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Valuation of environmental impacts of the Rural Development Program

- A hedonic model with application of GIS

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Abstract

The payments within the Rural Development Programme 2007- 2013 seek to improve the environment and contribute to rural development and economic growth. These policy measures may therefore have visual effects on the rural landscape. To achieve a measure of willingness to pay for these effects, a hedonic pricing approach is applied. The prices for staying at holdings in the "Staying on farms" registry are used to quantify the valuation of these visual effects. The results of this study indicate that there is a relationship between the price of rental objects and spatial variables constructed in GIS. Riparian strips and animals at the farm are positively valued. Cultivated land, grazing and meadow lands close to the settings are negatively valued. Hence, this study indicate that there is a positive willingness to pay for payments addressing user values in a diversified landscape and a negative willingness to pay for actions leading to a more monotonous landscape, such as payments to extensive grazing systems.

Keywords: Hedonic Valuation, Rural landscape, Rural Development Program, GIS.

JEL classification: Q150, Q180, Q510.

1. INTRODUCTION

The common agricultural policy was previously intended to support the production of food within the EU with various price support mechanisms. The common policy has presently become more oriented to land stewardship rather than crop production. The common Rural Development Programme (RDP hereafter) is an important step in the reformation of CAP and is intended to strengthen the agricultural and forestry sector, improving the competiveness of rural areas and preserve the environment and cultural heritage in the member states. The RDP for the period 2007-2013 constitutes the second pillar of the CAP and put considerable controls in the hands of each member states through the regional programs.

The measures within the RDP for Sweden are intended to improve the competitiveness of agriculture and to protect rural natural resources and the environment. In practice, the payments are distributed both to the conservation and management of farmland as well as to different types of tourism projects in rural areas, to support the planting of bio energy crops, youth activities in rural areas, food production and to improve the animal welfare at farm level. Although the CAP has undergone considerable cost saving reforms recent years, it still represent a relatively large proportion of the total EU budget. Of the total budget of EUR 13 billion per year, EUR 5.2 billion or 40 percent is addressed to agriculture. Of the EUR 52 billion, EUR 1.43 billion goes into the RDP. In Sweden, the environmental benefits as part of

Axis 2 is especially prioritized , which yearly achieves about 80 percent of the total budget (about EUR 0.35 billion per year, Rural Programme for Sweden 2007-2013). Regard to this fact, it is a relevant question whether assessed environmental benefits can be justified with regard to the costs of the reforms? In order to provide an answer to this, a deeper knowledge into consumer valuation of the environmental benefits is required.

In the literature, there exist two main approaches to detect individual valuation of environmental resources, namely the stated preferences and revealed preferences methods. Several studies use the stated preference methodology and investigate the willingness to pay for features in the agricultural landscape, see for example Drake (1992) and Hanley et al. (1998)). However, there are some problems inflicted by using the stated preference approaches in this respect. The choice situation presented to the respondent represents a hypothetical scenario, which may affect the answer of the respondent, who might exaggerate or under estimate its willingness to pay for a resource. In addition, natural resources are also considered to be public good, which may cause problems with free-riding behaviors by the respondents.

Methods dealing with revealed preferences may be a way to overcome the problems with under- or over estimated preferences, as an actual behavior is studied. . The hedonic valuation is a common method to apply when estimating revealed preferences (see for example Bastian, 2002). With the hedonic price model it is implicitly assumed that the price of property or a land area, also reflects the value of environmental goods such as landscape amenities or clean air surrounding the object (see for example Rosen, 1974). Everything else equal, the property values in areas with highly valued environmental qualities should be higher than the property values in areas with lower qualities. Hence it is possible to achieve a measure on consumer valuation of the environmental qualities. The hedonic pricing method is not entirely straightforward though. All individuals have to be provided with perfect information the market in order to make an efficient choice. and therefore can make the choice that best match their preferences. We may also experience problems with omitted variable bias, where some important explanatory factors are not included into the regression model or over specified models with unnecessary variables. This is in practice not possible because perfect information never exists. Furthermore, the total economic value of a natural resource both have user and existence values. By definition, the hedonic valuation only put a measure on user values. The hedonic price model is often criticized for its limited ability to include existence values (OECD, 2002).

