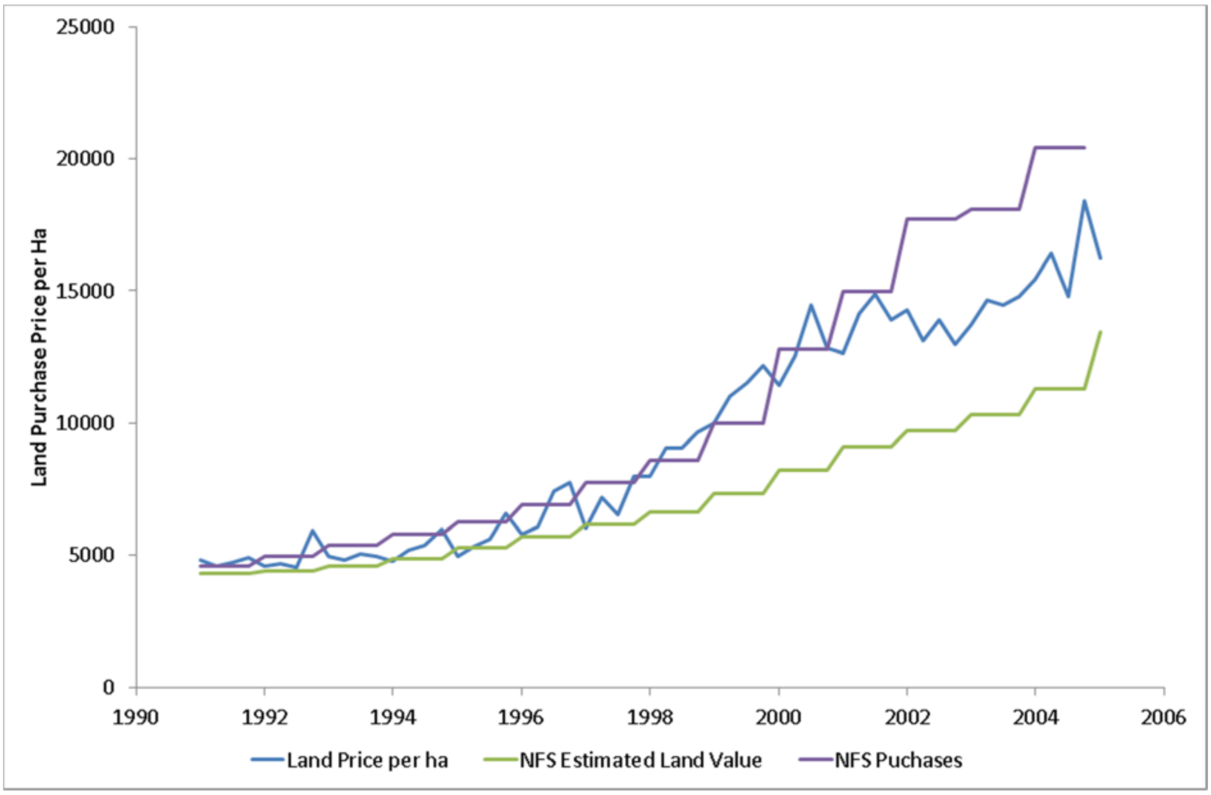
There are three potential dependent variables in the dataset

- Average Land Sales Value per Hectare
- Average Purchase Value per Hectare
- Self-Reported Land Value per hectare

Given the paucity of land transactions in Ireland, there are relatively few data points. In addition, as the NFS contains primarily active farmers, there are relatively few sales data points, with more purchase data points. However all farms contain self-reported land values. In order to validate the data, we compare in figure 1 the time-series of agricultural land values between the latter two NFS variables (purchases and self-reported land value per hectare) and the land transaction series of the national statistical agency (CSO).

Agricultural land sales data was collected from 1991 until 2005 by the CSO by sampling all agricultural land sales that are obtained electronically through the valuation office. Like the NFS sample, the CSO sample size remains relatively small and ranges from 200 to 300 transactions quarterly. The main collected variables are the area sold, price, and location of land.

