The effects of spatial spillovers on the provision of urban environmental amenities

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Résumé : L'urbanisation croissante favorise l'artificialisation des sols dans la plupart des villes. Dans ce contexte, les espaces verts urbains jouent un rôle clé pour la qualité de vie et l'attractivité des villes. Ce travail met en lumière les tenants et les aboutissants du processus de prise de décision afin de soulever les questions inhérentes à la fourniture des espaces verts. Nous examinons l'influence des externalités de débordement afin d'identifier les interactions stratégiques entres les communes voisines dans un échantillon de villes françaises. Notre objectif est d'évaluer l'efficacité des politiques publiques locales en identifiant les comportements stratégiques. A cette fin, nous avons mené une enquête auprès des services Espaces Verts en raison de l'absence de données centralisées sur les superficies et les dépenses engagées pour les espaces verts. Nous traitons les données à l'aide des techniques d'économétrie spatiale. Les résultats suggèrent que les communes ont tendance à imiter les communes voisines pour la fourniture des espaces verts. Il est également constaté que les dotations naturelles telles que les zones côtières et les vignes sont des substituts aux espaces verts.

Abstract: As land take favours the development of new artificial areas in most cities, urban green spaces (UGSs) play a key role for the quality of life and the attractiveness of cities. This paper highlights the ins and outs of the decision making-process in order to stress the issues inherent to the provision of UGSs. We examine the influence of spatial spillovers in order to identify strategic interactions between neighbouring municipalities in a sample of French municipalities. Our aim is to assess the efficiency of local policies as strategic behaviours may lead to a non optimal level of UGSs. For this purpose we conducted a survey with municipal greening services given the absence of centralized data regarding the surfaces and spending for UGSs. The analysis is based on spatial econometrics techniques. Using different weight matrices, we find that data follow a spatial lag pattern. The results suggest that municipalities tend to imitate their neighbours for the provision of UGSs. It is also found that environmental amenities such as coastal area and vineyards are substitutes to UGSs.

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L'urbanisation croissante favorise l'artificialisation des sols dans la plupart des villes. Dans ce contexte, les espaces verts urbains jouent un rôle clé pour la qualité de vie et l'attractivité des villes. Ce travail met en lumière les tenants et les aboutissants du processus de prise de décision afin de soulever les questions inhérentes à la fourniture des espaces verts. Nous examinons l'influence des externalités de débordement afin d'identifier les interactions stratégiques entres les communes voisines dans un échantillon de villes françaises. Notre objectif est d'évaluer l'efficacité des politiques publiques locales en identifiant les comportements stratégiques. A cette fin, nous avons mené une enquête auprès des services Espaces Verts en raison de l'absence de données centralisées sur les superficies et les dépenses engagées pour les espaces verts. Nous traitons les données à l'aide des techniques d'économétrie spatiale. Les résultats suggèrent que les communes ont tendance à imiter les communes voisines pour la fourniture des espaces verts. Il est également constaté que les dotations naturelles telles que les zones côtières et les vignes sont des substituts aux espaces verts.

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Introduction

Land uptake modifies the shape of landscape at the expense of natural and agricultural areas. The evolution of the territory is mostly driven by the development of housing, commerce and leisure areas. During the period 1990-2000, France has contributed to 15% of the new total urban and infrastructure sprawl in Europe (European Environment Agency, 2005). Urbanization enhances the demand for land whereas populations suffer from air pollution, noise and the lack of open space. Conflicts for land use arise as the demand for urban amenities is increasing.

In this context existing literature underlines the growing status of urban environmental amenities for residential choices (Jim, 2004; Jim and Chen, 2006). As such, urban green spaces (UGSs) play a key role in the sustainability of cities. They cover planted public or private open space in urban areas. More specifically, we focus on publicly provided UGSs including parks, public gardens, squares, traffic circles, urban trees, sport fields, cemeteries, urban forests, fallow lands and community gardens. They display various functions as they address environmental, ecological, social, urban regulation and aesthetic concerns (Bolund and Hunhammar, 1999).

In the present circumstances, UGSs appear as new bait for urban and business attractiveness. In France, municipalities undertake 95% of green spaces expenditures (DGCP-Ifen, 2004). The rest is provided by higher decision levels. Municipalities spend an average of 4 to 5% of their annual budget for greening services. On average, inhabitants have access to 20 to 25 m² of UGSs (CNFPT, 2001). Empirical data illustrate the importance of UGSs in local public policies. Private provision of UGSs is also significant. Its importance depends on each municipality. But it is difficult to assess private sector contribution due to lack of empirical data.

