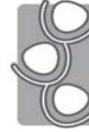




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Is there a "zoo effect" in French Local governments?

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Abstract

From the observation that many public goods –such as zoos– are indivisible, OATES (1988) put forward the idea that the range of public goods should increase with localities’ size; this is the “zoo effect”. But despite this argument appears obvious, it suffers from a limited empirical literature. Therefore, the purpose of the present paper is to test this theoretical argument using data on French inter-municipalities, i.e. local governments that gather several municipalities together in order to manage some local goods. Depending on their spatial position, we split our data set into three groups: urban, suburban and rural inter-municipalities. Using spatial econometrics, estimation results provide evidence for the existence of a zoo effect in French inter-municipalities. In other terms, we find that the variety of services provided in larger inter-municipalities exceeds those in smaller communities. Moreover, the intensity of the zoo effect depends on the urban-rural gradient. It is less intense in the suburban and rural areas than in the urban communities.

Keywords: local public services, population size, zoo effect, French jurisdictions, inter-municipalities, spatial econometrics.

JEL classification: H4, H7

1. Introduction

Since the seminal papers by BORCHERDING and DEACON (1972) and BERGSTROM and GOODMAN (1973), the estimation of demand functions for publicly provided goods has been widely studied in the literature. Based on the median voter model, both papers suggest that local and state governments provide goods which have roughly the same amount of rivalry in consumption as private goods do (REITER and WEICHENRIEDER, 2003). Their analysis facilitates their empirical implementation because it allows a derivation of a physical measurement of the publicly provided goods. However, OATES (1988) emphasizes one drawback of this approach that comes from the observation that the variety of services provided in larger cities exceeds those in smaller ones. The lower expenditure of smaller cities could not be explained by less crowding but simply from the fact that certain expenditure categories - such as a zoo – need a minimum population size to be supplied. This is the so called “zoo effect”.

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Although OATES' (1988) argument is greatly intuitive, it suffers from a lack of empirical evidences. Indeed, to our knowledge, the pioneer work on the zoo effect has been led by SCHMANDT and STEPHENS (1960), even before OATES (1988) had formalized it. In their study, they attempt to explain the number of services provided by some Milwaukee county municipalities. As a result, they highlight the expected positive relationship between municipalities' population size and the range of public services they supply.

In this paper, we keep the same general idea, but using modern econometric tools and grounding our estimations on a rich data set of 2,533 French inter-municipalities. Grouping several municipalities to collectively finance and manage some local public services, inter-municipalities gathered nearby 95% of French municipalities in 2010. Initially, this form of local cooperation has been widely prompted by the government thanks financial incentives in order to solve the problem of "municipal fragmentation" extremely intense in the country.² In that way, inter-municipalities were supposed to improve the coordination between local policies on one hand, and on the other hand, to release substantial economies of scale in order to reduce the public spending.

Therefore, the aim of this paper is to assess the impact of population size on the range of the public services provided by French inter-municipalities. In order to isolate this pure zoo effect, we have to cope with an indirect zoo effect, which can be explained by the French institutional context. In essence, the smaller is municipality, the more competences it will be likely to give to the inter-municipality, *ceteris paribus*. Our empirical specification allows us to disentangle those two effects. Moreover, we tried to improve our understanding of the relationship between the range of public services provided and the population size by considering the urban-rural gradient. Indeed, we think that the zoo effect may not exhibit the same features in urban, suburban and rural areas. Finally, we test for the existence of spatial correlation using spatial econometrics.

Besides, one should note that the issue raised by the zoo effect contributes to the active debate on the optimal organization of the public sector. Between centralization and decentralization, we arbitrate for higher economies of scale (i.e. less expensive public services), a higher range of public services, more rational local public policies vs. a better match between local public services supplied and heterogeneous citizens' preferences (de

² Nowadays, we count more than 36,500 French municipalities, i.e. nearby half of European municipalities (EU15). Consequently, 87% of French municipalities were smaller than 2,000 inhabitants in 2010, i.e. one fourth of the metropolitan French population. (DGCL - DESL, 2010)

TOQUEVILLE, 1935), a better control of citizens over government's actions (BRENNAN and BUCHANAN, 1980). At the same time, it also gives a critical view on the craze for inter-municipality in France, but also across European countries, in the sense that we accurately question the assumption that inter-municipality permits the diversification of local public goods supply. In that way, this paper deals with a phenomenon much larger than the simple case of the diversity of public services provided by French inter-municipalities.

The plan of the paper is as follows. We describe in the next section the zoo effect in detail. The French institutional context is presented in section 3. In Section 4 we present the methodology and the econometric model. Section 5 exhibits our estimation results. Conclusions are drawn in the final section.

2. The “zoo effect”: theory and empirics

Since many public goods –such as zoos– are indivisible, the range of public goods should increase with jurisdictions' size; this is the zoo effect as defined by OATES (1988). Basically, the intuition is that “the first 'unit' of output for such goods may require a substantial expenditure such that it does not become desirable to provide the good until population reaches a certain critical size –the size for which the sum of the marginal rates of substitution equals (or exceeds) the cost of the first unit” (OATES, 1988, p.88).

In line with the median voter model, OATES (1988) develops a framework where localities' expenditure level E is positively linked with the level of individual services³ L and with the range of services provided R :

$$E = f(L, R) \tag{1}$$

And by assumption, both L and R positively depend on localities' population N , that is:

$$L = g(N) \quad \text{and} \quad R = h(N) \quad \text{with} \quad g'(N) > 0 \quad \text{and} \quad h'(N) > 0 \tag{2}$$

Consequently, in presence of such a phenomenon, empirical studies would systematically underestimate the extent of economies of scale within the public sector. Indeed, OATES'

³ More specifically, L is defined in the existing literature as $L = TL/N^\gamma$, where TL is the total level of services provided by the jurisdiction with a population N , and γ is the crowding parameter (also called “capturability parameter”) such as $[\gamma = \varepsilon_{POP}/(1 + \varepsilon_{PRICE})]$ where ε_{POP} is the population elasticity of spending, and ε_{PRICE} is the price elasticity of demand.