There are numerous applications of the hedonic valuation method in the literature where rural tourism has also been subject to analysis. Quantification of spatial variables has previously been made in a number of studies. Paterson and Boyle (2002) estimated a hedonic pricing model for properties in a residential area with landscape attributes within a radius of 1 km from the housing unit. Among the independent variables, the proportion of cultivated land, forests and water surface was included. Ready and Abdalla (2005) conducted a hedonic study, based on data retrieved from Geographical Information Systems (GIS), on how property values were affected by land use in a 400 m radius around the objects and the relative landscape openness between 400 - 1 600 m from the objects of measurement.

The price of rental objects in the Swedish ”Staying on a farm” registry provides a unique opportunity to use a hedonic pricing model to value the environmental resources of the agrarian landscape resulting from the RDP. The rural tourism combined with farming has been assessed to generate over about EUR 0.1 billion a year. In this study, the independent variables describing the agricultural landscape amenities are developed using ArcGIS. By applying buffering zones around the farming units of interest, features of the surrounding landscape may be quantified, for instance the area cultivated land or the area natural and semi-natural grassland and meadows. Furthermore, it is possible to locate and determine the size of riparian strips around wetlands and watercourses. A number of geographic variabler describing the relation to urban areas and major roads are also included.

2. QUANTIFYING THE LANDSCAPE WITH GIS

GIS (Geographic Information System) is frequently applied in order to quantify the visual properties of a landscape. By using a GIS approach also spatial information of the landscape is retrieved, i.e. the geographical location is considered. In this study, variables are created from multiple map layers and overlay analysis in GIS. The overlay analysis provides a tool to explore the neighborhood around the farm objects, both in a two-dimensional and in a three-dimensional space. The variables are intended to describe the magnitude and character of the landscape close to a farm settlement. Hence a measure of the landscape characteristics is attained, which is not possible to attain through ordinary registry data. By using buffering operations, the area investigated can be limited to a specific radius around the object of interest, see for example Paterson and Boyle (2002) or Cotteleer et al. (2008). The importance of proximity is confirmed by Cavailhés et al. (2009), who show that the valuation of landscape attributes depends on the distance to the object. According to this study, landscape amenities further away than 100-300 m from the object of interest do not affect prices. A commonly applied buffering radius in hedonic studies is 200-500 m (Waltert and Schläpfer, 2007).

The map layers investigated in this study originates from different statistical sources. A map layer of urban areas is collected from Statistics Sweden. Urban areas are here defined as areas housing at least 200 people with a maximum of 200 m between the houses. The buffering distance within urban areas is 2 km, which implies that 135 of the total 324 farms are located within urban areas. Proximity to motorways has been buffered in a similar manner, with a 20 km buffer zone. The map layers of land use within the agricultural land are collected from the Board of Agriculture database. The layer contains in total 1 225 000 polygons, which are so called agricultural blocks, which may contain one or more land use areas. The variables investigated here are wetlands, riparian strips, grassland, pasture and the total area of cultivated land (the entire block area). The buffering zones applied for agricultural crops vary between 300-500 m. The buffering distance for riparian strips and wetlands is set to 5 000 m. The map layer of natural and semi-natural grazing land and pasture is collected from the Swedish Board of Agriculture. In 2002-2004 a major inventory of pastures and meadows was executed in Sweden. Overall, 300 000 hectares of land was included in the inventory and specific features, such as the size and characteristics of the grazing and pasture lands was registered. The registry contains restorable land as well as highly valued land with regard to biodiversity and cultural values and land included in the Natura 2000 networking programme. To the inventoried pastures and meadows a buffer zone of 500 m is applied.

A relevant question is how the information retrieved from the map layers in GIS correspond to the specific goals of the RDP. Within the goal we find for instance increased biodiversity, environmental sustainability, the protection of cultural environments and an open landscape. Table 2.2 shows how the different land uses collected from the map layers in GIS may be assumed to affect the specific goals of the RDP.

Table 2.2: Land use and the Rural Development Programme.

Variabel	**Biodiversity**	**Environmental sustainability**	**Cultural values**	**Open landscape**
Cultivated land	X			X
Pasture	X		X	X
Riparian strips	X	X		
Wetlands	X	X		
Grasslands	X	X		X
Semi natural meadows and pastures	X	X	X	X

From Table 2.2 we can see that all types of land use affect the biodiversity and the open landscape and environmental sustainability goals can be achieved by four out of six different use of land.