UGSs enter into conflicts in land use between the stakeholders of cities. Different types of actors (households, firms and public administrations) cohabit in the same territory and claim for different land uses. The task for public decision-makers is to execute trade-offs between these alternative uses and decide the allocation of land. Several studies assess the demand for UGSs (Morancho, 2003; Jim and Chen, 2006; Kong et al. 2006). However few studies focus on public choices regarding their provision. The decision-making process for local public goods is indeed complex as it is the result of various factors (economic, political, social and environmental). Given the share of UGSs in municipal budgets, it is crucial to understand the ins and outs of public spending. The understanding of institutions and their mechanism for collective choices is fundamental given the strategic importance of UGSs in terms of external benefits (Choumert and Salanié, 2008).

Founder studies in public economics only bring a limited explanation of the fixing of local public good expenditures, by focusing on local characteristics and by considering jurisdictions as isolated entities (Borcherding and Deacon, 1972; Bergstrom and Goodman, 1973). However the benefits of UGSs are not restricted to the residents of the municipality providing them. Residents of surrounding cities can also enjoy their consumption because of spatial spillovers. Spatial spillovers may influence local decision-makers by inducing free-riding behaviours, mimetic behaviours or "green competition" à la Tiebout (1956). Additionally, there may be strategic behaviours due to localization and the quality of the peri-urban and rural open space. There are no theoretical elements to state if urban environmental amenities and natural amenities are complements or substitutes. This has to be determined empirically.

In this paper we analyse the consequences of spatial spillovers in terms of public policy. The theoretical model is based on the median voter hypothesis (Borcherding and

Deacon, 1972; Bergstrom and Goodman, 1973) to explicit the provision of the local public good generating spatial spillovers. Here, the median voter can access UGSs provided by his own municipality as well as those provided by the surrounding ones. This approach could be applied to the provision of other environmental assets. The first attempt to analyse spatial spillovers using local government data is the one by Murdoch et al. (1993). The results show strong interactions between 85 communities in the Los Angeles metropolitan area for expenditures on recreation. They find a positive relationship between expenditures of neighbouring communities. Hanes (2002) extends this analysis to Swedish local rescue services in 288 municipalities. On the contrary he finds that reaction functions are negatively sloped, suggesting that municipalities react negatively to neighbouring municipalities' expenditures. Lundberg (2006) finds results suggesting that recreational and cultural services are strategic substitutes between 276 Swedish municipalities. Solé-Ollé (2006) addresses the issue of spatial spillovers with a study of local expenditures in 2610 Spanish local governments. Spatial spillovers appear to be a more severe problem in urban areas than in rural areas.

This paper makes several contributions. First, we extend the local public good provision model with spatial spillovers to urban environmental amenities. Second the provision of UGSs is analyzed using spatial autoregression techniques (Anselin, 1988). To our knowledge, it is the first attempt to analyze the provision of UGSs based on this framework. Furthermore the dataset has been built out from a survey carried out in cities belonging to the French «départment» Loire-Atlantique (Administrative unit) given that no centralized dataset exists. It allows us to test different measures of the supply of green spaces such as surface and expenditures. Last we investigate relationships between the provision of UGSs and the proximity of other environmental and landscape amenities. In the study area, landscape varies substantially by cities, providing an experimental setting for testing substitution and complementary effects between these amenities. The aim of this paper is to provide guidance to achieve the equilibrium between urbanization, environmental quality and the attractiveness of the territories.

The remainder of this article is organized as follows. In the first section we present the theoretical framework. This is followed by the specification of the empirical model. In this section we discuss the econometric specification and weight matrices. Data are presented in section 3. Sections 4 and 5 present the econometric results and section 5 draws some conclusions some concluding remarks.

