Hedonic estimates of agricultural landscape values in suburban areas

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Abstract— **This paper analyses the relationship between housing prices and suburban agriculture zones endowments using the hedonic price method. We use spatially referenced housing and land-use date to capture the effect of rural amenities around the house location in the area of Angers (France). Results indicate that put higher value on diversified landscapes rather than on unified ones. The proximity to vegetables, grasslands and vineyards do not have a significant impact on house prices while the proximity to forests has a positive impact. This impact differs following the shape of the forest.**

Keywords— **rural amenities, geographic information systems, hedonic price, landscape values.**

I. INTRODUCTION

In recent years, the rapid expansion of cities, termed "urban sprawl", has been considerably reduces the land for agricultural use. But agriculture land provides space for current and future development, recreation, access to public lands, wildlife habitat, and open space. In the absence of a market price for rural amenities, the benefits are usually underestimated by planning policy market, with the consequence that agriculture lands gradually encroached upon by urban sprawl. Such trends require the determination of the social value of rural amenities. Several methods such as the contingent valuation, travel cost models and hedonic price have been used in recent years to evaluate rural amenities.

The hedonic price method is used to estimate the value of environmental (dis)amenities that affect prices of marketed goods. Most applications use residential housing prices to estimate the value of environmental amenities. The development of geographic information system (GIS) has gradually made hedonic pricing model a powerful tool, but at present, it is still underutilized in urban and environmental economics [1]. One of the most advantages of a GIS is to position properties on a local map in terms of their geographic coordinates [2]. Spatial data within GIS have made possible the development of exact explanatory variables, such as accessibility to landscape amenities.

In this paper we analyse the relationship between housing price and suburban agriculture zones endowments using the hedonic price method and GIS. Our study has been conducted on the Angers urban area in western France. We attempted to evaluate the amenity of agricultural landscape in suburban zone. At the same time, implicit prices for other environmental characteristics related to housing, such as the proximity to city centre and the Loire River.

II. CASE STUDY AND DATA

This study has been conducted on the Angers urban area, in western France, near Loire River. It concerns 60 municipalities on about 90 km² for 300.000 inhabitants, crossed by the Loire River and one of its tributary, the Maine River. Angers urban development is then, as many other cities, constrained by rivers and natural areas on one side, and by very different types of agriculture (mainly orchards, vineyard, grassland for cattle, little parcels for seed production, and large ones for cereals).

A. Land use data

Land use data have been collected through the urbanism agency of Angers (AURA[1]). To enforce the Law on Solidarity and Urban Renewal (SRU[2]), the AURA has made a complete census on land occupation based on aerial and satellite photo-interpretation for the year 2005.

[1] Agence d'Urbanisme de la Région Angevine (http://www.aurangevine.org).
[2] Loi n° 2000-1028 du 13 décembre 2000 relative à la solidarité et au renouvellement urbains

This census describes 34 types of land occupation at a 0.5 meter (1.64 feet) resolution. The items cover a detailed description of housing types (dense or isolated), public infrastructures (schools, main roads, health institutes, urban parks, sewage treatment plants, etc.), large private (mines, industrial plants, etc.) and agricultural activities (vineyards, grasslands, orchards, forests, etc.). These data have been introduced within a Geographical Information System (Figure 1) using ArcGIS.