3. VALUATION OF A NATURAL RESOURCE

In a hedonic pricing model it is implicitly assumed that a commodity can be characterized by different quality attributes. Individuals may value these attributes to a varying extent and are therefore more or less inclined to buy the commodity. In this chapter the valuation of a natural resource with the hedonic pricing model is discussed.

3.1. Hedonic price models in the literature

In the literature there are several valuation studies of landscape amenities that applies the hedonic pricing model. If landscape amenities have monetary values this may be reflected in a higher demand for highly valued amenities and thus imply that these objects also have a higher property price. A study by Waltert and Schläpfer (2007) indicate that the visual attractiveness of a landscape may have the same attractive power as a low tax burden in a region.

An interesting conclusion to be drawn from different valuation studies is that preferences varies depending on what you study and where the area of investigation is located. A Swiss study by Schultz and Waltert (2009) reports some interesting differences in valuation between rural and urban areas. The study contains the attributes "open area" which measures the proportion of non-forestred land, "natural soil", which measures the proportion of special conservation value habitats in the vicinity as well as "historical amenities", which indicates whether there are buildings of historical value in the surrounding area. All these attributes affect housing prices in a positive direction in urban areas, while the same attributes have a negative impact on housing prices in more peripheral areas. They also found a higher valuation for proximity to water for objects located at higher altitudes. However, the proximity to water may be valued differently. Garrod and Willis (1999) finds that proximity to wetlands in the English country side affect property values in a negative direction, while Mahan et al. (2000) show that wetlands affect property values in metropolitan areas positively. Wetlands are not valued to the same extent as open water in this study. In general, proximity to forests and green spaces in urban areas are valued highly in hedonic price studies. Nilsson (2010) uses data from 7 565 property sales in the middle parts of Sweden for the years 1977-2007 in a hedonic pricing study. The location of pastures and semi natural grazing lands are relatively homogeneous and densely located within this area, and the proximity of the meadow and pastures within a radius of 500 m affects the property values in a positive direction. Bengochea-Morancho (2003) finds a positive value of green spaces in a survey of urban parks. Tyrväinen and Miettinen (2000) uses statistics from house sales in the Salo region in Finland to investigate the value of proximity to forests and recreational areas and finds that proximity to forests increase property prices.

The fact that the agricultural landscape is multifaceted implies that also the preferences of individuals for the landscape may be heterogeneous. Agriculture can be associated with strong positive attributes such as a beautiful landscape but also by more negative as noise or odor. For example, Andersson and Hoffmann (2008) found that intensive livestock husbandry is valued negatively. This is also supported by the results of Le Goffe (2000), who found that the cultivation of fodder crops are valued negatively. Results from Vanslembrouck et al. (2005) suggests, however, that there is a positive valuation of livestock grazing.

As mentioned earlier, GIS can be used to quantify variables describing the agricultural landscape. Bastian et al. (2002) applied GIS to create variables describing land use as well as sites for various types of agricultural landscapes in Wyoming, USA. Paterson and Boyle (2002) applied GIS to develop variables that describe the open landscape character within a certain distance in both urban and rural environment. The results suggest that the description of the surrounding landscape and assessed attractiveness is an important component in hedonic surveys as such in order to avoid problems with omitted variables and incorrectly specified models.

3.2. Rental price in a hedonic setting

There are examples in the literature on hedonic valuations of rural areas. A study by Le Goffe (2000) reports that the cultivation of food crops and livestock intensity affects rental price of farm cottages negatively, while pastures affect price positively. Mollard et al. (2007) compare the rental prices of cottages in two regions of southern France with similar geographic characteristics and proportions of pasture lands. Mollard report no significant correlation between the rental price and land use and also the size of variables differ significantly from those of LeGoffe. The authors explain the differences by the fundamentally different landscapes of the respective regions, in Normandy the grazing lands constitute about 9.5 percent of total cultivated land and in Ayron in southern France, the proportion of grazing lands exceeds 40 per cent. A study by Andersson and Hoffmann (2008) applies a hedonic model to analyze how the price of rental objects at ”Staying on a farm” holdings are affected by agricultural production orientations. The results indicate that price of rental objects is more dependent on marketing channels, competition than from the specific production orientation. This study also indicate that the price of rental objects are negatively related to the extent of agricultural diversification.

