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Laetitia Tuffery *

Abstract

Due to differences in terms of income, age, family status and household residential area, household preferences for housing are heterogeneous. Using average preferences is not representative of the territory specifities. The aim of this study is to analyze, through the estimation of the bid functions, how the socio-economic profile of households affects their preferences in terms of recreation in forest environment. The results tend to clarify the question of "nature" in urban and periurban areas and reveal heterogeneous preferences for recreational services of forests. When defined as greenery and amenity area in general, global forest environment value is higher for the upper classes and people over 45 years. When expressed by its protected areas for biodiversity, global forest environment negatively affects the demand of the least affluent classes but it is positively valued by some "managers and intellectual professions". Finally, considered as hiking and biking paths areas, forest environment is especially valued by the less affluent and younger households.

Keywords : *bid function; heterogenous preferences; recreational services; global forest environment*

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1 Introduction

Although they appear relatively homogeneous on average, household preferences for housing are scattered. For instance, French households prefer having access to housing property rather than renting, and prefer individual dwelling than collective. There is heterogeneity related to income, age, family situation of households as well as the housing location. A large number of studies interviewing French people highlight this diversity of preferences (Bigot et al. (2008), Blaudin-de The (2012), Bonnet (2012), INSEE : National Housing Survey(2006)). The study of Bonnet (2012) concludes that households remote from urban centers have important preferences for houses. Regarding age, young people mostly value the surface of their dwelling as well as the proximity to the urban amenities, such as schools. Conversely, older people have a preference for the proximity to the shops. These studies also highlight the importance of better understanding household demand for urban planning strategies and local public policies. Considering average demand does not allow the integration of territorial specificities and differences in terms of preferences, due to the socio-economic profile of households (eg a specificity of Paris in terms of collective housing preferences differ from other cities in the national survey).

In this work, we analyze how the socio-economic profile of households affects their preferences for the global forest environment in terms of recreational services through the study of the location choice.

The estimation of the hedonic function is widely used to assess the impact of different externalities on housing price. This method is used in many fields of study such as tax competition, impact of public infrastructures (school, hospital, etc.) and environmental amenities. It uses a two-step estimation. The first step is to analyze the hedonic function and the second step aims at revealing the willingness to pay (WTP) of households from the results of the hedonic function. However, while the hedonic function is relevant for the implicit price analysis, it appears more complex and less direct for estimating household preferences in terms of their socio-economic profile (due to the two steps).

Therefore, the auction method is used to estimate the WTP of the buyers of dwellings. The benefits of this approach are multiple, compared to the two-step approach presented by Rosen (1974) (Rouwendal (1992), Yinger (2015)). Instead of estimating the hedonic function at first, and then a set of simultaneous equations, we estimate a single equation. Although its estimation is more complex, it remains conceptually simple for the study of an amenity that could have a positive value for some households but a negative value for others (while the literature depicts the method of Rosen as relatively complex) (Yinger, 2015).

Since the nineteenth century, forests have become a popular environment for outings, sports or leisure activities for urban populations. Fifty five percent of French households went into forests at least once in 2010 (Dobré, 2005). Forests are the main support of environmental amenities such as recreational, ecological services and landscape. Specifically, recreational services are one of the most important non-market services provided by forests (Hanley et al., 2002). They are defined as non-material benefits that humans receive from the relationship with the natural ecosystems. Some examples of recreational services include the quality of landscape and aesthetics, recreational services, nature sports and tourism, but also the support for research and development of educational knowledge (Watson et al., 2005).

A relatively recent literature, based on the methods of the stated preferences (contingent valuation or choice experiment), concludes that household preferences for recreational areas are significantly heterogeneous. They differ on the characteristics of the sites and the users profiles (Brey et al. (2007), Christie et al. (2007)). Christie et al. (2007) define four sub-groups of users (cyclists, horse riders, nature watchers and general forest visitors) to measure the heterogeneity of preferences for different facilities and forestry policies. Their results show that regular users and forest areas specialists have a more important WTP for improving forest environment, rather than the general visitors. Moreover, differences are observed within each group of users, for example between mountain bikers and family cyclists. The heterogeneity of preferences for the recreational services of forests can also be explained by the socio-economic profile of individuals: income, age, gender and education level (Baerenklau, 2010). In the field using revealed preferences methods, only a few studies focus on estimating household preferences for the proximity to the amenities (or more specifically environmental amenities), by using the hedonic pricing method in two stages (Parsons (1986), Palmquist (1984), Bilbao-Terrol (2001), Baudry et al. (2009), Garcia & Raya (2010)).

Regarding the auction method, the literature is limited. Only few studies considered the bid functions of households for the proximity to urban and periurban amenities. Generally, they consider preferences for different amenities, such as transport network, public infrastructures and services, etc. ((Kazmierczack-Cousin, 1999), (Jayet & Kazmierczack-Cousin, 2001)). Some studies have a more theoretical objectives than empirical approach (Yinger, 2015). Flachaire et al. (2007) analyze the impact of the proximity to the urban park in the city center of Brest in France on households WTP. Concerning the environmental amenities assessment, the most famous study comes from Chattopadhyay (1998). He estimates the impact of air quality on households' WTP, by doing a methodo-logical work that compares the hedonic price method and the auction method. In the case of auction functions, he concludes that demand for the improvement of environmental quality is positively correlated to the households income as well as child number. He concludes that the results of both methods are in line with expected results. Therefore, both methods can be used for the estimation of WTP, but the hedonic price method remains more complex. To our knowledge, there is no study on the estimation of household preferences for forests areas and their recreational services using the auction method.

This study is based on original variables for forest recreational services. The literature generally considers the direct accessibility/proximity of housing to the nearest environmental amenities. However, in urban and periurban areas, households may have a preference for the diversity of forest areas in their neighborhood, according to their local recreational services. The originality of our study comes from the global forest assessment approach (distance between the housing and the whole forests areas included in the Seine-et-Marne *département*) and the auction functions estimates.