1. Theoretical framework

The median voter model is a microeconomic model of representative democracy (Derycke and Gilbert, 1988). It is the cornerstone to explaining public expenditures in many spheres ranging from environment to fire protection. Following Dawns (1957), Black (1958) and Borcherding and Deacon (1972), expenditure decisions of a jurisdiction reflect the choices of the decisive voter. Elected representatives act as if they maximize the utility of the median voter. This one is considered as the individual or household with the median income (Bergstrom and Goodman, 1973). Her/his vote determines the political outcome. According to Dawns (1957), elected representatives draw their policies in order to win elections instead of aiming at wining the elections in order to implement public policies. The model states that under the assumptions of single peaked preferences and majority voting, the quantity of the local public good offered is the demand of the median voter. The model explains the level of public expenditures by the median income and the median tax price. The tax price is the marginal amount an individual pays for an extra unit of the good.

The model is rather simple as it requires few data. However its applicability depends on the political functioning of each country. In France, for instance, the median voter model appears appropriate given the political context. Indeed since the laws of decentralization of 1992, the political process has been mainly conducted by the electoral matters rather than the economic aspect of essential decisions (Mougeot, 1990). Moreover empirical studies show that the provision of local public goods in France in determined by the demand of the median voter (Baudry et al., 2002).

Many empirical studies rely on the median voter framework (Mueller, 2003). They refer to the median voter model to explain the behaviour of elected representatives in democracies. A deviation from the median voter's preferences is considered as a government failure (Le Maux, 2006). Several studies bring explanations of local public choices based on the median voter. Yet empirical validations are not sufficient to make it incontestable. Its supremacy has been challenged in theoretical and empirical studies. It has been shown that alternative models provide a sound explanatory power for local public policies (Mueller, 2003).

The median voter model leads to a voting equilibrium but only to a second best optimum. Derycke and Gilbert (1988) argue that the level of expenditures derived from the median voter demand would converge towards the Pareto optimum only if all individuals have the same preferences. In this case, each individual is assumed to enjoy the same level of UGSs, for instance, and pay the same tax price. Also the median voter model does not meet the conditions of Pareto-optimality as the allocation of incomes within a municipality is biased. Following Derycke and Gilbert (1988), let us consider a municipality i where all voters receive the same share of UGSs. In other words, if N is the total population of a municipality, every individual can enjoy the level 1/N UGSs. Let us assume that the median income is lower than the mean income (i.e. many low incomes and few rich individuals) and that tax rates are proportional to income. Within this context, the median voter pays a low tax share given the level of UGSs she/he can benefit from. As a consequence the median voter will ask for more parks in relation with the optimum.

In this work we express the provision of UGSs with a simple local public good model. We assume that the median voter can enjoy the consumption of UGSs in its own municipality and in neighbouring ones. Local decision makers maximize the utility of the median voter. Following Cornes and Sandler (1996), the utility function of the median voter in municipality i is continuous, strictly increasing and strictly quasi-concave. It is given by:

$$U_i = U(x_i, z_i, z_j, e_i, v_i) \quad (1)$$

Where x_i is composite numeraire private good; z_i is the supply of UGSs in municipality i; z_j is the provision of green spaces in other cities and can be interpreted as the theoretical specification of spatial spillovers; e_i is a vector of substitutes; and v_i is a vector of characteristics of the municipality i.

The exogenous income M can be used to purchase the private good or acquire additional local public good. Here we assume that the local public good is not subject to crowding spillovers. Otherwise it would mean that local decision makers internalize spatial spillovers in the decision making process.

Maximization of utility is subject to the following linear budget constraint:

$$M_i = x_i + tz_i \quad (2)$$

Where M_i is the income of the median voter; and t is the tax rate necessary to finance the local public good (e.g. its price).

The first order conditions lead to a demand function expressed in terms of exogenous variables such as:

$$z_i^* = z(t_i, M_i, z_j, e_i, v_i) \quad (3)$$

The sign of $\frac{\partial z_i^*}{\partial M_i}$ depends on the nature of the local public good. If UGSs are normal goods, the sign will be positive whereas it will be negative if UGSs are inferior goods.

The sign of $\frac{\partial z_i^*}{\partial z_j}$ indicates whether local public goods are substitutes between cities. If the derivative is positive, UGSs are complementary between neighbouring cities otherwise they are substitutes and cities act as free-riders.

2. Empirical model

The model set out in the previous section implies that the provision of UGSs in municipality j affects the utility of the median voter in municipality i. To size this empirically, we use spatial econometrics techniques.