The assumption that the price of goods reflects a product's actual value and willingness to pay is based on the notion that the price is endogenous, i.e. that market price affects and are affected by overall supply at the market and hence the willingness to pay. An increase in price results in a decreasing consumer demand and in the longer run a lower provided quantity of the product at the market. Thus the willingness to pay reflects how consumers value the characteristics of a product. An exogenously given price implies though that the producers offer the same quantity of the product irrespective of the market price. On a housing market, an exogenous supply would imply that the supply remains constant regardless of price and instead price may vary depending on specific qualities such as living area, location, etc. However, to isolate price effects that simply reflect changes in quality is difficult in practice. The willingness to pay for a specific house is often related to various substitutes, for example, the house renting market or the market for condominiums. In order to correctly reflect the willingness to pay for quality attributes there can be no substitutes at the market. The assumption of an exogenous supply in the case of rental objects in the ”Staying on a farm” registry is questionable. Such rural accommodation can be considered as a sub in a larger market of alternative housing such as hotels, hostels and camping sites. There might be the case that rural tourists can choose alternative options of accommodations, which would imply a reduced supply of rental objects in the ”staying on a farm” registry. Hence, the price mechanisms of accommodations are not only affected by the valuation of the characteristics of “Staying on a farm” accommodations, but also by the changes in market supply. If the accommodations offered within the ”Staying on a Farm” registry can be associated as a sub market on a larger markets of rental objects, the rental price can be assumed to be fixed. If price increases for farm accommodations this will reduce consumer demand for associated farms and the price will return to its original level. A common method to avoid supply effects is to define the supply as a function of a fixed price in accordance with Nerlove (1995). Hence, an increase or decrease in demand is reflected by changes in supply at the given price level. By estimating the supplied quantity as a function of price and quality attributes an implicit assumption is made about an endogenous supply of accommodations.

3.3. Derivation of the hedonic price model

In the hedonic pricing model it is implicitly assumed that the dependent price variable is a function of a set of independent explanatory variables. The hedonic pricing model was originally developed by Rosen (1974), Freeman (1974 och 1979) Harrison and Rubinfeldt (1978) and Nelson (1978).

The hedonic model is usually derived in two stages; where the estimation of the marginal price as a function of the independent price variables is performed in the first stage. The estimated parameter values may therefore be interpreted as the marginal value of the environmental attributes. In the second step demand functions of the different attributes are estimated by using the consumed quantities of the different environmental attributes. In practice, the consumed quantities are often unknown to the analyst, which implies that only the first step of the hedonic pricing model is estimated:

$$\mathbf{X} = \mathbf{X}(\mathbf{D}, \mathbf{F}, \mathbf{V}, \mathbf{S}) \qquad (1)$$

X is here a vector containing the dependent price variables. The D vector contains descriptive variables regarding the object of interest, for instance number of rooms, specific facilities such as equipped kitchen, or closeness to different attractions such as trekking areas. F contains variables describing geographic features such as closeness to main roads or urban areas. The variables that can be related to the Axis 2 of the RDP are in vector V. These are for instance the different crops, wetland areas or areas of riparian strips.

From the price relation above the individual's utility function from renting a room at a "staying on a farm" registered holding can be assessed. The utility level depends on the price level as well as on the environmental attributes of the landscape

(from Palmquist, 1984 och Freeman, 1993):

$$U = U(P, \mathbf{D}, \mathbf{F}, \mathbf{V}, \mathbf{S}) \qquad (2)$$

The individual is assumed to maximize its own utility with respect to the income level, and the price of a particular choice as well as price levels of potential substitutes in X:

$$I = P + \mathbf{X} \qquad (3)$$

In this maximization problem, an individual is assumed place a specific value on each of the attributes in vector D, F and V. In order to have the marginal utility, the utility function is partially differentiated with respect to either variable in vector D, F or V. In this case an attribute q within one of the vectors:

$$\left(\frac{dU}{dq}\right) \Big/ \left(\frac{dU}{dP}\right) = \frac{d\mathbf{X}}{dq} \qquad (4)$$

Hereby an individual chooses an optimal consumption bundle with respect to preferences and income level. The derivation of the second stage of the hedonic pricing model in accordance with Freeman (1979) is not performed here. Instead the marginal willingness to pay from (4) is used as a measure of the relative demand.