(1988) original scope was to highlight a methodolnical weakness in both BORCHERDING and DEACON (1972), and BERGSTROM and GOODMAN (1973): without taking into account the zoo effect in the design of their econometric model, their estimates of the population elasticity of spending were upwardly biased, leading to a congestion parameter overvalued.⁴ In that way, the zoo effect contributes to the broad empirical literature that undertakes to identify the various explaining factors of the increasing level of public expenditure in developed countries over last decades. And more specifically, this is a relevant element in the valuation of economies of scale released by the collective production of public services.

But even if OATES' (1988) argument is greatly intuitive and has important consequences on the design of econometric models, it suffers from a lack of empirical evidences. As mentioned previously, SCHMANDT and STEPHENS' (1960) study appears, to our knowledge, as the only empirical work accurately dealing with the zoo effect phenomenon. Using a data set of 19 Milwaukee county municipalities, they build a service index based on a sharp partition of municipal services into 550 sub-functions.⁵ In this manner, they succeed in approximating the range of municipal public services by adding the number of those activities performed by each municipality. Finally, computing correlation coefficients, their study reveals that the bigger is a locality, the more diversify will be the supply of municipal services.

3. The French institutional context

From the beginning of the 90's, laws reviving local cooperation in France follow one another.⁶ Based on the volunteering principle, neighboring municipalities that desire to

⁴ $\frac{dE}{dN} = \frac{\partial E}{\partial L} \frac{dL}{dN} + \frac{\partial E}{\partial R} \frac{dR}{dN} > 0 \Rightarrow \varepsilon_{POP} = \frac{\partial E}{\partial L} \frac{dL}{dN} = \frac{dE}{dN} - \frac{\partial E}{\partial R} \frac{dR}{dN} = \hat{\varepsilon}_{POP} - \frac{\partial E}{\partial R} \frac{dR}{dN}$ with ε_{POP} the real population elasticity in comparison with $\hat{\varepsilon}_{POP}$ estimates of the population elasticity provided by BORCHERDING and DEACON (1972), and BERGSTROM and GOODMAN (1973), and $\frac{\partial E}{\partial R} \frac{dR}{dN}$ the zoo effect component.

⁵ For instance, "police protection is broken down into 65 categories including foot and motorcycle patrol, criminal investigation, youth aid bureau, ambulance and pulmotor service, school crossing guards, radio communication, radar speed units, and manual traffic control." (SCHMANDT and STEPHENS, 1960, 370-371)

⁶ Three laws mark important steps on the development of inter-municipality in France: the law of the 6th February 1992 lays down the basis of current inter-municipal cooperation that will be reinforced and simplified

collectively finance and manage some public services may create an inter-municipality. Then, this supra-municipal structure co-exists with the municipal ones and must respect both the “exclusivity” and “specialty” principles: competences given to an inter-municipality is not anymore exerted by any other local government unit and accurately delimit the field over which it can act within its perimeter. Initially, this form of local cooperation has been widely prompted by the government thanks financial incentives in order to solve the problem of “municipal fragmentation” extremely intense in the country.⁷ In that way, inter-municipalities were supposed to improve the coordination between local policies, to release substantial economies of scale in order to reduce the public spending, and to reduce fiscal and spending inequalities between member municipalities. This double objective should be reached by transferring both tax and spending abilities from municipalities to their inter-municipality.

Nowadays, 95% of French municipalities belong to one of those inter-municipalities. On the Map 1, we observe that the spatial repartition of inter-municipalities appears uniform and covering the quasi-totality of metropolitan France (Corse excluded). Here, we distinguish urban, suburban and rural inter-municipalities. Indeed, as we will see in section 5.1, data suggest that the intensity of the zoo effect differs from one space to another. The general idea is that given their position on the rural-urban gradient, inter-municipalities face different situations, in particular regarding spillover effects in the provision of local public goods or policies, which influence the number of public services locally provided.

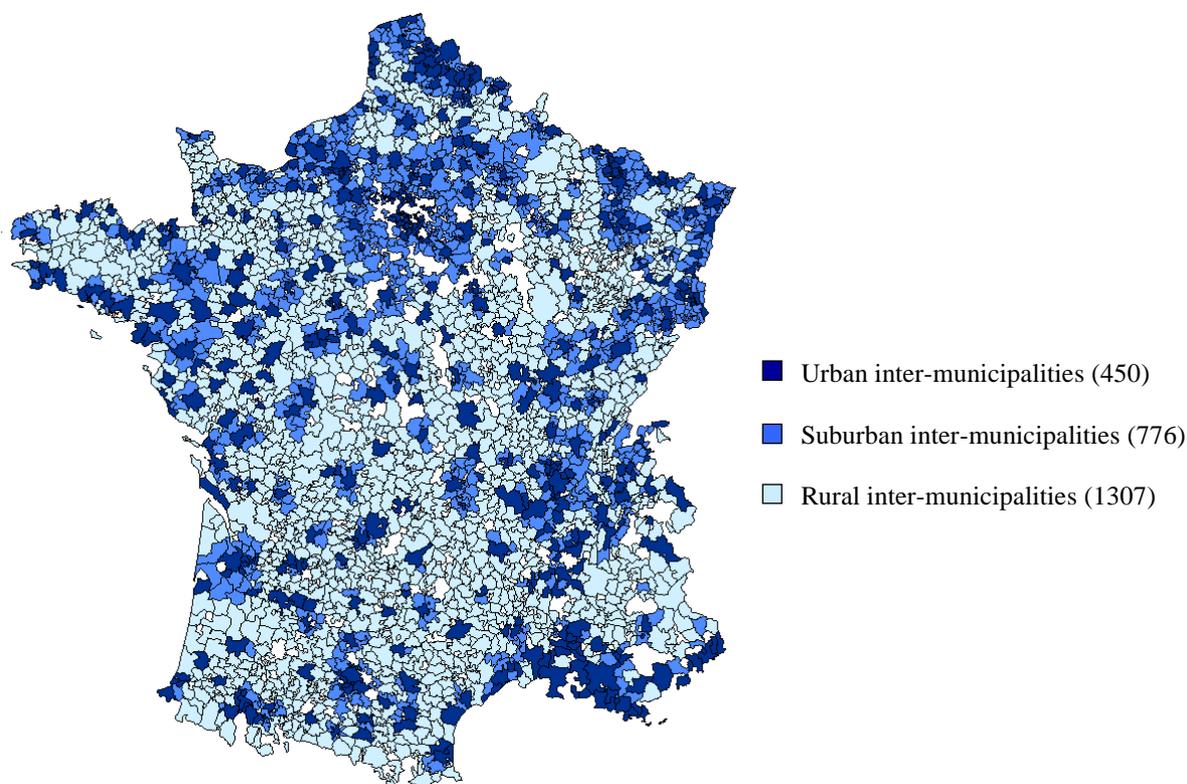
More precisely, we identify three jurisdictional forms of French inter-municipalities based on demographic criteria. The *communauté urbaine* (CU) must count at least 500,000 inhabitants, the *communauté d'agglomération* (CA) 50,000 inhabitants with a municipality bigger than 15,000 inhabitants, while there is no minimum size required for the *communauté de communes* (CC). As a result, the repartition of those three jurisdictional forms of French inter-municipality is highly unequal on the rural-urban gradient, with an over-representation of CUs and CAs in the urban space, while the suburban and rural spaces are exclusively constituted of CCs (see Table 1). Furthermore, we note that the mean number of municipalities per inter-municipality does not vary much from one space to another, with a