The demand for UGSs is assumed to take a linear form, written in a matrix form as follows:

$$y = \rho Wy + XB + \varepsilon \qquad (4)$$

Where y is the n×1 vector of the dependant variable (e.g. UGSs supply), ρ is the parameter to be estimated, W is an n×n weight matrix containing functions of distance or contiguity relations, Wy is an n×1 vector of spatially lagged variables, X is a n×k matrix of explanatory variables portraying the characteristics of the cities, B is a k×1 vector of parameters, and ε is a n×1 vector of error terms with $E(\varepsilon) = 0$ and $E(\varepsilon\varepsilon') = \sigma^2.I$.

The parameter ρ reflects the spatial dependence inherent in our sample. It captures the influence of neighbouring cities' UGSs provision on others. If there is no spatial autocorrelation, there is no link between neighbourhood and the degree of resemblance of cities. If $\rho > 0$, neighbouring cities are more similar than remote cities. In that case UGSs provided by neighbouring cities are complements. If $\rho < 0$, then neighbouring cities are more different than remote ones. In that case, UGSs are substitutes.

Unlike time series specifications, a correlation between the error term and the lagged variable is induced by the presence of the spatially lagged term. As a consequence, Ordinary Least Squares (OLS) are unable to provide consistent estimators (Anselin, 1988). The maximum likelihood method provides unbiased and consistent estimators. It is the common method to estimate a spatial lag model such as that expressed in equation (1) (Anselin, 1998).

The first task is to specify interdependencies among municipalities. It requires the construction of weight matrices. As pointed out earlier, geographic proximity between cities is the key element of this analysis. Different indicators for neighbourhood are considered. The existing economic literature does not present a theoretical answer to which weight matrix should be chosen. Consequently several matrices have to be tried empirically and specified exogenously (Anselin, 1988). It is reasonable to assume that in the case of UGSs, distance and time are significant factors of spatial spillovers. Given the nature of UGSs, the channel of transmission of spatial spillovers is more likely to be the mobility of individuals, which clearly depends on the distance between cities. The strength of spatial dependence between cities should lessen as distance between cities increases. Although geographical distance appears appropriate, it is sometimes more relevant to introduce other aspects of distance (Anselin, 1988). In the case of UGSs, we use three measures of distance: the Euclidian distance, the travel time in rush hours and the travel time in off-peak hours (Obtained from Odomatrix 2007, INRA-CESAER from BDR500C, INRA-CESAER / CERTU). The modelling of the road network uses major elements of the French road network. These elements are described by two levels of information: a geographic representation (two-dimensional coordinates of each point) and a semantic level (properties of objects). The travel time is derived from the length of the section and the speed of the traffic on the network. The latter is determined by the vocation of the road (principal road, local etc.) and by the geographical environment (agglomeration etc.). Traffic conditions related to network congestion are partially taken into account (Hilal, 2005).

The general form for a weight matrix is such as:

$$W_{ij} = f(d_{ij}) \quad (5)$$

With f an inverse function of the distance and with diagonal elements being zeros. Usually, the function takes different forms such as

$$W_{ij} = \frac{1}{d_{ij}^{\alpha}} \quad (6)$$

α being determined exogenously.

In this paper we use α = 1 and α = 2. We will consider row-standardized matrix which means that each row sums up to 1. We assume that all neighbours carry the same weight. Weights are then included between 0 and 1. In that case the connection between two cities relies on the relative distance and not the absolute distance. Also it will facilitate comparison of the ρ we will estimate with different weight matrix. Since the weight matrix is row-standardized, the spatially lagged variable is a weighted average of the supply in neighbouring cities. We then obtain an average level of UGSs in neighbouring municipalities.

INSERT TABLE 1

3. Data

Our source of data is a sample of 69 cities of the French «département» Loire-Atlantique, located in the West of France. The characteristics of municipalities were taken from official database, while data related to UGSs were obtained via a questionnaire sent to the municipalities. In France, cities are mainly responsible for the provision of UGSs except for Paris for which the region Ile de France is responsible.

Data related to UGSs comes from a survey we undertook. A questionnaire was sent to the services responsible for UGSs in the 77 cities of more than 3000 inhabitants of the region. Our sample represents 89% of the municipalities consulted.

We consider that the «département» Loire-Atlantique is a pertinent testing ground for theory. Two phenomena are observed: a concentration of the population in urban areas and urban sprawling. Secondly, the region has very diverse landscapes with allows us to test substitution effects with various amenities.