Figure 1.   CSO/NFS land values per ha comparison (1991-2005)

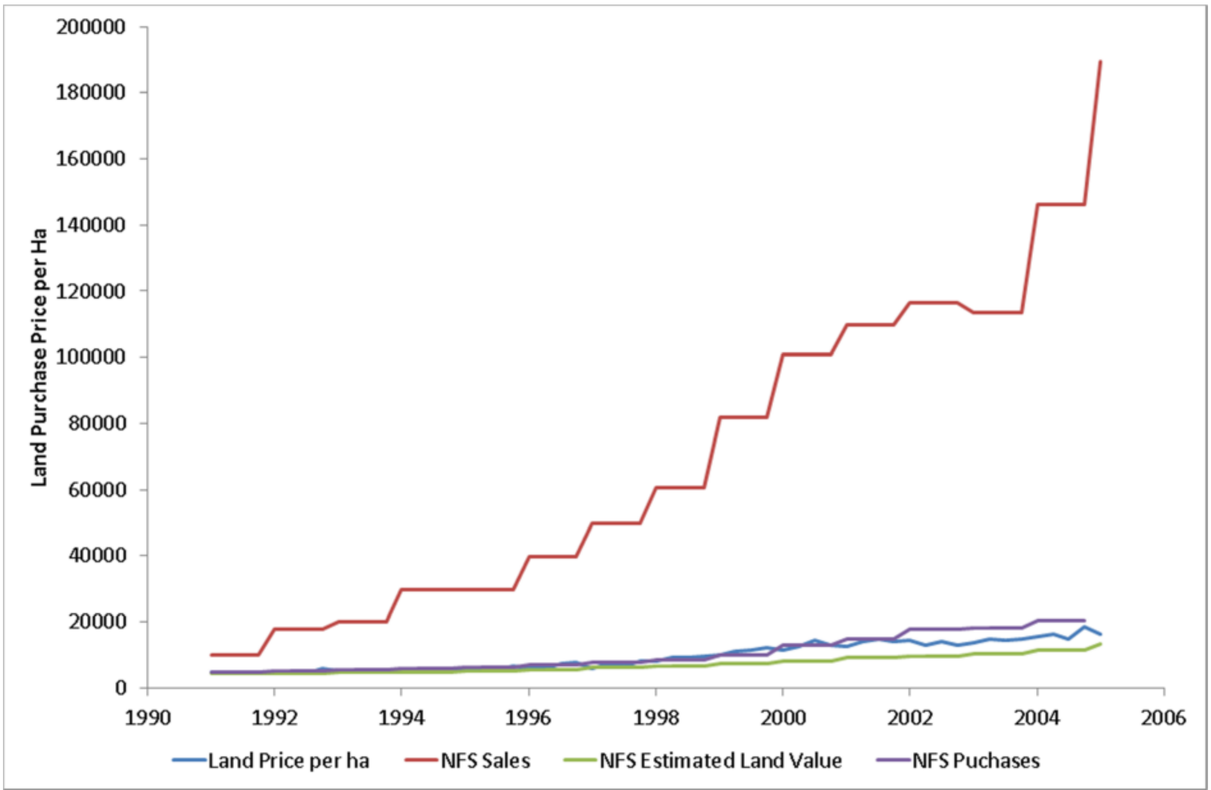


Source: Central Statistics Office Agricultural Land Price Series, Teagasc National Farm Survey

Comparing the 3 datasets, we find that the CSO and Teagasc land purchase data are strongly correlated, however with some divergence in the early 2000's. However what is most noticeable is that self-assessed land values are much lower. This reflects the fact that actual agricultural purchased land values are likely to be for better land or purchased for marginal convenience and may not necessarily reflect the average land quality etc.

In figure 2, we add also the land sales data, finding that the order of magnitude is much higher at about 7 times in the post 2000 period of the purchase value, reflecting the sales of land with development potential. We can explain these significant differences due to urbanization and the fact that farmers are generally reluctant to sell their land unless they get a significant premium for selling it. This would be exacerbated for land plots close to roads which are especially interesting for land development and building. This hypothesis is supported by Cavailhès and Wareski (2003) and applies in Ireland.

Figure 2. CSO/NFS land values per ha comparison incorporating NFS land sales values per ha(1991-2005)



Source: Central Statistics Office Agricultural Land Price Series, Teagasc National Farm Survey

Nevertheless, both datasets (actual sales prices and self-assessed) can be compared to the CSO's data on urban land prices. Given our validation of the NFS land value data, we can compare sales prices with house price sales data in figure 3, where the sales price curve post 2005 tracks the trend in house prices very well. Figure 4 captures this impact of urbanisation, with land prices in Dublin and the surrounding commuting areas having the biggest price spike during the property bubble that existed in Ireland in the mid 2000's.