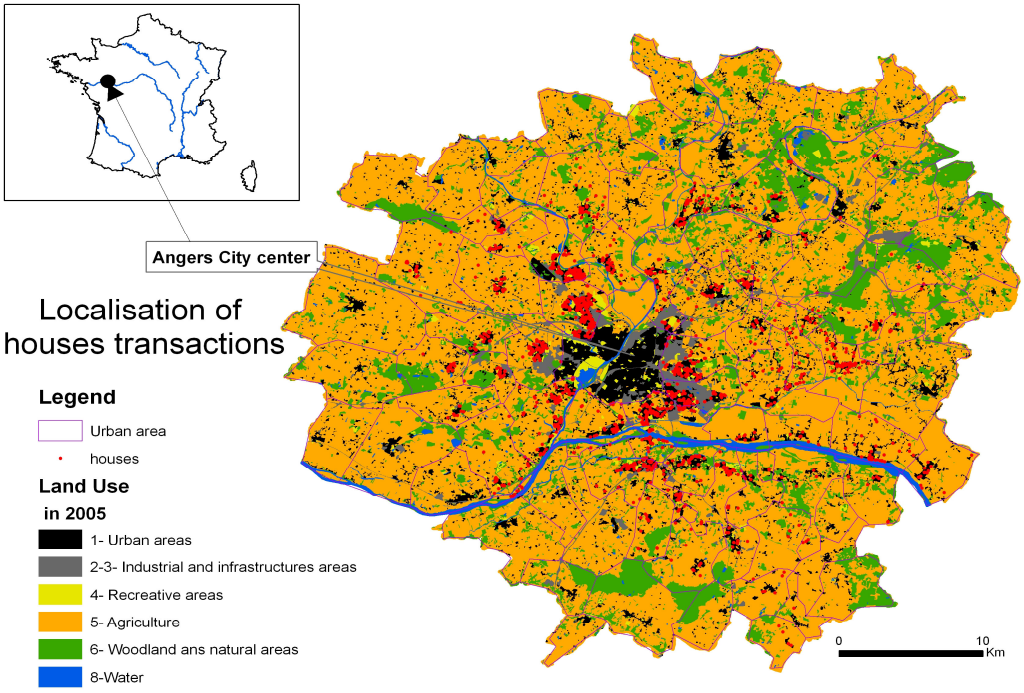

Fig.1. Localisation of houses transactions and land-use

B. Landscape indicators

The aim is to gather information about the landscape pattern of Angers' area from a land use map with a Geographical Information System software. The searched data will quantify and characterize the landscape. Landscape metrics have been calculated with the spatial analysis program FRAGSTATS [3] on three metrics level:

- Patch (one continuous polygon of one land use class)
- Class (all the different polygons of one land use class)
- Landscape (within a 100, 500 or 1000 meters buffer)

Different indicators described in Table 1 at the landscape scale have been calculated to characterize:

- landscape diversity (SHDI, PRD, AREA_MN, LPI, NP, PD);
- landscape texture (CONTAG, AI, IJI, DIVISION);

C. Data on houses transactions

Data on individual houses prices and characteristics are collected by the French Notarial Council[3]. Data are implemented by the notaries on a voluntary basis. The data used in this study concern an extract of the notarial database for the Angers urban area from January 2004 to October 2006. The dataset comprise house prices (in current €) and characteristics such as the floor and lot surface areas which are assumed to affect positively house prices. Data only concerns

[3] Conseil Supérieur du Notariat ; PERVAL database (http://www.perval.fr).

existing buildings transactions. Each real estate transaction has been spatially localized using cadastral parcels barycentre and then located on the land use data (Figure 1). We then calculated, with GIS, the Euclidian distance from each house in the sample to the nearest municipality centre and to Angers CBD[4]. We expect these variables to affect negatively house prices. We also collected data on the mean fiscal income in each municipality. This variable is a proxy for the level of equipment in each municipality and the nature of the social interactions. The mean fiscal income is hypothesized to have a positive impact on house prices.

III. RESULTS AND DISCUSSION

Hedonic price have been estimated using OLS over the whole sample of 1228 house transactions. We believe that market segmentation may not be an issue in our case since all the data come from the same (and hence assumed unique) employment area as defined by the French bureau of statistics (INSEE). The regression results presented in table are corrected for heteroskedasticity (White's correction). The absence of colinearity has been checked on the basis of the variance inflation factors of the regressions. None is greater than 20 indicating that the results are exempt of colinearity.

The several general landscape indicators were tested one by one. We have chosen to retain only one due to colinearity problems when several are put in the same equation. The aggregation index has been retained in the final specification because it works best at explaining the variance of our data. It has been selected in a one-by-one comparison of every indicator on the basis of the log-likelihood of the regression and on the absolute value of the Student t statistics. The sign of the significant indicators in every one-by-one regression are shown in table 3. Indicators in favour of a unified landscape (AI, LPI and AREA_MN) have a negative significant impact on house prices while indicators of a diversified landscape (SHDI, DIVISION, NP, and PD) have a positive significant impact. All the one-by-one regressions suggest that a diversified landscape has a greater value than a unified one.

Table 1. Signs of the general landscape indicators (one-by-one regressions).

Indicator	Name	Lin.	Semi -log	log-log
SHDI	Shannon's Diversity Index	+	+	+
PRD	Patch Richness Density			+
CONTAG	Contagion index			
AI	Aggregation index	–	–	–
IJI	Interspersion and Juxtaposition Index			
DIVISION	Division index	+	+	+
LPI	Largest Patch Index	–	–	–
AREA_MN	Area mean		–	–
NP	Number of Patches		+	+
PD	Patch Density		+	

The hedonic price function estimates for the several functional forms are shown in table 1. Most of the parameters are significant and of the expected sign. New houses get a premium of approximately 5 500 €. On the opposite, occupied house are sold at an inferior price than unoccupied ones. Floor size has a positive influence on lot price. A squared-meter is valued at 1 300 € /m². Distance to CBD also has a negative impact on houses prices. The impact of distance on house price can be approximated at 500 € / km. The monthly trend has a negative on house which is unexpected over the period. We have no explanation for this strangeness. The average income of the municipality which is a proxy for the level of equipment of the municipality has a positive but not significant impact on house prices.