There are however some methodological problems that should be considered in the application of hedonic pricing models. To specify a hedonic model that reflects market's preferences and consumers' marginal willingness to pay is a major challenge for two reasons. Firstly, consumers seldom have perfect information about a product all its qualities. Secondly, it may be inflicted with problems to include (or exclude) some variables in the estimation of the hedonic model. If an important variable is excluded from the analysis (explains the variation in price to a large extent) and this variable is correlated with any of the included variables we might have a misleading model with an omitted variable bias. The same applies to the variables included in the regression, these should not be overlapping, as this can cause problems with multi collinearity.

3.4. The functional form

The functional form of a hedonic pricing model is typically a non-linear as the relation between price and the independent variables may be complex (Rosen, 1974). Hedonic models are frequently quadratic, inverted, exponential log-linear, log-log applications or Box-Cox transformations. The choice of a particular functional form is typically based upon the specifics of the data (Maddison, 2001). In this setting, a number of different functional forms are tested. Initially an ordinary linear function is specified on the form:

$$P = \alpha + \boldsymbol{\eta} D_i + \boldsymbol{\beta} X_i + \varepsilon \qquad (1)$$

Where P is the price, Xi are the independent continuous variables and Di are independent discrete variables and ε depicts the error term. In order to investigate if the data exhibits a non-linear parametric for, a log-linear as well as a log-log parametric forms are estimated:

$$\log P = \alpha + \boldsymbol{\eta} D_i + \boldsymbol{\beta} X_i + \varepsilon \qquad \text{(log-linear)} \qquad (2)$$

and

$$\log P = \alpha + \boldsymbol{\eta} D_i + \boldsymbol{\beta} \log X_i + \varepsilon \qquad \text{(log-log)} \qquad (3)$$

The log-log model has been frequently applied in previous hedonic valuation studies of landscape amenities (see for example Paterson och Boyle (2002) or Vanslembrouck et al (2005)). By definition, the log-log model reveals the percentage change in the dependent variable, the price, from a change in one of the independent variables (see for example Greene, 2003).

An alternative approach to detect non-linearity is to apply a Box-Cox transformation of the parameters where the error terms exhibits a normal distribution. The value of λ is usually between -2 and 2 and determines the power of the transformation (Box and Cox, 1964):

$$h(y;\lambda) = \begin{Bmatrix} (y^{\lambda} - 1)/\lambda \\ \log(y) \end{Bmatrix} \text{ för } \begin{matrix} \lambda \neq 0 \\ \lambda = 0 \end{matrix}$$

As λ is close to zero, the approximation becomes close to log(y). The residuals of the transformed parameters P, Xi and λi are estimated by the Maximum Likelihood principle:

$$\frac{(P^{\lambda_i}-1)}{\lambda_i}-\left(\alpha-\mathbf{\eta}D_i-\mathbf{\beta}\frac{(X_i^{\lambda_i}-1)}{\lambda_i}\right) \qquad (4)$$

3.5. Spatial autocorrelation

When data exhibits a spatial distribution, testing procedures for spatial autocorrelation should be applied. If spatial autocorrelation is present, weighted regression models such as lagged spatial model (1) eller spatial error term model (2) are appropriate (Anselin, 1988):

$$p = \rho Wp + x\beta + \varepsilon \qquad (1)$$

$$p = x\beta + \varepsilon \;\; där \;\; \varepsilon = \lambda W\varepsilon + \zeta \qquad (2)$$

Where p is the dependent price vector of dimension n×1 and W is the spatial weight matrix (n×n), x is independent variables (n×k) and ε is the error terms (n×1). If spatial autocorrelation is present it is assumed that the price of the lagged spatial model is related to the independent variables of the neighboring observations. In the spatial error term model it is assumed that the error terms between the observations are correlated. Depending on the choice of model, the values of parameters ρ or λ are estimated. In order to detect whether autocorrelation is present, a Moran's test I can be applied:

$$I = \frac{N}{\sum_i\sum_j w_{ij}}\frac{\sum_i\sum_j w_{ij}(X_i - X)(X_j - X)}{\sum_i (X_i-\bar{X})^2} \qquad (3)$$

Here N is the number of observations; X is the variable for which spatial autocorrelation is tested and wij is the spatial weight matrix. Moran's test gives a general indication on whether spatial autocorrelation is present, however no information on how the observations are auto correlated. A negative value on Moran's I indicates a positive spatial autocorrelation, a value equal to one indicates a perfect autocorrelation and a value equal to zero indicates a random distribution of observations. The value of Moran's I can be converted into a Z test statistic, where values exceeding 1,96 indicates a spatial autocorrelation on the 5% significance level.