Figure 3. Comparing House Price Inflation with Farm Price

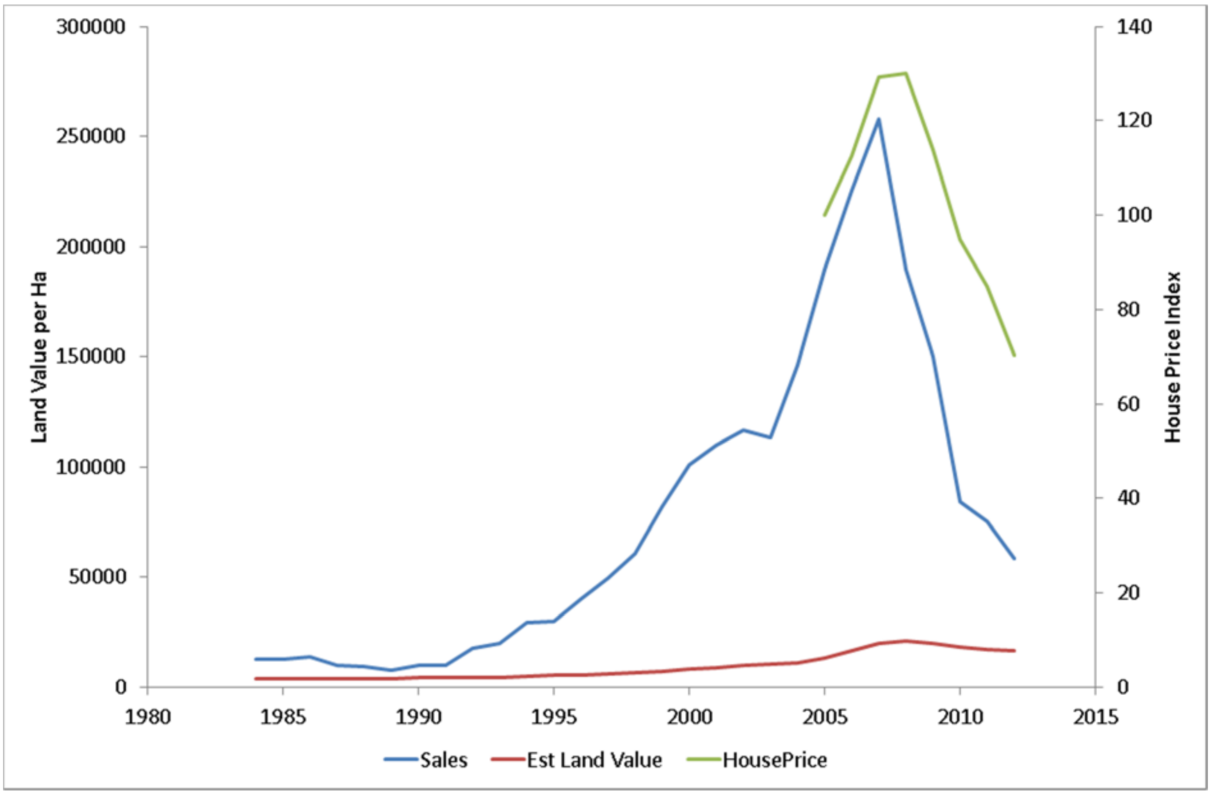
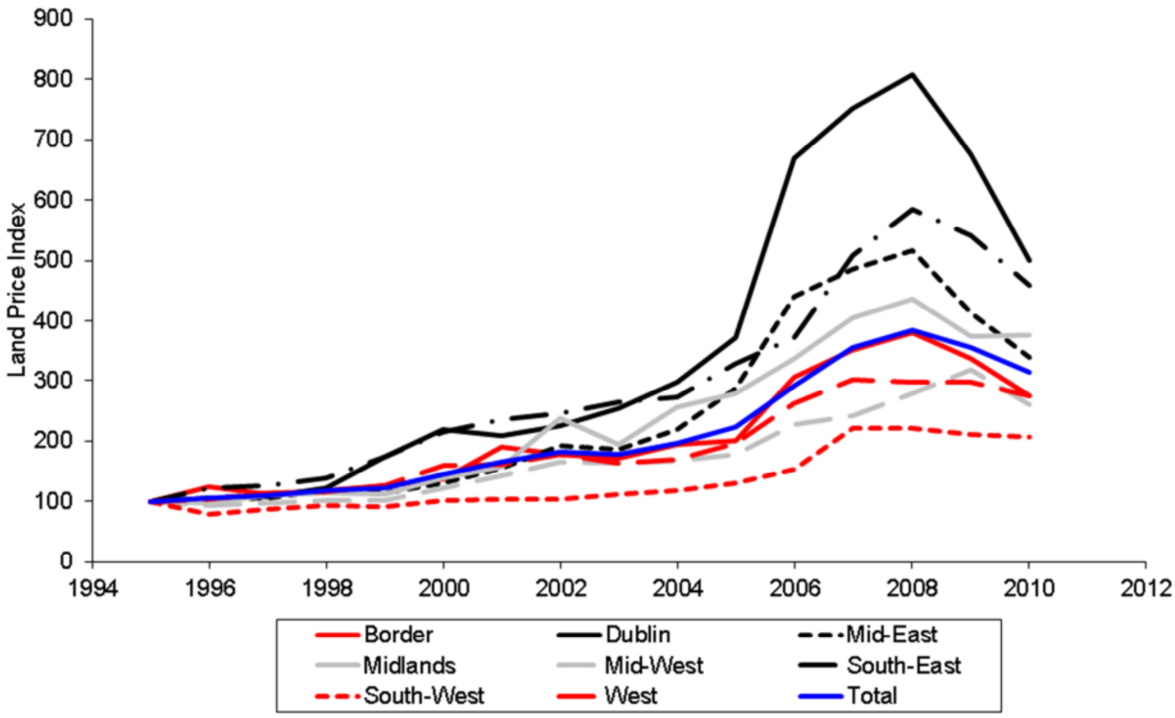