The dependant variable is the supply of UGSs for the year 2005. We test four indicators to be the dependant variable: current expenditures for UGSs per capita, current expenditures per square meter of UGS, square meter of UGSs per capita and the percentage of UGSs in the municipality.

INSERT TABLE 2

The income of the median voter is measured by the median fiscal income in the municipality in 2002. We assume that the resident with the median income is equivalent to the median voter (Bergstrom and Goodman, 1973). We expect UGSs to be normal goods; hence we expect to find a positive relationship between their provision and the median voter's income.

Measure of the price of UGSs is more difficult to identify, with the local tax price being its measure. We use the proxy variable t_i = 1/population in the municipality i. The underlying idea is that it is an equalized share of the local public good by inhabitants (Bergstrom and Goodman, 1973; Dudley and Montmarquette, 1981; Murdoch et al., 1993). Hence, the cost is equally divided between inhabitants of a municipality when UGSs expenditures increase. Based on economic theory we expect the parameter on tax price to be negatively signed, a common result in such studies (Hanes, 2002; Solé-Ollé, 2006).

The analysis of complementarity or substitution patterns between UGSs and other environmental amenities has been made on several variables described in table 3. We include indicators of the municipality natural environment such as the proximity to the ocean, the proximity to the Loire River and the proportions of grasslands and vineyards in the county. We expect most of these variables to be negatively signed. It would indicate that there is a substitution between UGSs and natural amenities found close to the municipality of concern.

INSERT TABLE 3

Other variables such as the percentage of the population under 19, the proximity of a regional natural park, the level of local equipment, the ratio of agricultural land in the county and the ratio of meadows in the county are not presented as they either present colinearity issues or are not significant.

4. Results and discussion

4.1 Moran's I statistic

We compute the Moran's I global spatial autocorrelation statistic. For each variable, we present the expected value under the null hypothesis of global spatial independence and the associated p-value. If the Moran statistic takes high values, it indicates positive spatial autocorrelation. In other words, the level of UGSs for neighbouring municipalities tends to be similar.

Results presented in table 4 show that the Moran's I statistic is positive and significant for the percentage of UGSs in the municipality (UGS_1) and expenditures per capita (UGS_3).

INSERT TABLE 4

4.2 Moran Test on residuals

We carry out diagnostic tests for spatial dependence in ordinary least square regressions for the two indicators showing significant global spatial autocorrelation. The Lagrange multiplier test (LM) and the robust Lagrange multiplier test (RLM) tell whether spatial autocorrelation is a problem is the data we observe. If only the LM error test is significant, we specify a spatial error model and if only the LM lag test is significant, we specify a spatial lag model. In the case that both are significant, RLM tests have to be checked. Similarly if RLM error test is significant, we specify a spatial error model and if the RLM lag test is significant, we specify a spatial lag model. Finally if none of the LM error and LM lag is significant, ordinary least squares provide consistent estimates.

Results presented in table 5 show that a spatial lag model should be applied for the variable Percentage of UGSs area in the municipality (UGS_1). For the variable Expenditures per capita (UGS_3), the use of ordinary least squares is accurate.

INSERT TABLE 5

4.3 Model specification

We improve the model by adding a spatially lagged dependent variable for the percentage of UGSs area in the municipality. The spatial lag model indicates that the values taken by the independent variable in one municipality is directly influenced by the valued of neighbouring municipalities. We look for the likelihood of observing the sample that we study as a function of the unknown parameters that characterize the distribution (Anselin, 1988). Next we choose the highest likelihood in order to find the best estimates.

Regressions are described in table 6. Two measures of income were tested for the median voter: income per capita and income per household. This distinction brings little to the analysis and we will present only the results obtained from the income per capita. The maximum likelihood estimates is obtained with the weight matrix W2 (Inverse of the square of the Euclidian distance). However results for the Euclidian distance and the results based on travel time do not significantly differ.

INSERT TABLE 6

Empirical results indicate the existence of spatial spillovers across municipalities for the percentage of UGSs area in the municipality. The spatial spillovers parameter ρ is positive (0,675) and significant showing that municipalities tend to imitate their neighbours. There is no evidence of free-riding behaviour although the intuition based on the existing literature would suggest that UGSs of neighbouring municipalities are substitutes. Here municipalities are expected to have higher provision level of UGSs if their neighbours have on average a high level of provision. The parameter on the median income is positive but not significant. We cannot conclude on this result as the dependent variable does not take into account the expenditures.