Agricultural landscape is approached by the distance to the different agro-forestry cultures, moderated by their shape (division index). Estimates for the different agricultural items are shown in table 2. Vineyards, grasslands, vegetables and water areas have no significant impact. Forests have a significant impact. As expected, forests are positively valued and their value, as capitalized in houses prices, decreases with distance. Additionally, the shape of forests is also important. The cross product of distance and shape has

[4] Central Business District assumed to be the Place du Ralliement.

been estimated in the regressions. The marginal effect of the proximity to forest is shown in figure 2.

Table 2. Hedonic price functions estimates.

Variable	Linear	Semi-log	Double-log
Constant	228720	13.761 ***	13.991600 ***
Occupied	-12731	-0.2181240 ***	-0.217651 ***
New	5514	0.0755779 **	0.073303 **
Floor size	1370 ***	0.0061498 ***	0.006150 ***
Lot size	0.169	-0.0000035	-0.000004‡
Trend	-1258 ***	-0.0057583 ***	-0.005772 ***
Distance CBD	-0.546	-0.0000041 *	-0.037535 *
Average Income	0.245	-0.0000001	0.000001
Aggregation	-1838	-0.0237068 *	-0.022508 *
Forest (Dist x shape)	-5.371 *	-0.0000247 ‡	-0.004005 **
Vineyards (Dist x shape)	0.099	0.0000026	0.003269
Grasslands (Dist x shape)	9.305	0.0000893	0.007792
Water area (Dist x shape)	0.320	0.0000044 ‡	0.000003 ‡
Vegetables (Dist x shape)	-1.821	-0.0000087	-0.012007
Adjusted R-squared	0.514	0.441	0.444
Log-L(0)	-15825	-793.9	-793.9
Log-L($\hat{\beta}$)	-15375	-429.9	-426.7
Observations	1228	1228	1228

****, **, * and ‡ indicate significance at the 1%, 5%, 10% and 20% level respectively.*

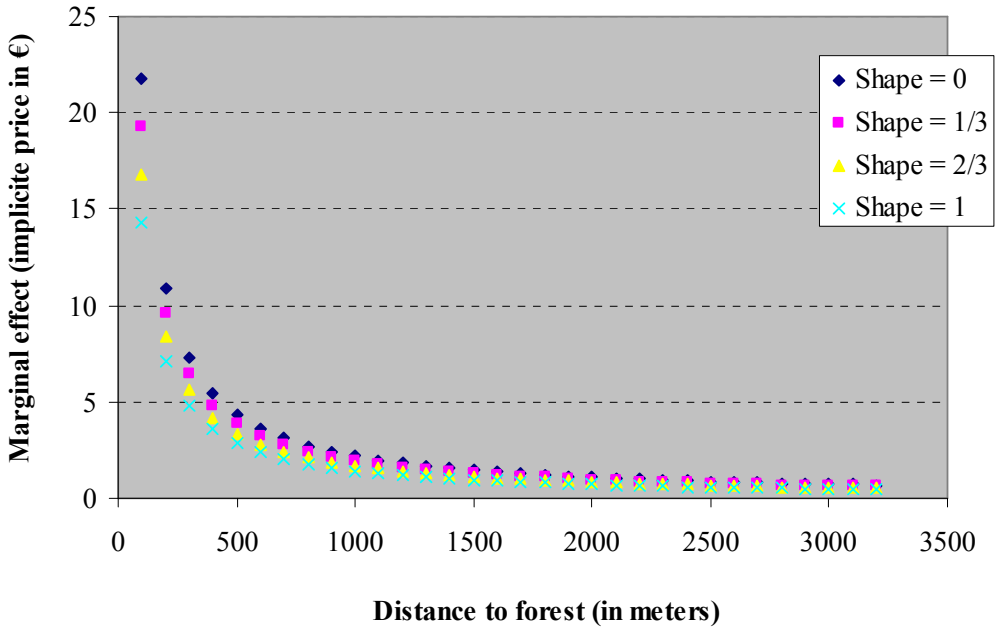

Fig.2. Marginal effects of distance to forests following the shape of forest (log-log functional form).

IV. CONCLUSION

This paper analyses the relationship between housing prices and suburban agriculture zones endowments using the hedonic price method. We use spatially referenced housing and land-use date to capture the effect of rural amenities around the house location in the area of Angers (France). Results indicate that put higher value on diversified landscapes rather than on unified ones. The proximity to vegetables, grasslands and vineyards do not have a significant impact on house prices while the proximity to forests has a positive impact. This impact differs following the shape of the forest.

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