Figure 4. Regional Land Price Indices



Given the selection bias associated actual sales or purchases, we have chosen to use <u>self-assessed</u> land prices from the NFS to compensate the lack of data in <u>actual</u> sales prices.

The dataset also includes a population density variable which may prove useful to assess the impact of urbanization on land prices.

The scale and period for which the National Farm Survey was conducted also allows to measure the impact of factors linked to changes in policy which are also a specific characteristic of agricultural land. Indeed, the 30 year period during which this survey was conducted allows us to capture the effect of policy changes over the years as well as to assess the extent to which subsidies are capitalised into the land prices. This is made even easier thanks to the change from coupled payments, with which farmers were paid more if their production increased, to decoupled payments in 2005, which forced farmers to make production decisions based on market signals. This change serves as a natural experiment for this study.

Principle Component Analysis

One of the key features of this dataset is that a large portion of it includes spatial data which is critical in order to assess the impact of pedo-climatic factors and localization on land prices. Indeed, the NFS also includes environmental and pedo-climatic data for each farm location featured in it. Some of those variables are obtained through remote sensing (grass growth, soil moisture) while soil texture data is obtained by means of direct measurement and geological studies. As the NFS has recently been geo-referenced for historical data, we can incorporate geo-referenced environmental data including

- Soils
- Population Density
- Altitude
- Rainfall
- Wind Speed
- Temperature
- Slope
- Spring Grass Growth
- Early Grass Cover

After a quick assessment of how massive the database is (especially considering the large number of agro-pedo-climatic varibles), it becomes obvious that the high dimensionality of the available data is an obstacle to the analysis: even though each variable adds more singular information, a large amount of the information may be redundant. The PCA allows us to reduce dimensionality (which makes information easier to compute with and understand) and to remove redundant information. This is done by formatting correlated variables into uncorrelated variables named “Principal Components” (or “main axis”). If we limit the number of principal components, it is possible to represent the data graphically along with its dispersion, which would be impossible otherwise. The main question here is the number of principal components we will decide to keep as reducing the number of dimensions causes data loss: depending on our results, our goal is to optimize the number of components and the explained variability. We select the highest 20 principal components, which account for 55%