In the next section we present the econometric model related to the auction method. Then, we introduce the data set used in this work. Finally, the results of the auction method are described and discussed in the fourth part, before we conclude.

2 Econometric model and estimation: The auction method

The theoretical model used in this work is based on the urban structuring models of the New Urban Economics, inspired by the work of Alonso (1964) and Muth (1969). It deals with the functioning of land and real estate markets and the household preferences for housing.

Alonso (1964) defined the housing by its surface and its distance to the city center. Rosen (1974) suggest a matching model between dwellings/individuals, defined as heterogenous, by adding the intrinsic characteristics of dwellings. These models were then developed by Ellickson (1981) to understand the structure of the real estate market and the price equilibria, by maximizing the auction functions. Ellickson (1981) and Lerman & Kern (1983) propose an alternative method to the hedonic model, in the case of the analysis of housing transactions. The housing market is characterized by the land-use competition and the relationship between the land rent and the land-use. Giving this information about the competition, the buyer for one specific dwelling is the one with the highest bid. Thus, the whole housing transactions on the same market constitute the set of auction functions.

The auction function represents the WTP of buyers in the housing market. It allows to estimate the impact of a marginal change in one or more characteristics on the agents well-being (and thus on the housing price). The WTP is not homogeneous. Thus, we introduce different auction functions reflecting the socio-economic characteristics of different sub-groups of buyers. Estimating the auction function therefore requires the crea-tion of K categories of buyers. Each function must represent homogeneous sub-groups of agents, in terms of preferences and WTP for a home $i = 1, ..., I$, with a set of characteristics X.

Thus, at equilibrium, the observed price is the upper envelope of the auction function, or the highest bid:

$$p_i = max_k E_i^k$$

with E_i^k, the auction of the buyer included in the category $k = 1, ..., K$ for a dwelling $i = 1, ..., I$.

The observed endogenous variables are the profile of the home buyer and the transaction price. The latent variable is the WTP of each agent. These variables allow defining K categories of purchasers characterized by homogeneous resources (see Table 1).

We use a generalized Tobit model. In this model, the probability of an observed transaction by a purchaser of a particular sub-group at a given price is the probability that the WTP of this purchaser is equal to the observed price of the dwelling and that the auctions of the potential buyers belonging to other categories are lower.

Theory provides limited insight regarding the form of the auction functions to be used. A log-linear functional form is chosen, as recommended by the literature (Kazmierczack-Cousin (1999), Bayer et al. (2004), Flachaire et al. (2007)). The specification of the model is the following:

$$lnE_i^k = \beta_k x_i + \sigma_k \epsilon_i^k \qquad (1)$$

where x_i is a row vector of specifications for the housing i, β_k is the vector of parameters associated with each attribute. These parameters measure the impact of the set of attributes on the auction of the household k. σ_k, is a parameter which defines the standard deviation of the error term, ϵ_i^k the independent and identically distributed error terms for the category of buyers k. The probability distribution has a cumulative function $F(\epsilon)$ and a density function $f(\epsilon)$.

As explained previously, we do not observe the auctions for each household. The latent variables are E_i^k. The observed variables are the category of each household, the housing transaction price and the characteristics of the dwelling. According to the equation 1:

$$\gamma_i = argmax_k E_i^k$$

$$\text{and } lnp_i = max_k E_i^k = E_i^{\gamma_i}$$

We obtain :

$$p_i = \beta_{\gamma_i} x_i + \sigma_{\gamma_i} \epsilon_i^{\gamma_i}$$

$$\text{and } p_i > \beta_k x_i + \sigma_k \epsilon_i^k$$

And :

$$\epsilon_i^{\gamma_i} = \frac{p_i - \beta_{\gamma_i} x_i}{\sigma_{\gamma_i}}$$

$$\text{and } \epsilon_i^k = \frac{p_i - \beta_k x_i}{\sigma_k}$$

The maximum likelihood is given by:

$$lnL = \sum_{i=1}^{I} \sum_{k=1}^{K} U_{\gamma_i}(k)\, lnf(\frac{p_i - \beta_k x_i}{\sigma_k}) + (1 - U_{\gamma_i}(k))\, lnF(\frac{p_i - \beta_k x_i}{\sigma_k})$$

with $U_{\gamma_i}(k) = 1$ when $k = \gamma_i$, 0 otherwise.

3 Databases and Variables

This method requires a large number of databases and variables. In this part, we describe all the variables used in this study for the auction function estimation.

3.1 Housing specifications database

Housing intrinsic characteristics are extracted from the BIEN database (Notarial database for the Paris region housing transactions) of the Chamber of Notaries of Paris. It results from the collect of informations on the real estate transactions since 1998 in the Paris region, based on the willingness of the notaries. This database includes the price and specifications of sold properties (surface area, number of rooms, number of bathrooms, garages, etc.) at the smallest geographic area available for the French national statistics (IRIS - 2000 persons per IRIS).

More specifically, this study concerns the Seine-et-Marne *département*, for the transactions between 2001 and 2008 (apartments and houses). Using the auction method, the price/m^2, the localization of dwellings at IRIS level and the profile of the buyers are needed. Our sample makes use of the 39 354 transactions with complete information available.

3.2 Characteristics of the natural and forest environment in housing areas

In order to make the best profile for the housing market in terms of natural neighborhood, all forest and woodland areas and their recreational characteristics of the Seine-et-Marne *département* are considered. The proximity of the forest areas and their services are used to assess the social demand for recreational activities.

Two databases are used to locate and map the forests at the *département* level. The

Paris region land-use atlas (MOS and ECOMOS databases, 2008) is an exhaustive atlas of land-use for monitoring and analyzing the Paris region (Paris Region Institute for Urban Planning and Development, IAU-IDF database, 2000). We use the "woods and forests" ECOMOS category in which all the forests of the *département* are localized. The public forests are identified by using the definitions from the National Forestry Office (ONF database, 2012). As a result, we end up with 406 forests areas, constituted by 360 private and 46 public forests.