Parameters for amenities are generally negatively signed on the exception of the proximity to the Loire River. Hence, municipalities close to the Loire River tend to provide more UGSs than others. There is a complementarity between this amenity and UGSs. This result is surprising in the sense that we would have expected them to be substitutes. We believe that this result is due to some form of clustering which has to be tested. Nantes, a rich municipality, is situated along the Loire River and may greatly influence this result.

Coastal cities provide less UGS than others. One explanation is that there may be substitution effects between the surface of UGSs and the coastal amenities that people can use in a similar way (recreation, walking, resting, etc.). Another explanation may be that the land rent in coastal cities is higher hence the opportunity cost of UGSs is high. The proportion of grasslands and of vineyards in the county influences negatively and significantly the provision of UGSs. Municipalities provide less UGSs as the proportion of these amenities in surrounding area increases.

5. Conclusion

The aim of this paper is to provide insights into factors influencing the provision of UGSs. We argue that due to their public nature, UGSs may be subject to spatial spillovers and municipalities may adopt strategic behaviours. Similarly, UGSs provide urban population with services that may be found outside the municipality. Hence the localization of a municipality respectfully to these amenities may affect its provision of UGSs. We address several questions: First, what are the determinants of the provision of UGSs in French municipalities? Second, do municipalities adopt strategic behaviours regarding neighbouring municipalities? Third, what kind of interactions is there between neighbouring municipalities?

The empirical model accounts for the spatial nature of the relationships to be tested. We use different weight matrices to introduce spatial dependence in the model. In addition to intrinsic characteristics of municipalities, the provision of UGSs in one municipality may not be independent from the provision in surrounding municipalities. The examination of spatial dependence or clustering may reveal strategic interactions that are missing from usual ordinary least square regressions. Potential spatial patterns can influence the understanding of how UGSs are actually supplied. Our results show the existence of spatial spillovers and that municipalities tend to imitate their neighbours for the quantity of UGSs provided. Moreover, there is a substitution between environmental amenities and the provision of urban green spaces such as the coastal area and vineyards.

The causes of strategic interactions can be the existence of horizontal competition or yardstick competition. On the one side, if we assume that there is horizontal competition (Wilson, 1986; Wildasin, 1988), fiscal bases are mobile and municipalities aim at attracting them. The mobility of residents will lead elected representatives to adopt mimetic behaviours. On the other hand, if we assume that there is yardstick competition among municipalities (Besley and Case, 1995), voters compare the performance of their elected representatives by comparing it with neighbouring municipalities. Voters will then re-elect incumbent representatives if they are satisfied with their policy by comparison with policies led in the neighbourhood. In this case, elected representatives take into account the policy led by neighbouring municipalities as sanction arises with vote. This has two implications. First, elected representatives of neighbouring municipalities will have a tendency to imitate each other to avoid penalty by the vote. Second, the level of UGSs provided may not be optimal.

The empirical analysis could be improved in the near future. Second, there is an opposition (in the data) between expenditures and surface. We believe that the decisions of providing a quality (expenditures) and a quantity (surface) of UGSs are not independent. There is then a need two model these to elements simultaneously in a system of spatial equations. Second, this question should be raised within an intertemporal framework for a better understanding of local public policies.

References

Anselin, L., 1988. *Spatial Econometrics: Methods and Models*. Dordrecht: Kluwer Academic Publishers.

Baudry, M., Leprince, M. and Moreau, C., 2002. Préférences révélées, bien public local et électeur médian: tests sur données françaises. *Economie et Prévision*, 5 (156), 125-146.

Bergstrom, T.C. and Goodman, R.P., 1973. Private demands for public goods. *American Economic Review*, 63:280-296.

Black, D., 1958. *The theory of Committees and Elections*. Cambridge: Cambridge University Press.

Bolund, P. and Hunhammar, S., 1999. Ecosystem services in urban areas. *Ecological economics*, 29, 293-301.

Borcherding, T.E. and Deacon, R.T., 1972. Demand for services of non-federal governments. *American Economic Review*, 62, 891-901.

Choumert, J. and Salanié, J., 2008. Provision of urban green spaces: some insights from economics. *Landscape Research,* 33(3), 331 – 345.

CNFPT, 2001. *Dossier sectoriel Espaces Verts*. Paris: Editions du CNFPT.