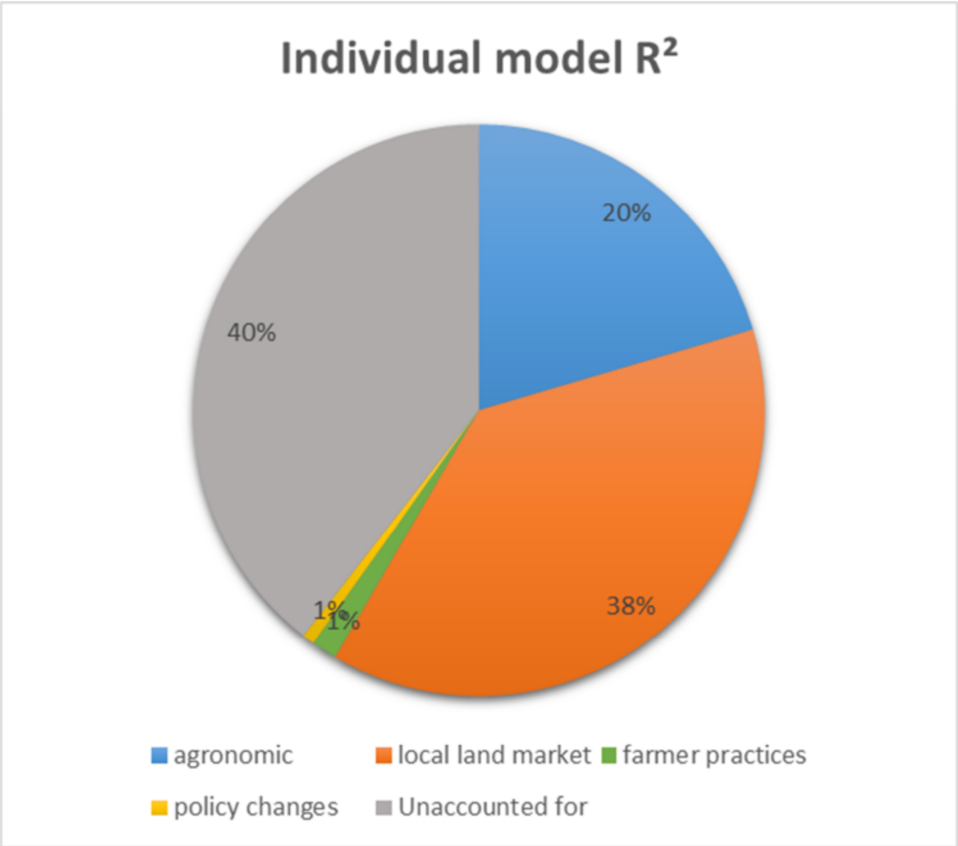
of the variability.

5. Results and further developments

The methodological framework which was previously discussed leads to a complete analysis of all variables independently (coefficients, standard error, significance etc.) as well as the per model analysis in order to give us a broader perspective. In this part, we will discuss and interpret those results. We will first analyze the output from the modeled analysis and then comment on some of the more interesting variables for a qualitative understanding of the processes behind their sign in the regression models.

Statistics summary

Figure 5. Individually added value to global R^2 for each factor category



This chart shows the individual R^2 for each category of factors or, in other words, it shows how much of the price variability can be explained with the variables which were used in this study and how much each factor "category" contributes to this variability.

As we can see, around 60% of the variability can be explained with model 4, which includes all of the variables used in the analysis, while 40% of this variability remains attributed to unknown factors, or phenomena that the proposed methodology cannot capture efficiently. Nevertheless, these results are satisfactory even though they can be argued with. They show us that, according to our model, about 20% of the price variability can be explained through agronomic and pedo-climatic factors while 38% of it can be explained through land market fluctuations. On the other hand, farm specific characteristics only account for 1% of the variability. Surprisingly, policy changes seem to create very little price variation and aren't that relevant on first analysis. These results will be discussed further.

Variable specific analysis

After applying the Principal component analysis to the agronomic and pedo-climatic variables, only 20 principal components (numbered f1 to f20) were kept to be in the first model along with the size of the plot, soil types, and whether the plot resides in a least favored area or not.