4. RESULTS

4.1. The data

In the survey, a total of 1 041 registered"Staying on a farm" firms were included, where 324 of were active in 2008 and hence included in the analysis. The variables available for the analysis are presented in Table 4.1 below.

The price variable is the price charged for one person in a double room per night. Each farm is also graded according to a classification system, where the grading is between 1 and 5.

Grade 1 of the variable "Classification" corresponds to a simple standard and 5 to a more luxurious accommodation. The size of the operation is measured by number of rooms and beds.

Table 4.1: Descriptive statistics

Variable	Mean	S.E.	Min	Max
Price	332	57,3	200	600
Classification	3,92	0,606	2	5
Rooms	3,73	2,77	1	30
Beds	7,39	6,31	1	68
Kitchen	0,891	0,313	0	1
TV	0,939	0,239	0	1
Assembly room	0,866	0,341	0	1
All year	0,903	0,297	0	1
Occupancy	0,057	0,052	0,012	0,270
Horse riding	0,105	0,308	0	1
Fishing	0,0567	0,232	0	1
MC	0,113	0,318	0	1
Conference	0,0688	0,254	0	1
Organic	0,154	0,362	0	1
Animal	0,802	0,400	0	1
Highway	0,477	0,501	0	1
Urban	0,231	0,424	0	1
Sn_pasture	48,67	283	0	4 219
Wetland	5 649	15 064	0	165 804
Riparian	2 394	5 274	0	37 976
Pasture_500	61 864	71 179	0	304 049
Grass_300	10 956	12 073	0	51 541
Cultivated_500	409 393	201 209	0	758 731

Some of the accommodations have also an own kitchen or has access to a kitchen. Most rooms are equipped with television, showers and toilets. Specific information about the agricultural production is given by the variables "Animal" which indicate whether there are animals at the holding and "Organic" if organic production is practiced at the farm . Some of the farms have an only seasonal activity which is indicated by the variable "All year". Specific themes of the accommodations exists for some of the farms, the activities offered are "Horse riding", "Mc", "Fishing" and "Conference". The attractiveness of the accommodation may vary depending on where the farm is situated. If a farm is located in a specific attractive area there is reason to believe that these farms are more popular and prices charged is higher. The variable "Occupancy" is indicating the relative attractiveness of a region. The environmental variables that are retrieved by overlay analysis in GIS all indicate different types of land use. The variables have been constructed using different buffer zones, which varies between 300 m for "Grass_300" and "Sn_pasture" for the semi natural pastures and grazing lands, 500 m for "Pasture_500" and "Cultivated_500" up to 5000 m for "Wetland" and "Riparian". In addition, if there is proximity to urban areas (within 2 km) and the major road of 20 km this is indicated with the dummy variables "Urban" and "Highway".

The magnitudes of the variables indicate that there is a relatively high heterogeneity within the data. Among the descriptive variables, the number of rooms and number of beds vary between 1 and 30 and 1 and 68, respectively. The average price for renting a double room is 332

SEK / night. Several variables are presented in values of 1 or 0 depending on whether this attribute is available or not. The occupancy rate is presented as a proportion of the total occupancy, which sum to 100 percent. A 15 percent share of the farms has organic production, which is somewhat higher than for the nation in total which is about 8 percent (Board of Agriculture, 2009). Proximity within the buffer zones to highways and urban areas in indicated by 1 and otherwise 0. An especially high variation is found in the variables "Wetland", "Sn_pasture" and "Riparian".

In order to detect correlation between the different variables, a correlation matrix is constructed. A strong correlation is present if any correlation coefficient exceeds 0.8. Overall, the correlation coefficients are relatively small. However, the correlation matrix indicated that there exists a high correlation between number of beds and rooms at the facility. This suggests that these two variables should not be combined into a regression.