The attractiveness of forests depends on their urban or rural environment, but also on their own ecosystem services quality: planning, recreation, accessibility, etc. Forests are categorized with respect to the presence (or the lack) of recreational services. Using the "Protection index" (Simon, 2015) and the "pools of biodiversity", biodiversity richness is integrated in the econometric estimation. The "protection index" is based on a set of French biodiversity protection layers; it ranges from 0 to 8: Natura 2000, Nature Reserve, Biological Reserve, Biosphere Reserve, Regional Nature Reserve, Biotope Protection or Natural Zone of Interest for Ecology, Flora and Fauna. Our hypothesis is that, the higher the number of labels, the richer the biodiversity. "Biodiversity pools" is a variable extracted from the IAU-IDF database and includes different natural areas, such as large forests, wetlands, natural or semi-natural areas and agricultural areas. Geographic data is used for hiking and biking paths as well as for leisure areas, extracted from the Seine-et-Marne plan for hikes and bikes (PDIPR database, 2009).

3.3 District and neighborhood indicators

The National Institute of Statistics and Economic Studies (INSEE) provides a large number of databases to define the environment/neighborhood of the dwelling. These databases are available from IRIS to city level. We detail all variables for the 514 towns and the 762 IRIS of the *département* of Seine-et-Marne.

Localized household taxable income (INSEE, 2000-2007) is a frequently used database for income distribution analyses (frequency, quartile, decile, mean, median, etc.), and provides structural indicators of these revenues (share of wages, pensions, retirement, etc.). We use this information to define the socio-economic profile of households at the city level.

The database on facilities (INSEE, 2010) provides information on shops, public services and facilities at the IRIS scale. To study the impact of urban development on housing price, data for leisure, culture, education, income and health facilities are derived from this database.

3.4 Accessibility variables

Most of urban and environmental economic assessment studies integrate accessibility variables, measured as the crow flies (Euclidean distance to amenities). This computation is limited for the location choice analysis in urban and metropolitan areas, as it does not represent effective distance and traveling time. Therefore, we use a geographic information system (GIS) to define the accessibility variables using the real road network. We compute the average traveling time over the year between the center of the IRIS and the amenities.

3.5 The variables of the model

3.5.1 The dependent variable

To measure the impact of the forest environment on housing prices, we use the price/m^2 of the transaction in constant euros.

3.5.2 The interest variables

Based on a detailed analysis of the proximity to recreational services in periurban forests, we define a set of variables relating to the recreational services of the forests. Four variables of interest are included in the model:

- A surface in km^2 of the global forest environment;

- A proxy variable for the biodiversity richness, combining an index of protected areas and the "pools of biodiversity";
- A dummy variable for biking and hiking paths, which takes 1 if there are present in the forest area, 0 otherwise;
- A dummy variable for leisure area, which takes 1 if one is present in the forest area, 0 otherwise;

These variables are integrated only if there are located into forest areas.

To measure the accessibility to the forest environment, all forests recreational services are weighted by the traveling time between housing and each forest area:

$$N_i = \exp(-T) * n_i, i = 1, ..., n \tag{2}$$

where T is the traveling time between each dwelling and each forest area and, $n_i, i = 1, ., n$ is the set of recreational services : surface, biodiversity richness, leisure areas, hiking and biking paths.

Figure 1 shows the distribution of the four variables of interest on the *département*. It is not homogeneous for each of the studied variables and across variables. Considering the surface variable, there is a high concentration of the forest environment in the center and the south of the *département*. Regarding the index of the biodiversity protected areas, forest areas with high biodiversity richness, are not concentrated in one area. There are located according to a bipolarity north-south. As for hiking and biking paths, they are concentrated in the northern part of the *département*.