Table 1. Results table for model 1-4 regression analysis (agro-pedo-climatic variables only)

	model 1		model 2		Model 3		model 4	
land value per hectare	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
UAA size	-.0060917	0.000	.0125077	0.000	-.0133904	0.000	-.0133904	0.000
soil quality	.5335684	0.000	.3292541	0.000	.3069591	0.000	.3068251	0.000
parental rock quality	.2025838	0.000	.2139384	0.000	.1982507	0.000	.198117	0.000
Non LFA	.3019906	0.000	-.0054062	0.662	.0070483	0.576	-.0002174	0.986
Medium LFA	.9302279	0.000	.0377078	0.022	.0323906	0.049	.024491	0.137
f1	-.0301364	0.000	-.0380076	0.000	-.035155	0.000	-.0346942	0.000
f2	-.1187352	0.000	-.0474405	0.000	-.0414293	0.000	-.0410861	0.000
f3	.0129096	0.047	-.006761	0.225	-.0066319	0.226	-.0062672	0.248
f4	.0953565	0.000	.0445373	0.000	.0392784	0.000	.0380063	0.000
f5	-.0365332	0.000	.0035331	0.510	.0031079	0.553	.0030954	0.551
f6	.0161299	0.017	.0075232	0.161	.0062334	0.236	.0061023	0.241
f7	-.0384374	0.000	-.0105837	0.055	-.0113373	0.035	-.0112805	0.034
f8	-.0060477	0.386	.0006726	0.902	.0004793	0.929	.0009607	0.856
f9	.0040443	0.587	.0156784	0.009	.0148943	0.012	.014384	0.014
f10	-.0193162	0.006	-.0115983	0.043	-.0098135	0.079	-.0096229	0.082
f11	-.0180435	0.014	-.0075941	0.184	-.0073315	0.189	-.0068565	0.215
f12	.0145382	0.052	.0026253	0.659	.0036745	0.527	.0034184	0.553
f13	.0264551	0.000	.0206625	0.000	.0179147	0.002	.0177089	0.002
f14	-.0250763	0.001	-.0019636	0.748	-.0027675	0.643	-.0026519	0.654
f15	.0120538	0.126	.003336	0.586	.0039444	0.509	.004297	0.468
f16	.0129244	0.085	.0155108	0.008	.0156826	0.006	.015842	0.005
f17	.0187079	0.016	.0136355	0.022	.016015	0.006	.0152306	0.008
f18	.0014435	0.848	.0045584	0.427	.005572	0.321	.0054625	0.326
f19	.0189533	0.015	.0146203	0.015	.0139649	0.017	.0138209	0.017
f20	.0198407	0.008	.0082778	0.143	.0081801	0.139	.0079397	0.147
_cons	8.813036	0.000	8.378481	0.000	8.251514	0.000	8.229334	0.000

We can see that most of the variables in the table above have a very low or null p-value which indicates that these variables have a significant influence on agricultural land prices, as one would expect of agronomic variables, even though they only account for 20% of the variability (Highlighted p-values are over 0.1 and are considered less accurate thus left out of the interpretation). Nevertheless, it is possible to interpret the sign of the variable coefficients in order to understand how (positively or negatively) each variable influences land prices. In this regard, we can see the intuitive idea that land prices tend to go up with soil quality is verified as both soil variables positively correlated to price. Another interesting variable which is presented in this table is the “Medium Least Favoured Area” variable. In areas designated as "less-favoured", agricultural production or activity is more difficult because of natural handicaps, e.g. difficult climatic conditions, steep slopes in mountain areas, or low soil productivity in other less favoured areas. As such, these areas benefit from the LFA payment scheme, emanating from the EU, in order to mitigate the risk of land abandonment. Under the Articles of Council Regulation (EC) 1257/1999 still in force, an area may be classified as less favoured according to one of three categories, Medium least favored area being one of those: Under article 19 of the afore mentioned regulation, an area may be classified as “medium least favored area” if they display poor productivity, productions which result from low productivity of the natural environment, and a low or dwindling population predominantly dependent on agricultural activity. The fact that the coefficients are positive in all 4 models tells us that selling a plot in a least favoured area generally makes the price rise, which doesn’t seem logical at first. However, this is a strong argument in favour of the capitalisation of subsidies playing a role in the definition of agricultural land prices. This idea is further supported by the results from the direct payments/ha and 2005 decoupling natural experiment mentioned earlier. Before the decoupling period, farmers were paid as their production increased as an incentive to produce more. Nevertheless, after the decoupling period, subsidies were moved to a fixed amount rather than being dependent on produced quantities.

