Environmental and Resource Economics **15:** 397–401, 2000.

Note

Hedonic Pricing of Agriculture and Forestry Externalities

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Accepted 25 March 1999

Abstract. In this study, the hedonic price method was used to identify and monetarize some of the external effects of agricultural and sylvicultural activities. We examined the renting price of rural self-catering cottages, or gîtes. Intensive livestock farming caused the renting-price of gîtes to decrease, whereas permanent grassland had the opposite effect.

Key words: agriculture, benefit, damage, environment, externality, forestry, hedonic pricing, tourism, valuation

JEL classification: Q21, Q26, Q29

Introduction

In the French agricultural sector, as in most European countries, the ever increasing use of factors of industrial origin and the specialization of farmers are responsible for a double blow to the environment. One can observe the simultaneous appearance of negative externalities and the cancellation of positive services provided by agriculture. The quest for profit in the forest sector leads to similar effects, although perhaps not to the same degree. The policies aiming to reduce agricultural pollution or to provide environmental goods by agriculture or forestry produce benefits which are mainly non-market. Estimating these non-market benefits would permit assess to the corresponding public policies using cost-benefit analysis. It would also give some valuable information to design the appropriate economic incentives or to implement the Beneficiaries Pay Principle wherever this is possible. Several methods can be used to measure non-market benefits; this paper deals with the application of the hedonic price method (HPM) to rural issues.

The theoretical and practical questions raised by the environmental application of the HPM have been presented in various surveys (see Freeman 1993), which are based on the work of Rosen (1974) dealing with the theoretical model of markets of differentiated goods. According to Rosen, measuring the relationship

between housing prices and the quality of the environment could be a first step in estimating the willingness to pay (WTP) for an improved environment. The relationship between housing prices and their attributes of livability, location, and environmental quality (the hedonic price function) makes it possible to obtain the implicit price of the environment. The empirical applications of the HPM involve the valuation of urban assets essentially, such as noise or air-quality. The rural applications are extremely limited: the results concern forests and natural areas (Garrod and Willis 1992, 1993) and swine nuisance (Palmquist et al. 1997).

In our paper, the hedonic approach is applied to the renting price of rural self-catering cottages, or gîtes. The objective of our research was to identify the agricultural or sylvicultural activities which affect tourism profitability and public welfare in a general way. This paper presents the methodology used, then some preliminary results and a final discussion.

Methodology

The study was limited to Britanny, located in western France, the first French region for intensive livestock farming. The rural gîtes, which often belong to farmers, are rented for holidays by local or foreign people. A sample of 579 gîtes, first stratified according to the 4 departments of Brittany, was then selected in such a way as to create a sufficient variability in the use of the soil, in particular in connection to the intensive or extensive nature of the agriculture, as well as to the degree of forest cover. We considered the weekly renting prices for the 1995 summer season, dealing of course with the prices listed and not with equilibrium prices. The prices of the gîtes are fixed at the beginning of the season, they are not negotiated later. However, the rate of occupancy is nearly 100 percent in the summer season. The owner takes into account the rate of occupancy and adjusts his price from one year to the next, in order to fill his gîte at the highest price. The idea was that the renting price of the gîte, which is set roughly the first year of its existence, has had the time to adjust, notably to the demand for environmental amenities. The gîtes are characterized by three main categories of attributes: intrinsic, geographic, and environmental. Table I gives statistics describing the attributes used in the hedonic model.

Defining environmental attributes raises difficult questions, often discussed in writings on the topic (Freeman 1993). Lacking ecological indicators to measure externalities, we adopted a global approach measuring the use of the soil by agriculture and by forest. Each gîte was described according to the proportion of the total surface area of its commune dedicated to forest, permanent grassland, cereal and fodder crops, these being the main uses of the soil in Brittany. We completed the data on plant production with statistics about the density of intensive livestock in the commune. With this approach, the agricultural and sylvicultural variables synthesize several environmental influences, which become impossible to isolate. Thus, the existence of fodder crops implies the use of species (corn) and/or farming

Table I. Descriptive statistics and OLS estimation of the hedonic price function[a] (linear model), using the Eicker-White procedure.