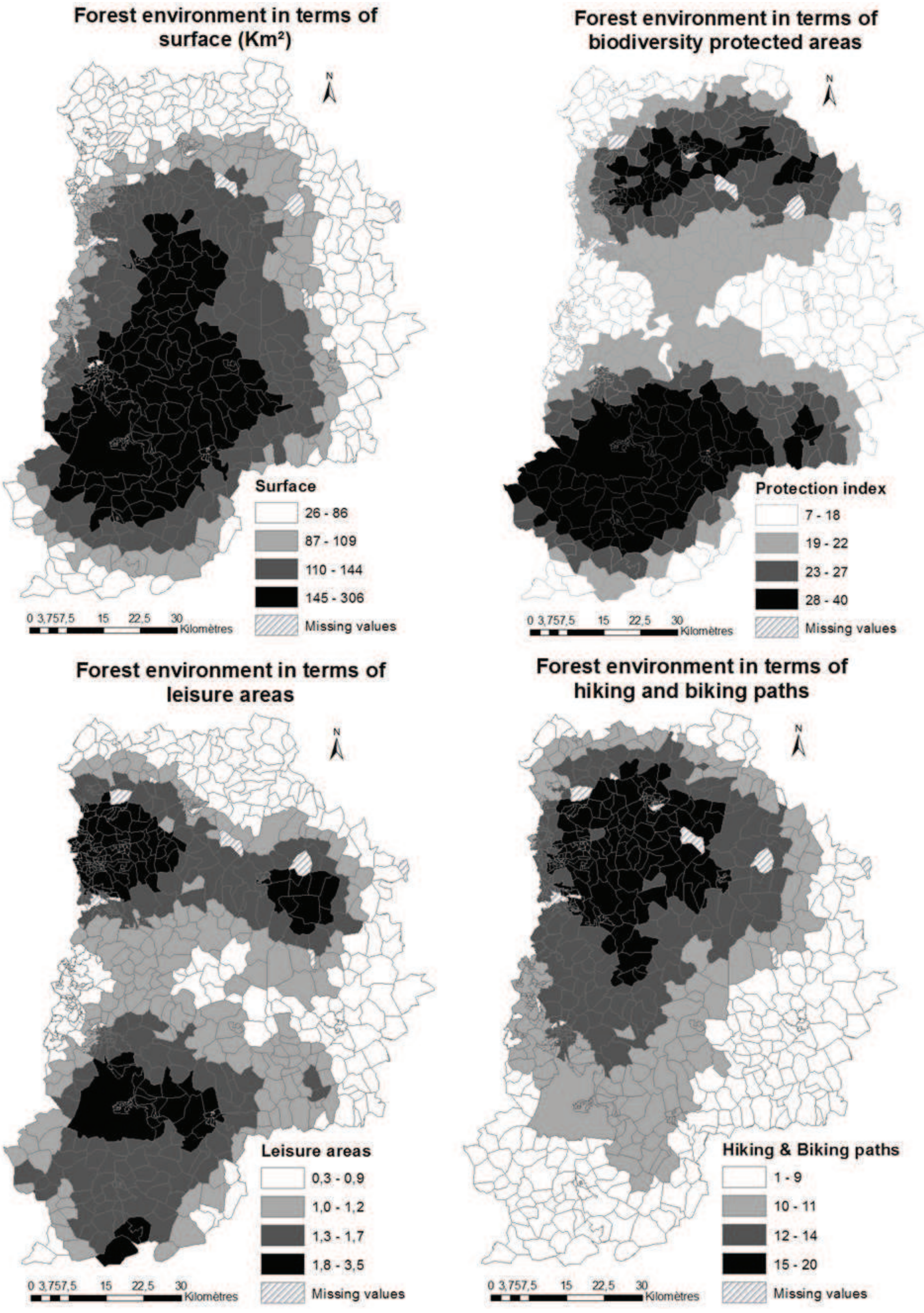

Figure 1: Global forest environment with recreational services
Sources : MOS 2008, IAURIF et ONF.
Cartography : Tuffery, 2015

3.5.3 The control variables

The variables extracted from the BIEN database are: the surface area of the transaction (m^2), the age of the housing (1 if housing has been built more than 5 years ago, 0 otherwise), type of housing (1 if it is a house, 0 otherwise), the number of garages and the number of bathrooms.

Moreover, from the INSEE databases, accessibility variables are used to measure the impact of the neighborhood and the urban amenities: median income at the city level (in constant euros the year preceding the transaction), the number of supermarkets, bakeries and cinemas at the IRIS level, the traveling time to the train station, high school, hospital, mall and park.

4 Results of the auction function estimation

Theoretically, the method to elaborate the categories of buyers affects the results and the analysis. In this part, we start by explaining our segmentation, before describing the results of the auction method.

4.1 The construction of buyers categories

In order to create buyers sub-groups, we use the two variables of the BIEN database related to the profile of the buyers: socio-professional category (SPC) and the age of the reference person of the household. These variables are proxies of the income level, employment and family status. One limitation concerns the fact that the reference person is not always representative of the family profile. However, we can assume that the profile of the reference person is usually considered as representative of his family.

Several methods exist to define these categories. The first is based on a statistical analysis of the composition and structure of the sample. The second method offers a more normative approach of the socio-economic profile of the household and their preferences in terms of housing and location strategy. In this case, the variables "age" and "SPC" are interpreted as proxies of household structure and determine the preferences for housing. Sabine Kazmierczack-Cousin (1999) compares the two methods and supports the use of the second one. Indeed, strictly statistical analyses do not match theory and empirical work, because of the household composition is important in the location choice. Therefore, as the location choice is not only dependent on the sample structure, we prefer the second (theoretical) method. From the two variables mentioned above, we thus distinguish 12 categories of buyers.

We start from the four SPCs present in our database: managers and intellectual professions, intermediate professions, employees and workers. The age is divided into three classes: < 30 years, 30-45 years and > 45 years. The second category is representative of a family, potentially with children and in search of a larger housing (Flachaire et al., 2007). Table 1 shows the classification in 12 sub-groups. The descriptive statistics are presented in Annex A. Despite a higher proportion of "intermediate professions", we observe a relatively important number of transactions in each sub-sample. The minimum is 3% of our total sample with 1126 observations for the category "managers < 30 years". All 12 categories are represented on the whole territory (see Table 2).

Despite the existence of 41 SPCs and potentially more than three family profiles depending on age, we choose to restrain our analysis to the 12 sub-groups described above. This choice is motived by statistical restrictions, as well as the wish to maintain an adequate framework for our analysis.

4.2 Results of the auction functions

The results of the maximum likelihood estimation are presented in Table 3. Appendix B contains the overall results for the control variables. In this part, we focus on the results related to the heterogeneity of the households preferences for forest recreational services.

Table 1: The distribution of housing transactions for each category

SPC	Age	Frequency	%
	< 30 years	1126	3%
Managers and intellectual professions	30-45 years	2994	8%
	> 45 years	3283	8%
	< 30 years	3869	10%
Intermediate professions	30-45 years	6229	16%
	> 45 years	5039	13%
	< 30 years	3039	8%
Employees	30-45 years	4143	11%
	> 45 years	3507	9%
	< 30 years	1672	4%
Workers	30-45 years	2388	6%
	> 45 years	2065	5%
Total		39354	100%

Table 2: The distribution of the categories by employment areas (%)