Table 1. payment decoupling variables results

	Coef.	Std. Err.	z	P>|z|	[95% Conf	Interval]
_Idecoupli~1	(omitted)					
direct payments/ha	.0000869	.0000198	4.39	0.000	.0000481	.0001256
Direct Payments per ha x Decoupled period (year >= 2005)	.0001044	.0000246	4.24	0.000	.0000562	.0001527

As we can see, both direct payment per hectare variables have positive coefficients which shows that this change in European policy has indeed contributed to an increase in land prices as a result of subsidy capitalization by the farmers. This is probably due to an inclusion of the newly fixed subsidy into the land price similarly to a fixed wage given for using that plot.

Further Developments

Data and processing short-comings

There were several issues with the data and processing method which affect the final results of the study. The biggest problem has to do with the 40% of unknown variability in the model. With such a large portion of unexplained factors, some of the categories which were used to analyse the data are bound to be underrepresented in the model, especially when considering the fact that the model only attributes 1% of the price variability to Policy changes. This is particularly surprising as the literature seems to suggest that policy changes play a greater role in the making of agricultural land prices. This could be explained by the fact that least favoured area classification was included in the agronomic and pedo-climatic factors even though it is heavily influenced by policy changes and accounts for a significant portion of subsidies going to farmers in Ireland. This effect is emphasized by the fact that most of Ireland’s utilised agricultural area is classified as least favoured by the European Union. Nonetheless, it is very likely that the impact of policy changes is largely underestimated.

A choice also had to be made whether or not to include the time variable in the agro-pedo-climatic model or in the local land market model. Both options have pros and cons as including the time factor in the second model allows us to capture the importance of market adaptation, but this also prevents us to see the reactivity to climate change which could affect land price faster than market fluctuation would. This may have led to an overestimation of the effect of local land markets to the expense of climate variations.

Furthermore, much of the variability related to farmer specific practices and their ability to make the most of their land has been ignored for lack of relevant data. This seems especially important when one considers the fact that much of the data related to land quality is self-assessed. Therefore, farmer’s assessment of the value of their land may depend on their qualification level and a wide range of sociological variables that are very difficult to test for.

Lastly, the effect of Urbanisation on land prices cannot be assessed with this study as none of the variables associated with the phenomenon are significant in the model. Nevertheless, there are other ways to understand the impact of urbanisation on land prices by comparing self-assessed land prices and actual sales prices, as discussed further on.

Alternate data processing method: quantile regression

An alternate processing method was suggested early on during the study as a possible substitute for the methodological framework presented in this paper. Quantile regression provides a more complete view of possible causal relationships between variables, especially in ecological processes for which it has proven useful in discovering more useful predictive relationships between variables in cases where there were only weak relationships between the means of these same variables. Quantile regression has proven to be a robust regression analysis method against outliers in the data.

Issues related to spatial autocorrelation

There are several studies supporting and underling the strong theoretical basis for a nonlinear hedonic pricing function [Ekeland et al. (2004)]. This is especially important if we take social interactions into account as shown by Nesheim (2002) as these interactions may be a source of spatial dependence simply because land owners may independently adopt similar land valuation practices locally leading to a spatial clustering of this behavior rather than a true spatial process [Kostov (2009)]. Another example of a phenomenon which may lead to spatial dependence in terms of farm land analysis would be rainfall. Ignoring these issues of spatial autocorrelation could lead to biased and less accurate estimates than had the samples been independent [Patton and McErlean (2003)]. Despite the methodological framework in this study, there are still some problems linked to autocorrelation as we can see that some of the variable have coefficients of the opposite sign from one model to the next.

6. Conclusions

This study offers the first steps in the process of understanding agricultural land price variations and general behavior in Ireland. It sets a methodological framework as well as provides a general overview of the existing literature. We have applied a random effects generalized least squares model to a hedonic and price model in order to understand the effects of varying hedonic characteristics on land prices. We have applied this approach to the

Irish National Farm Survey on a period ranging from 1984 to 2012. The results from the proposed methodology allow us to have a general understanding of what drives the farmland market in Ireland even though their statistical resilience is too weak to go into much detail as to how much each factor influences the final results.

As mentioned previously, this study is to be continued by TEAGASC staff members by using more robust statistical methods (e.g.: quantile regression, IVQR) to have a better understanding of the complex relationships with the numerous variables which may influence land prices.

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