by the law of the 12th July 1999, and the law of the 13th August 2004 goes towards a rationalization of the inter-municipal map.

⁷ Nowadays, we count more than 36,500 French municipalities, i.e. nearby half of European municipalities (EU15). Consequently, 87% of French municipalities were smaller than 2,000 inhabitants in 2010, i.e. one fourth of the metropolitan French population. (DGCL-DESL, 2010)

National average of 13.2 (14.3 in the urban space, 12.4 in the suburban space and 13.2 in the rural space).

Map 1. *Spatial distribution of inter-municipal jurisdictions with their position on the rural-urban gradient*



Data source: INSEE-INRA, DGCL⁸

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⁸ INSEE: Institut National de la Statistique et des Etudes Economiques, INRA: Institut Nationale de la Recherche Agronomique, DGCL: Direction Générale des Collectivités Locales.

Table 1: *Distribution of the various types of inter-municipalities on the rural-urban gradient*

	Communauté urbaines	Communauté d'agglomération	Communauté de communes	Total
Urban	14	158	277	449
Suburban	0	3	772	775
Rural	0	2	1307	1309
National	14	163	2356	2533

Data source: INSEE-INRA, DGCL

In practice, municipalities democratically decide what competences will be transferred to their inter-municipality among 84 competences broken down in 14 categories. In that way, every competence judged as being of inter-municipal interest may be collectively financed and managed by the inter-municipality. However, this notion of inter-municipal interest greatly varies from an inter-municipality to another. Consequently, the number of competences transferred to an inter-municipality rests partly on strategic choices.

Besides, each jurisdictional status involves some compulsory competences. For instance, a CC must manage at least one competence pertaining to the “space planning” category, and another to the “economic development and planning” category. Similarly, a CA has to exert one competence related to four specific categories, and six for a CU.⁹ Consequently, we observe that economic planning and development competences, as garbage collection and treatment, are the competences the most frequently managed by inter-municipalities at the National level (see Table 2). One notes that this behavior clearly fits with government’s aims regarding the coordination between local policies and economies of scale particularly important in network services.

Nevertheless, legislation does not constitute a bias to our study. Indeed, it may impact inter-municipalities’ choices, but more marginally the number of competences they exert. On our whole sample of data, only three CCs have chosen to manage the minimum number of public services required by the law. Moreover, the mean number of competences by inter-municipalities remains much higher with a small standard deviation at any space considered. For instance, the average equals 17.5 with a standard deviation of 6.3 at the National level.

⁹ In addition to the “space planning” and “economic development and planning” categories, a CA must manage at least one competence pertaining to the “accommodation and housing conditions” category and another to the “urban policy”, while a CU must manage also a competence pertaining to the “management of collective interest services” and “environment and living environment” categories.

Table 2: Six most exerted competences by inter-municipalities by jurisdictional form and by space on the rural-urban gradient¹⁰

		1st	2nd	3rd	4th	5th	6th
By jurisdictional form	COMMUNAUTE URBAINE	Water treatment and distribtuion (100%)	Garbage collection (100%)	Organisation of urban public transport (100%)	Road maintenance (100%)	Local program for living environment (100%)	Collective cleaning-up (92.9%)
	COMMUNAUTE D'AGGLOMERATION	Economic planning (99.4%)	Local program for living environment (98.2%)	Organisation of urban public transport (96.9%)	Economic development (95.7%)	ZAC (93.3%)	SCoT (92.6%)
	COMMUNAUTE DE COMMUNES	Economic planning (89.3%)	Garbage collection (85.8%)	Economic development (84.9%)	Garbage treatment (82.7%)	Tourism (80.9%)	Other environmental actions (70.6%)
By space on the rural-urban gradient	URBAN	Economic planning (93.8%)	Economic development (89.8%)	Garbage collection (84.7%)	SCoT (84.2%)	Garbage treatment (82.9%)	Local program for living environment (81.8%)
	SUBURBAN	Economic planning (88.9%)	Garbage collection (86.2%)	Garbage treatment (84.8%)	Economic development (81.7%)	SCoT (75.3%)	Tourism (74.9%)
	RURAL	Economic planning (89.1%)	Economic development (86.3%)	Garbage collection (86.0%)	Tourism (85.8%)	Garbage treatment (82.0%)	Other environmental actions (72.2%)
	NATIONAL	Economic planning (89.9%)	Garbage collection (85.8%)	Economic development (85.5%)	Garbage treatment (83.0%)	Tourism (80.2%)	Other environmental actions (71.1%)

¹⁰

SCoT and ZAC denote town planning documents. They are competences of the category “space planning”. Percentages enter parenthesis denote the fraction of EPCIs of the group considered that manage a specific competence.

4. The econometric model

We here undertake to assess the zoo effect within French inter-municipalities. The basic idea is to estimate the impact of population size on the range of public services provided by inter-municipalities.

Indeed, in our case, we need to distinguish two phenomena. On one hand, the bigger is an inter-municipality the more public services it would supply to its citizens. This is the zoo effect as originally defined by OATES (1988) and empirically measured by SCHMANDT and STEPHENS (1960). But on the other hand, the number of competences an inter-municipality exerts partly rests on municipalities' choice between keeping a public service at the municipal level, or transferring it to the inter-municipality. In other words, they would arbitrate between giving up their political power on a particular competence (and risking to weaken the link with their electors), or attempting to release economies of scale and improve the coordination with neighboring municipal policies. Thus, we are confronted to an alternative effect: the indirect zoo effect. In essence, the smaller is a municipality, the smaller is its range of public services performed, and the more competences it will transfer to the inter-municipality, *ceteris paribus*.¹¹ As a result, the share of relative small municipalities within an inter-municipality would spur competences' transfers.