Employment area	Managers and intellectual prof.			Intermediate prof.		
	< 30 years	30-45 years	< 45 years	< 30 years	30-45 years	< 45 years
Créteil	1,07	0,47	0,76	0,96	0,82	0,99
Coulommiers	3,82	3,84	3,75	4,32	3,21	3,41
Marne-la-Vallée	20,34	18,70	18,70	18,74	20,08	18,48
Meaux	10,30	10,12	9,56	8,45	9,42	8,77
Melun	29,22	32,90	32,53	32,26	32,00	33,06
Montereau	1,78	2,30	2,77	2,17	2,36	2,40
Nemours	3,55	4,04	4,02	3,54	4,01	3,43
Provins	12,70	12,02	10,33	13,00	12,27	13,22
Paris	9,33	7,62	9,47	8,61	8,41	8,37
Roissy	7,90	7,98	8,10	7,96	7,42	7,86
Total	100,0	100,0	100,0	100,0	100,0	100,0
Employment area	Employees			Workers		
	< 30 years	30-45 years	< 45 years	< 30 years	30-45 years	< 45 years
Créteil	0,79	0,65	0,63	1,02	0,67	0,92
Coulommiers	3,36	3,52	3,11	3,83	3,22	3,87
Marne-la-Vallée	18,13	19,65	18,96	19,56	19,18	18,89
Meaux	8,00	9,49	8,98	8,91	8,84	9,20
Melun	34,25	32,83	32,79	32,78	33,17	31,96
Montereau	2,70	1,76	2,45	1,85	2,18	2,18
Nemours	3,39	3,55	3,88	3,47	3,39	3,44
Provins	12,67	12,21	13,12	12,74	12,23	12,11
Paris	8,98	8,16	8,24	7,66	9,59	7,94
Roissy	7,73	8,18	7,84	8,19	7,54	9,49
Total	100,0	100,0	100,0	100,0	100,0	100,0

The surface variable of global forest environment is globally significant with respect to our sample and across our sub-groups. Moreover, the value of the coefficient differs, depending on the group of purchasers. The sub-groups being based on both age and SPC, a two dimension analysis is required. Firstly, for the wealthier SPCs (managers and intermediate professions), forest area appears as an amenity with a positive impact on housing prices. Conversely, the estimated effect, when it is significant, is negative for the less affluent SPCs. Secondly, within the most affluent SPCs, the age categories modify the coefficient. We observe that the older the household, the higher the coefficient and the greater its significance. The effect of the age for the surface variable estimation is not significant for the other SPCs.

The proxy variable for the biodiversity richness in forest areas appears significant but with important diversity across our sample. The results show that the estimated effect of protected areas is negative for "workers", with a significant threshold at (1%). The impact on housing price is the same for the "employees" and "intermediate professions" under 30 years groups. However, if we observe the value for "managers and intellectual professions" between 30-45 years category, the effect of protected areas is reversed with a positive coefficient, significant at the threshold of 10%.

As for the estimated effect of leisure areas, differences are not explained by the SPCs. However, the age groups are a determining factor for the valuation. Only the households with a reference person over 45 years positively value the proximity to leisure areas. This impact is not significant for the other groups, except for the "employees" under 30 years.

Regarding hiking and biking paths variable, the effect of age and SCPs on the WTP is opposed. Indeed, the older and the wealthier the reference person of the households, the lower the valuation of hiking and biking path. All categories, except for "managers and intellectual professions", positively and significantly values these recreational services. For the "managers and intellectual professions", only the group over 45 years significantly value these facilities, with a negative coefficient. Age negatively affect the coefficient, as the effect decreases when age increases. The coefficients for group under 30 years are twice that of buyers age over 45. Hence, hiking and biking paths are stronger determinants of the WTP for the young and less affluent SPCs households.

Table 3: Results of the auction functions estimation (price/m^2 in constant euros)
if $p < 0.10$, ** if $p < 0.05$, *** if $p < 0.01$

Variables	**Managers and intellectual prof.**			**Intermediate prof.**		
	< 30 years	**30-45 years**	**> 45 years**	**< 30 years**	**30-45 years**	**> 45 years**
Surface of forest environment						
Coeff	**0,0008***	**0,0015*****	**0,0023*****	-0,0001	**0,0005***	**0,0010*****
Std error	0,000	0,000	0,000	0,000	0,000	0,000
P-value	0,083	0,000	0,000	0,845	0,067	0,000
Biodiversity pools*Protection index						
Coeff	0,001	**0,005***	0,003	**-0,006****	-0,002	-0,001
Std error	0,004	0,003	0,003	0,003	0,002	0,002
P-value	0,881	0,080	0,260	0,024	0,423	0,659
Leisure areas						
Coeff	0,033	**0,049****	**0,085*****	-0,006	0,008	**0,049*****
Std error	0,031	0,023	0,022	0,021	0,018	0,019
P-value	0,290	0,034	0,000	0,774	0,664	0,009
Hiking*Biking paths						
Coeff	0,009	0,006	**-0,010****	**0,021*****	**0,020*****	**0,006***
Std error	0,006	0,004	0,004	0,004	0,003	0,004
P-value	0,130	0,189	0,017	0,000	0,000	0,084
Variables	**Employees**			**Workers**		
	< 30 years	**30-45 years**	**> 45 years**	**< 30 years**	**30-45 years**	**> 45 years**
Surface de l'envt forestier						
Coeff	-0,0008	**-0,0007****	0,0004	**-0,0007***	-0,0004	**-0,0007***
Std error	0,000	0,000	0,000	0,000	0,000	0,000
P-value	0,017	0,017	0,223	0,062	0,277	0,059
Biodiversity pools*Protection index						
Coeff	**-0,005***	-0,002	-0,003	**-0,013*****	**-0,015*****	**-0,009*****
Std error	0,003	0,002	0,002	0,003	0,003	0,003
P-value	0,068	0,416	0,190	0,000	0,000	0,001
Leisure areas						
Coeff	**-0,039***	0,001	0,026	0,022	0,013	**0,062****
Std error	0,023	0,020	0,021	0,028	0,024	0,025
P-value	0,084	0,964	0,210	0,423	0,600	0,013
Hiking*Biking paths						
Coeff	**0,022*****	**0,025*****	**0,009****	**0,019*****	**0,016*****	**0,011****
Std error	0,004	0,004	0,004	0,005	0,005	0,005
P-value	0,000	0,000	0,018	0,000	0,000	0,017

4.3 Forward-looking scenarios and simulations

Stating from the coefficients resulting from the estimation (see Table 4 for interest variables and Appendix B for control variables), Table 4 gives a representation of the auction price for the all SPCs and 30-45 years sub-groups [1]. Thus, we define a baseline situation (which is the same for all categories) and observe how changes in the forest environment and its characteristics can impact the household WTP.