Cornes, R. and Sandler, T., 1986. *The theory of externalities, public goods, and club goods*. Cambridge: Cambridge University Press.

Dawns, W., 1957. *An economic theory of democracy*. New York: Harper & Row.

DGCP – Ifen, 2004. *Les dépenses des communes et de leurs groupements pour l'environnement en 2002*. Paris : Direction générale de la comptabilité publique.

Derycke, P.H. and Gilbert, G., 1988. *Economie publique locale*. Paris : Economica.

Dudley, L. and Montmarquette, C., 1981. The demand for military expenditures: An international comparison. *Public Choice*, 37, 5-31.

European Environment Agency, 2005. *The European environment – State and outlook 2005.* Copenhagen.

Hanes, N., 2002. Spatial spillover Effects in the Swedish Local Rescue Service. *Regional Studies*, 36, 531-539.

Hilal, M., 2005. *Modélisation du réseau routier et calcul des distances routières. Centre d'Economie et de sociologie appliquées à l'agriculture et aux espaces ruraux*. INRA-CESAER, Dijon.

Jim, C.Y., 2004. Green-space preservation and allocation for sustainable greening of compact cities. *Cities*, 21 (4), 311 – 320.

Jim, C.Y. and Chen, W.Y., 2006. Impacts of urban environmental elements on residential housing prices in Guangzhou (China). *Landscape and Urban Planning*, 78, 422-434.

Kong, F., Yin, H. and Nakagoshi, N., 2006. Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: A case study in Jinan Municipality, China. *Landscape and Urban Planning*, 79, 240-252.

Le Maux, B., 2006. *Local Public Choice in Representative Democracy: Which Theory Best Explains the Data?*, Unpublished Ph.D. Thesis. Université Rennes 1.

Lundberg, J., 2006. Spatial Interaction Model of Spillovers from Locally Provided Public Services. *Regional Studies*, 40, 631-644.

Morancho, A.B., 2003. A hedonic valuation of urban green areas. *Landscape and Urban Planning*, 66, 35-41.

Mougeot, M., 1990. Economie publique locale et théorie économique. *Revue économique*, 41, 153-158.

Mueller, D., 2003. *Public Choice III*. Cambridge: Cambridge University Press.

Murdoch, J.C., Rahmatian, M. and Thayer, M.A., 1993. A spatially autoregressive median voter model of recreation expenditures. *Public Finance Quarterly*, 21, 334-350.

Solé-Ollé, A. 2006. Expenditure spillovers and fiscal interactions: Empirical evidence from local governments in Spain. *Journal of Urban Economics*, 59, 32-53.

Tiebout, C.M., 1956. A pure theory of local expenditures. *Journal of Political Economy*, 64, 615-624.

Table 1. Weight matrices

	$W_{ij} = \frac{1}{d_{ij}}$	$W_{ij} = \frac{1}{d_{ij}^2}$
Euclidian distance (meters)	W1	W2
Travel time off-peak hours (minutes)	W3	W4
Travel time off-peak hours (minutes)	W5	W6

Table 2. Indicators of the provision of urban green spaces

Variable	Name	Mean	S.D.	Minimum	Maximum
Surface of UGSs in the municipality (%)	UGS_1	2.68	3.45	0.06	13.93
Surface per capita (square meter)	UGS_2	55.82	35.37	8.65	157.48
Expenditures (€ per capita)	UGS_3	51.62	27.20	11.60	156.71
Expenditures (€ per square meter)	UGS_4	1.21	.82	.29	3.57

Table 3. Descriptive statistics of explanatory variables

Variable	Unit	Mean	S.D.	Minimum	Maximum
Median Income	€	9937.14	1235.98	7979	13486
Taxe Price	Per inhabitant	0.0001798	0.0000936	0.0000037	0.000328
Population aged above 60	Percentage	19.94	5.61	10.1	38.5
Loire	Dummy indicating the adjacency to the Loire river	1.27	0.44	1	2
Coastal	Dummy indicating the adjacency to the ocean	1.20	0.40	1	2
Grasslands	Ratio of grasslands in the county total surface area	0.11	0.08	0	0.38
Vineyards	Ratio of vineyards in the county total surface area	0.03	0.08	0	0.41

Sources: National Institute of Statistics (INSEE), 1999 census, 2002 income indicators.