In addition, as data suggest (see section 5.1), we take into account spatial specificities of inter-municipalities distinguishing urban, suburban and rural inter-municipalities. The idea is that the relationship between the supply of public services and population size may differ from one space to another on the rural-urban gradient. More specifically, we expect the zoo effect to be less intense for suburban than urban inter-municipalities. Because of spillover effects and easy-riding behavior¹², they would generally be inclined to provide fewer public services as they would do if they were cut off. This behavior should also appear in rural inter-municipalities, but more marginally since easy-riding opportunities become scarcer as the distance with the urban area increases. However, since member municipalities' population is smaller as we as we turn to suburban and rural areas, citizens would better control government's actions and demand model would better fit data than supply ones (JOSSELIN *et al.*, 2009). Consequently, in order to preserve a strong link with citizens' preferences,

¹¹ This behavior has already been observed in the case of French inter-municipalities by LEPRINCE and GUENGANT (2002).

¹² In comparison with free-riding, easy-riding relaxes the assumption of zero contribution to public provision (CORNES and SANDLER, 1984).

suburban and mostly rural municipalities would tend to keep their decisional powers for local public services and the zoo effect should be less intense. But at the same time, we also note that some competences –such as “aid actions for higher education”– are systematically abandoned to the urban and suburban areas, limiting therefore the possibilities of competences coming under inter-municipal interest.

At the end, we should observe a less intense zoo effect in rural and suburban inter-municipalities than in urban ones. Furthermore, since rural inter-municipalities generally group small municipalities, the indirect zoo effect is more likely to be intense than for urban or suburban inter-municipalities.

Finally, following OATES’ (1988) specification (cf. equation 2), the general idea of the paper can be summed up by the following equation:

$$R_i = h [PopEPCI_i ; RRSM_i] \quad (3)$$

With R_i the range of public services provided by the inter-municipality, $PopEPCI$ its total population and $RRSM$ its rate of relative small municipalities that respectively measure the direct zoo effect (DZE) and the indirect zoo effect (IZE), such as by assumption:

$$\frac{dh}{dPopEPCI} = \frac{\partial h}{\partial DZE} \frac{dDZE}{dPopEPCI} \geq 0 \quad \text{and} \quad \frac{dh}{dRRSM} = \frac{\partial h}{\partial IZE} \frac{dIZE}{dRRSM} \geq 0$$

More precisely, R , $PopEPCI$ and $RRSM$ are obtained as follows:

- R is the number of competences exerted by an inter-municipality. Quarterly updated, this data base is provided by the DGCL. For each inter-municipality, it lists all member municipalities and based on the national nomenclature, all competences it exerts. All in all, it represents 14 categories broken down in 84 competences. (*Data source: DGCL, 2008*)
- $PopEPCI$ denotes the total population of the inter-municipality. For an inter-municipality grouping N municipalities j with a population Pop_j , $PopEPCI$ is basically defined as follows :

$$PopEPCI = \sum_{j=1}^N Pop_j$$

Because of the zoo effect, we expect a positive sign of the associated coefficient (see previous section). (*Data source: INSEE, 2006*)

- *RRSM* is the rate of relative small municipalities. For an inter-municipality grouping N municipalities j with a population Pop_j *RRSM* is defined as follows :

$$RRSM = \sum_{j=1}^N \frac{Pop_j}{PopEPCI} \frac{PopEPCI - Pop_j}{PopEPCI} = \sum_{j=1}^N \frac{Pop_j (PopEPCI - Pop_j)}{PopEPCI^2}$$

Therefore, the higher is *RRSM*, the smaller are municipalities grouped in the inter-municipality. And because of the indirect zoo effect, we expect a positive sign of the associated coefficient (see previously). (*Data source: INSEE, 2006*)

In a second time, as data suggest distinguishing urban, suburban and rural inter-municipalities (see section 5.1), we run our estimations on those three sub-samples. Here, we use the ZAUER (“zoning in urban areas and labor areas of the rural space”), a data base that locates French municipalities on the rural-urban gradient. Then, we affect an inter-municipality to the group that gather the majority of its inhabitants. (*Data source: INSEE-INRA, 1999*)

Additionally, the range of public services of the inter-municipality can be determined by structural characteristics of the inter-municipality (social, economic and geographic characteristics). Therefore, we include in our econometric those four additional explaining variables:

- *Surf* is the total surface area of the inter-municipality. This variable is supposed to take into account some network effects. More specifically, since we are following a *ceteris paribus* reasoning and we already control the total population of the inter-municipality with *PopEPCI*, *Surf* actually measures the impact of the population density on the number of competences exerted by an inter-municipality. Therefore, inter-municipalities where the population density is relatively low (i.e. for a given population level, the surface area is relatively important), gains released by economies of scale would be so small that municipalities would be inclined to conserve their decision-making powers and do not transfer their competence to the inter-municipality. This phenomenon would appear for some particular competences -such as “road maintenance” or “water treatment and distribution”- and we expect that it would be characteristic of rural inter-municipalities.¹³ Consequently, the surface area would have a negative impact on the

¹³ In contrast, we could imagine that inter-municipalities where the population density is relatively high (i.e. for a given population level, the surface area is relatively small), there would be some congestion effects

number of public services provided by inter-municipalities, mostly in rural areas more exposed to network effects. (*Data source: INSEE, 2006*)

- U is the unemployment rate of the inter-municipality calculated as a weighted average of municipal unemployment rates, where weights are municipalities' population. The expected impact of this variable on the number of competences is uncertain: if the inter-municipality is seen as a solution to solve imbalances on the local labor market, we should observe a positive impact. But on the other hand, municipalities where the unemployment rate is relatively high may prefer to keep their decisional powers on this sensitive point in order to hang on a strong relationship with their electors. (*Data source: INSEE, 2006*)
- $Pop15$ and $Pop60$ respectively denote, for each inter-municipality, the percentage of population under 15 years old and over 60 years old. These variables are obtained by a weighted average of municipal observations, where weights are municipalities' population. Here, we suppose that the political argument put forward for the variable $UnemployRate$ is weaker than the one of local efficiency. Therefore, when the share of young and old people in the inter-municipality is relatively high, municipalities would tend to transfer competences regarding exclusively this population (or corresponding to their particularly high demand for local public services) in order to decrease the production cost thanks economies of scale, or improve the quality of public services.