The baseline is: the transaction, made in 2008, is a house of 100 m^2, built more than 5 years ago. There is a garage, bathroom and the neighborhood includes nearby amenities (within the IRIS), such as bakery, shops and a cinema. The city median income is 10 000 euros (average of our sample in constant euros). The nearest train station, employment area, school, hospital, mall and park are located within 15 minutes and the center of Paris is distant of 45 minutes by public transport. The average traveling time to the forest environment is 10 minutes. Three scenarios of changing forest environment are elaborated [2]:

- Scenario 1: the forest environment is within 20 minutes of the housing;
- Scenario 2: the forest environment has an additional protection layers;
- Scenario 3: the forest environment is without any recreational facilities, such biking paths and hiking paths.

Table 4: Auction price computed in constant euros and rate of variation

	Buyers of 30-45 years							
	Managers and intellectual prof.		Intermediate prof.		Employees		Workers	
	Price	Var.rate	Price	Var.rate	Price	Var.rate	Price	Var.rate
Reference	*1264*		*2219*		*1525*		*1237*	
scenario 1	1245	*-1,5*	2181	*-1,7*	1495	*-1,9*	1235	*-0,2*
scenario 2	1274	*0,8*	2217	*-0,1*	1522	*-0,2*	1220	*-1,4*
scenario 3	1253	*-0,8*	2174	*-2,0*	1487	*-2,5*	1217	*-1,7*

The results in Table 4 show that an increase of traveling time between dwellings and forest environment has an estimated negative effect on housing price, regardless of the category. However, this impact is more important for managers, intermediate professions and employees than for the workers sub-groups. Considering the scenario 2, the effect

[1] We retain here 30-45 years due to their importance in our sample and their role in theory on the housing purchase.

[2] These scenarios are fictional.

is different. The impact of an additional protection layer is negative for three SPCs out of four, except for the managers categories which positively value this environmental policy. For the third scenario, a forest environment without biking and hiking paths, the computed auction price is negative for employees, intermediate professions and workers; the effect is less sensible for the categories of managers.

5 Conclusion and Discussion

The heterogeneity assessment of the preferences is an important issue in terms of urban planning strategy. More specifically, these preferences are determinant for forest environment planning in urban and periurban areas. The auction method allows revealing this diversity of values for forest recreational services, according to the socio-economic profile of household.

All households, regardless of the socioeconomic profile studied, positively value the recreational aspects of the forest, although this value differs with respect to the recreational attributes. The wealthiest households over 45, value the forest area for its surface and the presence of "leisure areas". This result corroborates the literature. The income, education and age have a significant and positive impact on the willingness to pay for the proximity to forest areas (Baerenklau (2010), Abildtrup et al. (2013)).

The effect of the protected areas for biodiversity conservation in forests is globally less significant, except for the households included in the SPC "managers" and 30-45 year category. For the less affluent SPCs, the results for the biodiversity protection variable are significant and opposed to that of the wealthier SPC. The coefficient is negative and significant at the threshold of 1% for all "workers" groups. Studies on forest areas assessment generally support a positive impact of biodiversity richness on the individuals willingness to pay (Willis & Garrod (1993), Garrod & Willis (1997), Scarpa et al. (2000), Rulleau et al. (2010), Garcia et al. (2011), Abildtrup et al. (2013)). However, in this work, we define and estimate biodiversity richness by the protection of biodiversity policies. Using the same definition, Shultz & King (2001) find a negative impact for the diversity of the fauna habitats in forest areas on housing prices (especially for the most virgin, wild and protected ones). Our results are consistent with the finding of Shultz & King (2001). However, when distinguishing between the different sub-groups, proximity to the protected biodiversity areas is positively valued by managers between 30-45 years old. Although, this finding is opposed to that of Shultz & King (2001), it is in line with the literature concluding that there is a significant and positive relationship between income, SPC, level of education or age on the one hand, and the interest and sensitivity for biodiversity on the other hand (Kinzig et al. (2005), Strohbach et al. (2009), Simon et al. (2012), Shwartz et al. (2012)). For example, Simon et al. (2012) show that households with higher socioeconomic profiles (income and SPC) are characterized by a greater concern for biodiversity conservation. Our results corroborate these findings.

Recreational facilities, such as biking and hiking paths, are positively and significantly valued by all the categories. Preferences remain heterogeneous in terms of coefficient value. The coefficient is larger for the "employees" and "worker" SPCs, aged less than 30.

Our conclusion is centered on the following three major findings:

- When defined as greenery and amenities area in general, global forest environment value is higher for the upper classes and people over 45 years.
- When expressed by its protected areas for biodiversity conservation, global forest environment negatively affects the demand of the least affluent classes but is positively valued by "managers and intellectual professions", aged between 30-45.
- Finally, when forest environment is defined through its recreational services as hiking and biking paths, it is valued by all and especially the less affluent and younger households.

The results of this study will help to clarify the relationship between households with different socioeconomic profiles, and the value of urban and periurban forest areas across the spectrum of their recreational services.

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Appendix A Statistics on buyers categories