Table 4. Moran's I statistics

	W1		W2		W3		W4		W5		W6	
	Moran I	p-value	Moran I	p-value	Moran I	p-value	Moran I	p-value	Moran I	p-value	Moran I	p-value
UGS_1	0.126	0.000	0.333	0.000	0.067	0.000	0.223	0.000	0.055	0.000	0.192	0.000
UGS_2	- 0.009	0.386	0.000	0.379	- 0.017	0.447	- 0.008	0.435	- 0.018	0.423	- 0.010	0.448
UGS_3	0.034	0.004	0.071	0.038	0.027	0.002	0.085	0. 005	0.022	0.005	0.071	0.013
UGS_4	0.002	0.185	- 0.001	0.387	0.000	0.153	0.001	0.342	- 0.001	0.165	- 0.004	0.390

Table 5. Tests on spatial dependence

		W1		W2		W3		W4		W5		W6	
	UGS_1	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Spatial error	Moran's I	6.026	0.000	5.661	0.000	4.186	0.000	4.271	0.000	3.957	0.000	3.939	0.000
	LM	4.329	0.037	15.154	0.000	0.780	0.377	6.247	0.012	0.630	0.4277	5.012	0.025
	RLM	6.966	0.008	0.195	0.659	14.562	0.000	5.217	0.022	14.508	0.000	5.787	0.016
Spatial lag	LM	14.040	0.000	25.047	0.000	5.682	0.017	18.852	0.000	4.423	0.035	15.530	0.000
	RLM	16.678	0.000	10.088	0.001	19.463	0.000	17.822	0.000	18.301	0.000	16.304	0.000
	UGS_3	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Spatial error	Moran's I	0.614	0.539	0.319	0.750	0.701	0.483	0.835	0.404	0.457	0.648	0.504	0.614
	LM	0.390	0.532	0.231	0.631	0.399	0.527	0.026	0.872	0.536	0.464	0.172	0.679
	RLM	4.381	0.036	2.485	0.115	5.798	0.016	4.403	0.036	5.757	0.016	5.142	0.023

Spatial lag	LM RLM	0.023 4.014	0.880 0.045	0.042 2.296	0.837 0.130	0.015 5.413	0.904 0.020	0.533 4.909	0.465 0.027	0.001 5.221	0.981 0.022	0.234 5.204	0.629 0.023

Table 6. Maximum Likelihood Estimates

UGS_1	W1		W2		W3		W4		W5		W6	
	Coef.	p.	Coef.	p.	Coef.	p.	Coef.	p.	Coef.	p.	Coef.	p.
Median income	0.000	0.159	0.000	0.238	0.004	0.123	0.003	0.180	0.000	0.114	0.000	0.160
Tax price	- 11204.78	0.002	- 10306.92	0.002	- 11662.96	0.002	- 11029.18	0.001	- 11721.13	0.002	- 11240.83	0.001
Population aged above 60	0.165	0.004	0.180	0.001	0.153	0.010	0.171	0.001	0.150	0.013	0.164	0.003
Loire	2.265	0.001	1.856	0.003	2.440	0.000	1.969	0.001	2.474	0.000	2.055	0.001
Coastal	- 1.573	0.055	- 1.681	0.027	- 1.662	0.051	- 1.774	0.020	- 1.692	0.049	- 1.817	0.019
Grasslands	- 7.912	0.031	- 6.568	0.056	- 8.519	0.025	- 6.686	0.050	- 8.666	0.024	- 7.112	0.041
Vineyards	- 5.621	0.078	- 4.333	0.146	- 5.996	0.070	- 4.971	0.093	- 6.090	0.068	- 5.351	0.076
R^2	0.601		0.654		0.567		0.658		0.561		0.643	
Log likelihood	- 152.73		- 148.46		- 155.07		- 148.86		- 155.48		- 150.11	
ρ	0.835	0.000	0.675	0.000	0.770	0.000	0.832	0.000	0.744	0.002	0.818	0.000
Wald test	29.086	0.000	25.345	0.000	12.297	0.000	40.354	0.000	9.357	0.002	33.161	0.000
LR	9.350	0.002	17.901	0.000	4.678	0.031	17.093	0.000	3.852	0.050	14.598	0.000
LM	14.040	0.000	25.047	0.000	5.682	0.017	18.852	0.000	4.423	0.035	15.530	0.000

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