As a consequence, we extend the equation (3) in considering that the range of public services is also determined by the surface of inter-municipalities, $Surf_i$, by unemployment rate, U_i , and also by the structure of demography, $Pop15_i$ and $Pop60_i$.

$$R_i = h [PopEPCI_i ; RRSM_i ; Surf_i ; U_i ; Pop15_i ; Pop60_i] \quad (4)$$

Here, because of the availability of the data, we use three different bases, all dated from a different year: 2008 for the endogenous variable, 2006 for our explaining variables, and 1999 for inter-municipalities' spatial position on the rural-urban gradient. Nevertheless, we reasonably assume that it will not bias our estimation results. Indeed, even if suburbanization movements have been observed since 1999 in France, they remain marginal in comparison of

diminishing the net gains released by economies of scale. Also in that case, municipalities would be less favorable, *ceteris paribus*, to transfer those competences. Here, we would expect this phenomenon to be characteristic of urban EPCIs. Yet, none of the competences that an EPCI can exert appears as particularly sensitive to congestion effects.

the important number of observations we have. Moreover, our classification in only three groups should be less sensitive to those changes with respect to the original ZAUER classification that distinguishes six different spaces on the rural-urban gradient. Otherwise, studying the important waits for any modification of the competences exerted by an inter-municipality, we also reasonably suppose that the socio-economic situation observed in 2006 prevails to the competences exerted by inter-municipalities at the 01/01/2008, day of the first update of BANATIC file.

Therefore, we analyze the determinants of the range of public services, at the national level and then for each various space of the rural-urban gradient, by specifying the model according to Eq. (4):

$$\ln(R_i) = \beta_0 + \beta_1 \ln(\text{PopEPCI}_i) + \beta_2 \ln(\text{RRSM}_i) + \beta_3 \ln(\text{Surf}_i) + \beta_4 \ln(U_i) + \beta_5 \ln(\text{Pop15}_i) + \beta_6 \ln(\text{Pop60}_i) + \varepsilon_i \quad (5)$$

If spatial statistics applied to estimated Eq. (5) point the existence of spatial dependence in the model, the next step is to include it in the model's specification. Thus, we consider two ways to include spatial autocorrelation in the model:

The first, by a spatial error model (SEM):

$$\ln(R_i) = \beta_0 + \beta_1 \ln(\text{PopEPCI}_i) + \beta_2 \ln(\text{RRSM}_i) + \beta_3 \ln(\text{Surf}_i) + \beta_4 \ln(U_i) + \beta_5 \ln(\text{Pop15}_i) + \beta_6 \ln(\text{Pop60}_i) + \varepsilon_i$$

such as $\varepsilon_i = \lambda W \varepsilon_i + v_i$

Where W is the weight matrix based on euclidean distance decay between the inter-municipalities.

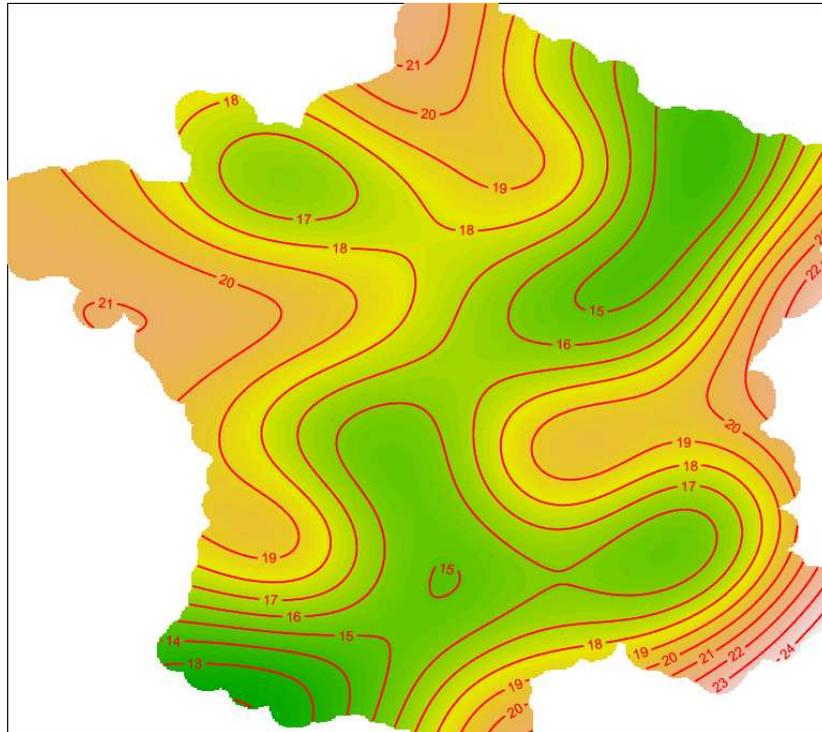
The second, by a spatial autoregressive model (SAR):

$$\ln(R_i) = \beta_0 + \rho \ln(WR_{.i}) + \beta_1 \ln(\text{PopEPCI}_i) + \beta_2 \ln(\text{RRSM}_i) + \beta_3 \ln(\text{Surf}_i) + \beta_4 \ln(U_i) + \beta_5 \ln(\text{Pop15}_i) + \beta_6 \ln(\text{Pop60}_i) + \varepsilon_i \quad (7)$$

As using OLS provide inconsistent and biased estimators, we use Maximum-Likelihood for the two models. Moreover, considering the Map 2, spatial correction appears pertinent as we observe a highly unequal repartition of the number of competences exerted by inter-municipalities on the French territory. Interestingly, we note that all along the “diagonal of the vacuum”, a straight line that goes through the country from North-East to South-West

characterized by a low population density, inter-municipalities exert a low number of competences.