Table 5: Statistics on buyers categories

Variables	**Managers and intellectual prof.** < **30 years**	**30-45 years**	> **45 years**	**Intermediate professions** < **30 years**	**30-45 years**	> **45 years**
Obs	1126	2994	3283	3869	6229	5039
Price/m^2	1907,92	1892,66	1944,48	1868,56	1815,05	1837,13
Surface floor (log)	81,90	110,19	111,65	73,94	97,15	99,41
Nber of garage (log)	0,89	0,96	1,00	0,83	0,90	0,92
Nber of Bathroom (log)	1,16	1,39	1,44	1,09	1,27	1,31
Housing age (> 5 years)	0,88	0,89	0,87	0,91	0,91	0,91
House	0,51	0,79	0,72	0,48	0,75	0,70
Bakery	0,31	0,29	0,30	0,37	0,30	0,31
Mall	0,90	0,82	0,97	1,02	0,84	0,92
Cinema	0,02	0,02	0,02	0,03	0,02	0,02
Median income (log)	10974,85	11307,72	11045,39	10785,07	11093,94	10898,43
Train station	3,95	4,06	4,36	4,48	4,66	4,54
Paris by train	49,52	51,40	53,31	50,70	52,02	52,88
Employment area	13,99	14,30	13,56	14,30	14,87	14,32
Hight school	5,46	5,86	5,71	5,88	6,45	6,19
Hospital	2,19	2,25	2,17	2,26	2,47	2,30
Shops	2,85	2,94	3,11	3,05	3,43	3,28
Park	8,34	8,54	8,99	8,93	9,24	9,35
Surface of forests	122,30	130,15	134,90	116,28	121,04	125,38
Biodiversity pools*Protection index	23,56	24,33	24,94	22,91	23,24	23,85
Leisure areas	1,81	1,75	1,73	1,72	1,67	1,69
Hiking*biking paths	12,88	12,62	12,36	12,82	12,64	12,47

Variables	**Employees** < **30 years**	**30-45 years**	> **45 years**	**Workers** < **30 years**	**30-45 years**	> **45 years**
Obs	3039	4143	3507	1672	2388	2065
Price/m^2	1842,24	1766,97	1777,34	1730,78	1653,45	1708,02
Surface floor (log)	69,60	91,73	90,66	73,89	91,31	90,00
Nber of garage(log)	0,81	0,89	0,90	0,76	0,85	0,84
Nber of Bathroom (log)	1,08	1,22	1,23	1,06	1,17	1,18
Housing age (> 5 years)	0,91	0,91	0,92	0,95	0,95	0,94
House	0,44	0,71	0,66	0,58	0,80	0,76
Bakery	0,38	0,31	0,36	0,34	0,29	0,29
Mall	1,02	0,82	0,98	0,89	0,74	0,89
Cinema	0,03	0,02	0,01	0,02	0,02	0,02
Median income (log)	10616,40	10947,31	10785,72	10589,43	10794,86	10585,71
Train station	4,68	4,83	4,59	5,26	5,39	5,21
Paris by train	51,13	52,23	52,82	53,78	54,52	54,52
Employment area	14,46	14,60	14,39	15,55	15,43	14,85
Hight school	6,32	6,61	6,25	7,19	7,29	7,00
Hospital	2,28	2,42	2,26	2,59	2,65	2,50
Shops	3,22	3,50	3,34	3,91	3,96	3,71
Park	9,59	9,69	9,35	10,61	10,59	10,38
Surface of forests	113,23	116,75	121,81	113,34	116,41	116,39
Biodiversity pools*Protection index	22,59	22,97	23,43	22,40	22,37	22,95
Leisure areas	1,67	1,65	1,67	1,58	1,53	1,60
Hiking*Biking paths	12,71	12,68	12,47	12,30	12,16	12,22

Appendix B Results of the auction functions estimation for the control variables

Table 6: Results of the auction functions estimation for the control variables

Variables	**Managers and intellectual prof.**			**Intermediate prof.**		
	< 30 years	**30-45 years**	**> 45 years**	**< 30 years**	**30-45 years**	**> 45 years**
Constant						
Coeff	1,545*	-0,970	-0,024*	4,885***	2,719***	3,831***
Std error	0,944	0,662	0,635	0,640	0,534	0,561
2001 (ref)						
2002						
Coeff	0,022	0,102**	0,087**	0,036	0,075**	0,084**
Std error	0,057	0,042	0,041	0,039	0,033	0,035
2003						
Coeff	0,092	0,177***	0,158***	0,161***	0,175***	0,141***
Std error	0,056	0,041	0,040	0,038	0,033	0,034
2004						
Coeff	0,225***	0,330***	0,315***	0,220***	0,282***	0,215***
Std error	0,053	0,039	0,038	0,037	0,031	0,033
2005						
Coeff	0,304***	0,427***	0,382***	0,391***	0,467***	0,384***
Std error	0,055	0,039	0,039	0,036	0,031	0,033
2006						
Coeff	0,498***	0,571***	0,510***	0,501***	0,579***	0,503***
Std error	0,055	0,041	0,040	0,038	0,032	0,034
2007						
Coeff	0,566***	0,593***	0,584***	0,566***	0,611***	0,575***
Std error	0,054	0,041	0,039	0,037	0,032	0,034
2008						
Coeff	0,558***	0,563***	0,582***	0,502***	0,558***	0,598***
Std error	0,057	0,044	0,042	0,040	0,035	0,036
Surface floor(log)						
Coeff	-0,331***	0,098***	0,039	-0,644***	-0,226***	-0,196***
Std error	0,041	0,033	0,030	0,028	0,025	0,026
Nber of garage (log)						
Coeff	0,125***	0,138***	0,261***	0,085***	0,134***	0,171***
Std error	0,043	0,031	0,030	0,029	0,025	0,026
Nber of bathroom (log)						
Coeff	-0,068	0,298***	0,640***	-0,224***	0,123***	0,400***
Std error	0,083	0,053	0,052	0,060	0,045	0,047
Housing age (> 5 ans)						
Coeff	-0,241***	-0,387***	-0,484***	-0,084**	-0,195***	-0,232***
Std error	0,046	0,035	0,032	0,034	0,029	0,030