A test for spatial autocorrelation is executed in GeoDa (Anselin, 2004). The weight matrices are based on the distance between each location of registered farms (W1) and the distance to the nearest neighboring farms (rook distance) (W2). For both type of weight matrices the null hypothesis of existence of spatial auto correlation can be rejected as the P value from Moran's test is 0.4 and 0.6 respectively. In Table 4.2 below, the summary of Moran's test as well as from Lagrange Multiplier and Robust LM tests is presented.

Table 4.2: Tests for spatial autocorrelation

	MI/DF		Value		P	
Test	W1	W2	W1	W2	W1	W2
Moran's I	-0.003	-0.007	0.845	-0.474	0.398	0.635
LM (lag)	1	1	0.468	3.681	0.494	0.0550
Robust LM (lag)	1	1	0.228	3.425	0.632	0.0642

4.2. Model estimation

As discussed in previous section, two alternative approaches can be applied to the valuation of environmental attributes in relation to a "staying on a farm" operation. Depending on whether the market mechanisms are assumed to be endogenous or exogenous, either the price or the supplied quantities can be used as dependent variables. However, when the supplied quantities at the farms are used instead of prices, most of the explanatory variables are not significant. Therefore it is not a realistic assumption that environmental qualities are reflected into the supplied quantities. Instead the estimation of the hedonic pricing model is made with the price as a dependent variable.

In estimation of the hedonic pricing model the linear and non linear functional forms from section 3.4 were tested. In most hedonic pricing models, a non linear relationship is used in order to investigate the relation between price and explanatory variables, as preferences are relatively complex and not possible to repackage into a linear functional form. The variables show varying degrees in significance and explanatory power. Only the variables indicating explanatory power were kept in the final estimations as presented below.

As a first step, a regression model with Box-Cox transformed parameters was estimated. Here constant transformation parameters were applied, as the estimation of full model with simulation did not converge. The values of the parameters λ0, λ1, λ2, λ3, λ4, λ5 och λ6 were chosen in order to have highest possible level of significance.

$$\frac{p^{\lambda_0}-1}{\lambda_0} = C + \alpha_0 \cdot Classification + \alpha_1 \cdot Urban + \alpha_2 \cdot Animal + \beta_i \left(\frac{X^{\lambda i}-1}{\lambda_i} \right)$$

The results from estimation of the Box-Cox model are presented in Table 4.3 below:

Table 4.3: Box-Cox estimation

Parameter	**Estimate**	**S.E.**
C	7.01388	0.131823
Classification	.195868	0.030593
Urban	-.095534	0.038980
Animal	.146574	0.040993
Riparian	0.114 e-8	0.746 e-9
Wetland	-0.774 e-7	0.981 e-7
Cultivated_500	-0.323 e-12	0.232 e-12
Sn_pasture	-0.111 e-6	0.692 e-7
Pasture_500	-0.311 e-6	0.272 e-6
Grass_300	-0.294 e-2	0.283 e-2
λ	0.1	
λ_1	1.9	
λ_2	-1.95	
λ_3	2	
λ_4	-2	
λ_5	1	
λ_6	0.001	
LogL	-1332.11	

A regression with Box-Cox transformed parameters may be, when many observations are equal to zero, complicated to estimate (see for example Magee, 1988). A possible methodology to overcome this potential problem is to replace all null observation to values close to zero; 0.001. In the regression with Box-Cox transformation of the parameter, the variable measuring the sizes of riparian strips is positively related to the price as well as the existence of animals at the farm and the classification standard. The values of the transformation parameters vary between -2 and 1.9. The values of λ are close to zero as well as close to unity, which indicate that the model has both a linear and logarithmic functional forms. However, the results from the Box-Cox estimation should be interpreted with caution as the transformed parameters are treated as fixed in this model setting.

The Box-Cox regression indicated that a non-linear relation best describes the relationship between the dependent and the explanatory variables. In order to test for this a model with linear, log linear as well as a log-log functional form is estimated. The log-log functional for has the highest number of significant parameters and relatively high explanatory power. As the log linear and the log-log functional forms are non-nested, it is not possible to compare the log-likelihood values of the respective models. In order to test for the best specification, a MWD (MacKinnon et al, 1983) test is performed. The result from the test indicates that the log-log model specification is the preferable model.

The result from the estimation of the log-log model is presented below. Among the independent variables we have a positive sign on the variable 'Riparian'. The variables 'Cultivated_500', 'Sn_pasture' and 'Grass_300' are all negatively related to the price.