Map 2: *Spatial distribution of the number of competences exerted by French inter-municipalities*¹⁴



5. Estimation results

Our estimation strategy is as follows. First, we estimate the model in equation (5) using OLS. At this point, we also confront the linearity hypothesis to the square hypothesis of the relation between the population of an inter-municipality and the number of competences it exerts by including $[\ln(\text{PopEPCI})]^2$ in our explanatory variables (see table in Appendix 1). Based on the OLS error term, we then derive from the best specification the Lagrange multipliers (Tables 3 and 5). First, the SARMA test will allow us to test the general hypothesis of the presence of spatial dependency in our model.¹⁵ Then, comparing significance levels of LM_{LAG} , LM_{ERR} and their robust versions RLM_{LAG} and RLM_{ERR} , we will be able to identify the source of the problem. More precisely, we apply the decision rule copied out in LE GALLO (2002, p.153):

¹⁴ The Map 2 is a graphical representation of a GAM (Generalized Additive Model) estimation where we explained the number of competences exerted by inter-municipalities as a function of their spatial coordinates.

¹⁵ Following a chi-square law, the null hypothesis is that there is no spatial autocorrelation.

If LM_{LAG} is more significant than LM_{ERR} and RLM_{LAG} is significant but not RLM_{ERR} , we are in presence of spatial *lag* dependency. Conversely, if LM_{ERR} is more significant than LM_{LAG} and RLM_{ERR} is significant but not RLM_{LAG} , we are in presence of spatial *error* dependency.

If we detect spatial error or lag dependency, we then implement the maximum likelihood (ML) to estimate respectively a SEM (spatial error) or a SAR (spatial autoregressive) model (Tables 4 and 6). First, we run our estimations at the National level and then, as data suggest, on three subsamples distinguishing urban, suburban and rural inter-municipalities.

5.1 At the National level

Table 3. Lagrange Multiplier tests on the whole sample

SARMA	LM_{ERR}	LM_{LAG}	RLM_{ERR}	RLM_{LAG}
650.3645 ($<.0001$)	650.200 ($<.0001$)	513.889 ($<.0001$)	136.475 ($<.0001$)	0.165 0.6848

p-value in parentheses.

Applying the decision rule previously set out, we detect the presence of spatial error dependency and consequently, we use the Spatial Error Model in order to correct our results and provide consistent and unbiased estimators.

Table 4. SEM estimation results on the whole sample

SEM		
<i>Intercept</i>	3.105***	($<.0001$)
$\log(\text{PopEPCI})$	-0.168***	(0.0080)
$[\log(\text{PopEPCI})]^2$	0.018***	($<.0001$)
$\log(\text{RRSM})$	0.067*	(0.0590)
$\log(\text{Surf})$	-0.003	(0.8144)
$\log(\text{UnemployRate})$	0.002	(0.9040)
$\log(\text{PopUnder15})$	0.049	(0.3612)
$\log(\text{PopOver60})$	0.098**	(0.0145)
λ	0.599***	($<.0001$)
In Likelihood	-733.7	
Observations	2537	

p-value in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Since we validate the quadratic forms in first step (see OLS estimation results in Appendix 1), we keep this specification to compute the ML estimators. Finally, both $\ln(\text{PopEPCI})$ and $[\ln(\text{PopEPCI})]^2$ appears significant, respectively with a negative and positive coefficient (Table 4). Therefore, given the specification in logarithms of our econometric model (Eq. 6) and considering the values of those coefficients, we observe that the range of public services provided by the inter-municipality is an increasing function of its population size, concave for smallest inter-municipalities (those with $\text{PopEPCI}_i < 301$) and convex for others (see Appendix 2 for more details). This result may basically reflect an indirect zoo effect –not totally capture by our variable RRSM– greater than the direct zoo effect in small inter-municipalities, while the tendency is reversed for inter-municipalities bigger than 300 inhabitants.

Result 1: There is a “zoo effect” in the French inter-municipalities. In other terms, the variety of services provided in larger inter-municipalities exceeds those in smaller communities. Otherwise, above a critical size (around 300 inhabitants), this effect is less intense as the population increases.

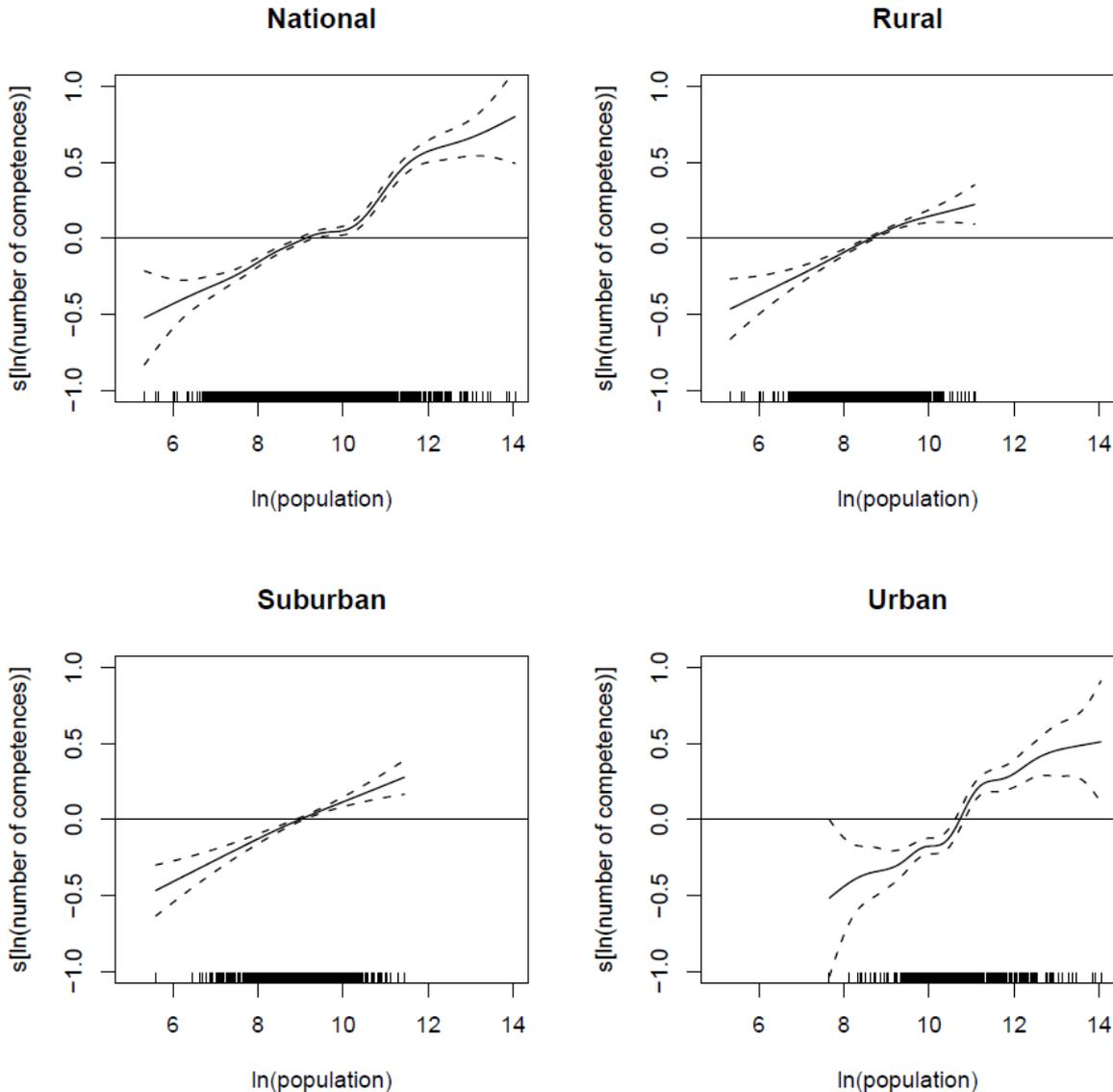
Before turning to other results, we look for improving our knowledge on the form of the function s linking the number of competences exerted by an inter-municipality with its population. Therefore, we estimate the following Generalized Additive Model (GAM):