Attribute	Descriptive statistics		Estimation results	
	Average	Standard deviation	Coefficient	t value
Lodging capacity (number of persons)	4.8	1.4	197	18.0
Gîte rating (stars)	2.1	0.7	179	9.9
Adjacent gîte (1 = yes, 0 = no)	0.47		−117	−3.7
Shared courtyard (1 = yes, 0 = no)	0.27		−79	−2.2
Distance from the sea (km)	20.4	17.0	−8.4	−8.6
Distance from Paris (km)	501	54	1.4	4.6
Geographical location (1 = north, 0 = south)	0.46		−96	−3.7
Livestock density (ANU[b]/ha TSA[c])	0.55	0.44	−123	−3.9
Fodder crops (%TSA)	32.2	10.8	−4.9	−4.1
Permanent Grassland (%TSA)	9.5	5.2	5.1	2.2
Cereal crops (%TSA)	18.1	8.8	3.3	1.8
Forests (%TSA)	7.6	6.9	−3.5	−1.7

[a] Weekly price in French francs; n = 579; R^2 = 0.65; constant = 396.
[b] Animal Nitrogen Unit; pig per head = 0.1 ANU; poultry per head = 0.005 ANU.
[c] Total surface area.

practices which are potentially harmful to the environment, the systematic recourse to fertilizers and pesticides, the frequent destruction of hedgerows, and a high density of dairy cattle. On the contrary, permanent grassland characterizes more extensive systems which are more respectful of hedgerows, soil and water quality. At the same time, a high density of either pigs or poultry causes problems of noxious odors, degradation of the landscape by livestock buildings, and pollution of air and water by manure. This is the reason for which these intensive livestocks have been grouped and expressed on the basis of the nitrogen contained in their manure (Animal Nitrogen Unit = ANU).

The hedonic price function is specified empirically as follows:

$$H_i = H(I_i, L_i, Q_i)$$

where H_i is the price of weekly rent for gîte i, and where I_i, L_i, and Q_i designate the vectors of the intrinsic, location, and environmental attributes of gîte i. Lacking a simple analytical solution of the Rosen model, the theory gives few indications about the specification of the functional form of the hedonic equation, which, however, is known for affecting implicit prices. The different functional forms found in the literature were tested: linear, log-linear, log-log. OLS estimations were performed. Preliminary results showed that the White heteroscedasticity test was positive. We then decided to compute the standard

errors of the regression coefficients using the Eicker-White procedure (Davidson and MacKinnon 1993, pp. 552–556). The Eicker-White procedure generates an heteroscedasticity-consistent covariance estimate that is asymptotically valid when there is heteroscedasticity of unknown forms (White 1980).

Results and Discussion

The best results were obtained for the linear functional form with 65% variation explained by the model (Table I). Multicollinearity is a classical problem in hedonic studies. Here, the condition index of 61.5 indicates a medium collinearity according to Belsey et al. (1980), but it does not seem to harm the estimation considering the relatively high «t» values. Among the environmental attributes we maintained in the model, three are clearly significant. It appears that the price of gîtes is negatively influenced by intensive fodder and livestock farming, and positively related to permanent grassland, with robust signs and coefficients when one modifies the model. The result is approximately FF5 per point for the fodder crops or permanent grassland and FF120 per additional ANU per hectar for intensive livestock, which represents, in each case, a range of FF300 renting price between the extremes; the average weekly price of gites being FF1964. The implicit price of the proportion of forests, even if not significant, have a fairly robust negative sign.

Knowing implicit prices allows us to envision a cost-benefit analysis of the policies aiming to reduce agricultural pollution or to provide environmental goods by agriculture. The benefits to the tourism sector and the non-market benefits incurred by local residents (gathered from the differences in housing prices) would then be compared to the costs of the considered policies (manure treatment, reduction in intensive livestock farming, change in agricultural practices, conversion of arable land into permanent grassland). We should also measure the market benefits involving water treatment, fish farming and similar value categories.

We also attempted to compare the level of implicit prices to the rate of the economic incentives which have been, or will soon be, brought into play in France. We assume that the implicit price of an attribute represents the corresponding marginal damage or benefit, which is only true if the market is in equilibrium and if gîte consumers maximize their utility (see Methodology). Two cases were considered. First, the marginal benefit of the increase of permanent grassland was compared to the subsidy allotted for converting arable land into permanent grassland (agri-environmental contract for water protection). Second, the marginal damage caused by the increase in livestock density was compared to the corresponding nitrogen pollution tax. In each case, the benefit per hectar or damage per additional ANU per hectar is obtained by aggregating the implicit annual price over all of the resident Breton households, and dividing it by the appropriate surface area or livestock. When we compare homogeneous data, the benefit (damage) is clearly superior to the subsidy (tax) considered, particularly in the case of nitrogen pollution caused by livestock farming.

Nevertheless, these two exercises suffer from the methodological limitations of our study. These limits stem from the specificity of gîtes (lack of environmental attribute information to gîtes consumers, institutional nature of prices, tourist-resident transfer), the difficulty of indexing external factors (global and indirect agricultural variables) and the impossibility of estimating a demand function (lack of data and linear functional form). Collecting information about housing consumers would permit interpretation of hedonic results and to verify if the application of the HPM is well-founded. Furthermore, it would be interesting to use the contingent valuation method in order to compare its results with hedonic WTP.

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