Variables	Managers and intellectual prof.			Intermediate prof.		
	< 30 years	30-45 years	> 45 years	< 30 years	30-45 years	> 45 years
House						
Coeff	-0,090*	0,266***	0,043	-0,053**	0,311***	0,148***
Std error	0,039	0,030	0,029	0,026	0,023	0,025
Bakery						
Coeff	-0,045	-0,022	-0,044***	0,000	-0,016	-0,030**
Std error	0,023	0,017	0,016	0,014	0,013	0,013
Mall						
Coeff	0,011	0,026***	0,047***	0,003	0,020***	0,028***
Std error	0,010	0,007	0,006	0,006	0,006	0,006
Cinema						
Coeff	-0,037	0,114	0,157**	0,126**	0,078	0,019
Std error	0,109	0,077	0,072	0,064	0,059	0,064
Median income (log)						
Coeff	0,588***	0,632***	0,536***	0,425***	0,423***	0,263***
Std error	0,099	0,070	0,067	0,067	0,056	0,059
Train station						
Coeff	-0,007	-0,011***	0,003	0,002	-0,003	-0,004
Std error	0,005	0,004	0,003	0,003	0,003	0,003
Paris by train						
Coeff	-0,007***	-0,006***	-0,001	-0,004***	-0,005***	-0,002**
Std error	0,002	0,001	0,001	0,001	0,001	0,001
Employment area						
Coeff	0,002	0,003**	0,000	0,003**	0,004***	0,002**
Std error	0,002	0,001	0,001	0,001	0,001	0,001
Hight school						
Coeff	-0,008	-0,008**	-0,015***	-0,007**	-0,003	-0,004
Std error	0,005	0,004	0,004	0,003	0,003	0,003
Hospital						
Coeff	0,012	-0,010	-0,024***	0,012*	0,008	-0,008
Std error	0,010	0,007	0,007	0,006	0,005	0,006
Shops						
Coeff	-0,004	-0,014***	0,002	-0,004	-0,003	-0,006
Std error	0,006	0,004	0,004	0,004	0,003	0,003
Park						
Coeff	-0,002	-0,004	-0,002	-0,005*	-0,007***	-0,001
Std error	0,004	0,003	0,003	0,002	0,002	0,002

Variables	Employees < 30 years	30-45 years	> 45 years	Workers < 30 years	30-45 years	> 45 years
Constant						
Coeff	7,315***	4,221***	5,511***	8,260***	7,160***	8,759***
Std error	0,707	0,600	0,629	0,868	0,733	0,760
2001 (ref)						
2002						
Coeff	0,045	0,058	0,053	-0,012	0,086**	0,072
Std error	0,043	0,037	0,038	0,050	0,042	0,046
2003						
Coeff	0,130***	0,172***	0,100***	0,058	0,118***	0,103**
Std error	0,042	0,036	0,038	0,049	0,042	0,046
2004						
Coeff	0,245***	0,278***	0,198***	0,127***	0,182***	0,204***
Std error	0,040	0,035	0,036	0,048	0,041	0,044
2005						
Coeff	0,417***	0,409***	0,276***	0,294***	0,282***	0,349***
Std error	0,040	0,035	0,037	0,047	0,042	0,044
2006						
Coeff	0,504***	0,480***	0,410***	0,433***	0,424***	0,466***
Std error	0,041	0,036	0,038	0,048	0,043	0,045
2007						
Coeff	0,534***	0,554***	0,522***	0,481***	0,490***	0,577***
Std error	0,041	0,036	0,037	0,048	0,043	0,044
2008						
Coeff	0,494***	0,493***	0,482***	0,534***	0,419***	0,507***
Std error	0,044	0,039	0,040	0,051	0,047	0,048
Surface (log)						
Coeff	-0,770***	-0,347***	-0,403***	-0,721***	-0,487***	-0,536***
Std error	0,030	0,028	0,029	0,036	0,034	0,034
Nber of garages (log)						
Coeff	0,086***	0,147***	0,232***	0,044	0,155***	0,168***
Std error	0,031	0,028	0,029	0,037	0,033	0,035
Nber of bathroom (log)						
Coeff	-0,106	0,073	0,193***	-0,336***	-0,125**	0,020
Std error	0,067	0,052	0,054	0,079	0,062	0,065
Housing age (> 5 ans)						
Coeff	-0,061***	-0,169***	-0,122***	0,053	-0,011	-0,066
Std error	0,037	0,033	0,035	0,052	0,046	0,046

Variables	Employees			Workers		
	< 30 years	**30-45 years**	**> 45 years**	**< 30 years**	**30-45 years**	**> 45 years**
House						
Coeff	-0,080***	0,268***	0,201***	0,143***	0,552***	0,500***
Std error	0,028	0,026	0,027	0,035	0,033	0,034
Bakery						
Coeff	-0,001	-0,009	0,005	0,004	0,002	-0,041**
Std error	0,015	0,014	0,014	0,019	0,017	0,019
Mall						
Coeff	-0,008	0,002	0,021***	-0,013	-0,007	0,014*
Std error	0,007	0,006	0,006	0,009	0,008	0,008
Cinema						
Coeff	0,082	0,043	-0,076	-0,003	-0,049	-0,082
Std error	0,069	0,066	0,075	0,087	0,084	0,087
Median income						
Coeff	0,204***	0,311***	0,178***	0,026	0,029	-0,149*
Std error	0,074	0,063	0,066	0,091	0,077	0,080
Train station						
Coeff	-0,004	-0,003	-0,006*	-0,004	-0,001	-0,004
Std error	0,004	0,003	0,003	0,004	0,004	0,004
Paris by train						
Coeff	-0,004***	-0,004***	-0,001	0,000	0,000	0,000
Std error	0,001	0,001	0,001	0,001	0,001	0,001
Employment area						
Coeff	0,002	0,001	0,003*	0,007***	0,005***	0,004*
Std error	0,002	0,001	0,001	0,002	0,002	0,002
Hight school						
Coeff	0,005	0,004	-0,002	0,002	-0,003	0,001
Std error	0,003	0,003	0,003	0,004	0,004	0,004
Hosptial						
Coeff	0,010	-0,004	-0,014**	0,021***	0,008	0,001
Std error	0,007	0,006	0,006	0,008	0,007	0,007
Shops						
Coeff	-0,007*	-0,008*	0,001	-0,005	-0,008**	-0,010***
Std error	0,004	0,003	0,004	0,004	0,004	0,004
Park						
Coeff	0,001	-0,001	-0,006**	0,001	-0,002	0,001
Std error	0,003	0,002	0,002	0,003	0,003	0,003