$$\ln(R_i) = s [\ln(\text{PopEPCI}_i)] \quad (8)$$

Results are presented in Figure 1. From the intuition that inter-municipalities may face different situations according to their position on the rural-urban gradient, which may impact the intensity of the zoo effect, we then have distinguished urban, suburban and rural inter-municipalities.

Those diagrams strikingly go in favor of a distinction of those three spaces: rural and suburban areas present highly similar diagrams, with s assuming the form of an increasing quasi-linear function; while in comparison, urban areas are characterized by a function s less monotone, with a significant jump of the number of competences exerted by inter-municipalities around 60,000 inhabitants ($\approx e^{11}$). In order to address this issue, we re-estimate in next section our model for each subsample.

Figure 1. GAM estimation results at the National level, and for each space of the rural-urban gradient



5.2 On each space of the rural-urban gradient

As in section 5.1, we first estimate our model with the OLS method, validating this time the linear specification for each subsample (see Appendix 1), and derive from the error term the Lagrange multipliers. Here, we detect spatial error dependency in urban and suburban areas, and spatial lag dependency in rural areas (see Table 5). Consequently, we use the appropriate estimating method for each subsample and present results in Table 6.

Table 5. Lagrange Multiplier tests on each space of the rural-urban gradient

	SARMA	LM _{ERR}	LM _{LAG}	RLM _{ERR}	RLM _{LAG}
Urban	12.498 (0.0019)	10.339 (0.0013)	4.927 (0.0264)	7.570 (0.0060)	2.159 (0.1418)
Suburban	8.703 (0.0129)	7.522 (0.0061)	3.765 (0.0523)	4.938 (0.0263)	1.181 (0.2771)
Rural	317.517 (<.0001)	291.686 (<.0001)	314.860 (<.0001)	2.657 (0.1031)	25.830 (<.0001)

p-value in parentheses.

Table 6. SEM and SAR estimation results on each space of the rural-urban gradient

	Urban SEM	Suburban SEM	Rural SAR
<i>Intercept</i>	0.874** (0.0453)	1.915*** (<.0001)	0.276 (0.2349)
<i>log(PopEPCI)</i>	0.237*** (<.0001)	0.118*** (<.0001)	0.095*** (<.0001)
<i>log(RRSM)</i>	-0.011 (0.8585)	0.082 (0.4013)	0.148*** (0.0078)
<i>log(Surf)</i>	-0.0029463 (0.9045)	0.033 (0.2094)	0.019 (0.2880)
<i>log(UnemployRate)</i>	0.027 (0.6379)	-0.043 (0.2425)	-0.019 (0.3888)
<i>log(PopUnder15)</i>	0.091 (0.6129)	0.186 (0.1409)	0.024 (0.7061)
<i>log(PopOver60)</i>	0.094 (0.4234)	0.110 (0.1182)	0.030 (0.5651)
λ	0.283*** (0.0008)	0.329*** (0.0174)	- -
ρ	- -	- -	0.589*** (<.0001)
In Likelihood	-190.4	-291.5	-315.9
Observations	450	776	1311

p-value in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%.

First, we note that ML estimations provide a positive and highly significant parameter associated with the population size for urban, suburban and rural inter-municipalities. However, the value of this coefficient decreases as we turn to suburban and rural areas. As expected, it suggests that the zoo effect is more intense in urban areas than in suburban and

rural areas. Rural, and mostly suburban inter-municipalities, would take advantage of spillover effects on local public goods and behave as easy-riders. Moreover, this trend would be fostered by the fact that suburban, and mostly rural inter-municipalities, generally group small municipalities that would prefer a municipal management permitting a better appropriateness with their citizens' preferences (JOSSELIN *et al.*, 2009).

Result 2: The intensity of the “zoo effect” depends on the urban-rural gradient. It is less intense in suburban and rural areas than in urban ones.

Now, we focus our attention on the estimation results regarding the indirect zoo effect, *i.e.* the fact that a high proportion of small localities in an inter-municipality will favor the transfer of municipal competences to the inter-municipal group. This effect is taken into account by our variable *RRSM* whose associated parameter appears, in accordance with our expectations, positive and significant (at 1%) but only for the rural subsample.

Result 3: In rural areas, a high proportion of small communities tend to increase the number of competences exerted at the inter-municipal level.