Tabell 4.4: Results from the log-log model

Variable	**Estimate**	**S.E.**
C	5,793***	0,266
Classification	0,106***	0,019
Urban	-0,050***	0,025
Animal	0,102***	0,036
Occupancy	0,181	0,211
Riparian	0,342e-2***	0,168e-2
Wetland	-0,194e-2	0,149e-2
Cultivated_500	-0,030*	0,020
Sn_pasture	-0,452e-2**	0,238e-2
Pasture_500	-0,815e-2	0,889e-2
Grass_300	-0,408e-2***	0,192e-2
LogL	90,894	
R^2	0,286	

*10% level of significance ** 5 % level of significance *** 1 % level of significance

In order to test for heteroscedasticity a Lagrange Multiplier (LM) test was adopted. (Kennedy, 1998). No significant heteroscedasticity could be detected for the log-log specification.

5. SUMMARY AND CONCLUSIONS

In this report, a hedonic pricing model is applied to value the visual characters of the agricultural landscape using Geographical Information System, GIS. The agricultural landscape amenities are here assumed to be affected by the Rural Development Program and due to differences in valuation of their attractiveness these are valued too various extents. By making use of the accommodation prices of "Staying on a farm" holdings, it is implicitly assumed that the price mechanism reflects the assessed attractiveness of the landscape and natural resources at the farm, i.e. the price charged for a room per night is assumed to reflect the values of the natural resources surrounding the farm. Hereby, it is implicitly assumed that the price of rental is set through an endogenous mechanism, where the price affects and is affected by supply and demand at the market (Nerlove, 1995). Hence site-specific characteristics may be valued too various extent and consequently be reflected in the willingness to pay. The fact that rural tourism has become an increasingly important component in the growth of the rural economy supports the fact that there exists an own market for rural tourism. This notion is further supported by findings by Nilsson (1998). It is assessed that rural tourism combined with farming turns over about EUR 0.1 billion a year. “Staying on a farm” is today a most popular tourist activity, especially during the summer months. As all farmers in the Swedish registry hold an agricultural operation, the visitors may therefore experience various types of agricultural activities with livestock, cereal production or forestry.

The spatial variables used for the hedonic pricing model are quantified in GIS in order to capture the various landscape features of rural areas. The geographic locations of the holdings in the “Staying on a Farm” registry are combined with multiple map layers containing meadows, pastures or restorable land from the Swedish inventory of semi-natural pastures and mown meadows (TUVA), cultivated land from the agricultural block inventory from the Swedish Board of Agriculture, road layers from the Swedish Transport Agency and urban area layers from Statistics Sweden. By applying overlay and buffering methodologies in GIS, the agricultural landscape and land uses surrounding the object of interest can be limited to a specific radius. Hereby, the landscape amenities surrounding a farm are quantified irrespectively of ownership and hence describe the characteristics of the landscape the visitors of the farm may actually experience. The variables analyzed in the hedonic model are for example the size of cultivated land and pastures, permanent grasslands or the inventory of semi-natural pastures and mown meadows in a 500 m radius from the farm operation. Furthermore, the size of riparian strips and wetlands in the neighbourhood are located and also the relation to urban areas and major public roads. In order to estimate the hedonic pricing model with rental price as a function of the explanatory variables, both linear as well as nonlinear models are specified. The presence of spatial effects, namely, geographic location of objects and the auto correlation between various locations are also taken into account in model estimation by the use of spatial lag and spatial error models. As for most hedonic pricing model, the relationship is also here a typical non-linear one and no spatial auto correlation could be detected. A log-log model specification has relatively good explanatory power and indicated no problems with heteroscedasticity. The case of non-linearity is further supported by a Box-Cox transformation of parameters. The results of this study indicate that visitors to “Staying on a farm” tend value riparian strips and the presence of animals at the farms positively. Cultivated land and permanent grasslands are negatively valued.

The loss of valuable countryside assets can be associated with agricultural change as well as to policy schemes such as the RDP. Therefore it is of increasingly importance to perform valuation studies associated with landscape attributes. The results from this hedonic pricing survey indicate that there exist a relation between landscape amenities and the price of rental objects on “Staying on a farm”. A main conclusion is that visitors seems to be more willing to pay for measures that contribute to a more heterogeneous landscape setting and assess more monotonous landscapes negatively.

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