Before turning to the other explanatory variables, we can notice another specificity of rural areas. Indeed, we find a positive and significant coefficient for the spatial lag parameter suggesting that the supply of public services provided in rural inter-municipalities depends on the supply of the neighboring communities. This is a mimicking behavior in the number of competences exerted by these inter-municipalities. A possible explanation may be given by a complementarity/continuity behavior of rural inter-municipalities in relation to urban and suburban areas: they would adjust their choices to the public services already provided by neighboring urban or suburban inter-municipality(ies). Two cases are considered: (1) if there *are* substantial spillover effects, rural inter-municipalities would provide public services that *are not* already provided by neighboring urban or suburban inter-municipality(ies) in order to diversify the range of local public services their citizens could enjoy (this is the complementarity behavior), or (2) if there *are not any* substantial spillover effects, rural inter-municipalities would provide public services that *are* already provided by neighboring urban or suburban inter-municipality(ies) in order to ensure a continuity in services locally provided (this is the continuity behavior). In that way, the number of competences exerted by rural

inter-municipalities would be locally similar from one to another. In addition, the lack of individual decisional power of rural inter-municipalities may emphasize this spatial dependency: they would be less able than urban or suburban inter-municipalities to make their choices autonomously and look for information in neighbors' practices.

Otherwise, spatial error dependency at the National level, and for urban and suburban subgroups, reveals some omitted explanatory variables spatially correlated with the error term. Yet, the maximum likelihood method provides unbiased and consistent estimators confirming the presence of a zoo effect in French inter-municipalities.

Finally, no other explanatory variables are significant, except for the proportion of population over 60 y.o. in the whole sample (see Table 4). This result reveals that inter-municipalities' socio-economic characteristics are not relevant in the number of competences they exert, which is even more puzzling for inter-municipalities in suburban or rural areas. Indeed, they generally group municipalities smaller than 5,000 inhabitants (the average municipal population is respectively around 900 and 600 inhabitants), the critical size below which demand models would better fit data than supply models regarding the provision of local public goods (JOSSELIN *et al.*, 2009). The most evident explanation is that contrary to municipalities, inter-municipalities are not subject to any voting process. In comparison, it would be interesting to study the impact of inter-municipalities' political characteristics –such as the political color or political fragmentation. Yet, such information is not available.¹⁶

6. Conclusion

The purpose of the present paper is to test this theoretical argument using data on French inter-municipalities, i.e. local governments that gather several municipalities together in order to manage some local goods. Depending on their spatial position, we split our data set into three groups: urban, suburban and rural inter-municipalities. Using spatial econometrics, estimation results provide evidence for the existence of a zoo effect in French inter-municipalities. In other terms, we find that the variety of services provided in larger inter-municipalities exceeds those in smaller communities. Moreover, the intensity of the zoo effect

¹⁶ More precisely, we know the political color of town councils only for municipalities where the population exceeds 3,500 inhabitants. But even if we would restrict our sample of data to inter-municipalities where every member municipalities respect this criterion, we do not know the accurate repartition of seats between municipalities at the inter-municipal council. Then, we are not able to take into account the political fragmentation, or even the political color, of inter-municipalities in our study.

depends on the urban-rural gradient. It is less intense in the suburban and rural areas than in the urban communities. Therefore, gathering citizens of various neighboring municipalities, inter-municipalities may promote the range of local public services. In comparison with a municipal management, this phenomenon could be fostered by economies of scale and higher tax revenues *via* an increase of local tax rates, consequence of a less intense local fiscal competition (CHARLOT *et al.*, 2009).

Appendix 1: OLS parameter estimates

	National, N = 2537			Urban, N = 450			Suburban, N = 776			Rural, N = 1311		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<i>Intercept</i>	1.402*** (<.0001)	2.396*** (<.0001)	2.697*** (<.0001)	0.611*** (0.0017)	0.309 (0.828)	0.729* (0.0964)	1.679*** (<.0001)	0.618 (0.530)	1.890*** (<.0001)	1.668*** (<.0001)	0.556 (0.4360)	1.694*** (<.0001)
<i>ln(PopEPCI)</i>	0.155*** (<.0001)	-0.057 (0.3802)	-0.104 (0.1224)	0.226*** (<.0001)	0.282 (0.282)	0.230*** (<.0001)	0.122*** (<.0001)	0.363 (0.102)	0.119*** (<.0001)	0.1301*** (<.0001)	0.392** (0.0188)	0.132*** (<.0001)
<i>[ln(PopEPCI)]²</i>	- (0.0011)	0.011*** (<.0001)	0.014*** (<.0001)	- (0.831)	-0.003 (0.831)	- (0.831)	- (0.276)	-0.014 (0.276)	- (0.276)	- (0.276)	-0.015 (0.1154)	- (0.1154)
<i>ln(RRSM)</i>	0.076** (0.0261)	0.093*** (0.0072)	0.055 (0.1365)	-0.025 (0.6821)	-0.025 (0.685)	-0.025 (0.6949)	0.148* (0.0886)	0.140 (0.109)	0.085 (0.382)	0.212*** (0.0001)	0.206*** (0.0002)	0.186*** (0.0021)
<i>ln(Surf)</i>	- (0.6791)	- (0.6791)	0.024** (0.0383)	- (0.6791)	- (0.6791)	0.001 (0.6791)	- (0.350)	- (0.350)	0.024 (0.350)	- (0.350)	- (0.350)	0.010 (0.6106)
<i>ln(UnemployRate)</i>	- (0.9932)	- (0.9932)	-0.034* (0.0678)	- (0.9932)	- (0.9932)	-0.001 (0.9932)	- (0.307)	- (0.307)	-0.038 (0.307)	- (0.307)	- (0.307)	-0.052** (0.0294)
<i>ln(PopUnder15)</i>	- (0.8412)	- (0.8412)	0.097* (0.0860)	- (0.8412)	- (0.8412)	0.036 (0.8412)	- (0.240)	- (0.240)	0.148 (0.240)	- (0.240)	- (0.240)	0.090 (0.1907)
<i>ln(PopOver60)</i>	- (0.4161)	- (0.4161)	0.107*** (0.0087)	- (0.4161)	- (0.4161)	0.097 (0.4161)	- (0.127)	- (0.127)	0.107 (0.127)	- (0.127)	- (0.127)	0.044 (0.4447)
R²	0.1897	0.1931	0.1984	0.2672	0.2672	0.2703	0.0849	0.0863	0.0905	0.1004	0.1021	0.1051

p-value in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix 2

Given the specification of our econometric model (see Eq. 6) and considering only the explaining variables that appears significant in ML estimation result for the whole sample of data (see Table 5, column 1), we have:

$$\ln(R_i) = \beta_0 + \beta_1 \ln(PopEPCI_i) + \beta_2 \ln(RRSM_i) + \beta_3 \ln(Surf_i) + \beta_4 \ln(U_i) \\ + \beta_6 \ln(Pop60_i) + \lambda W \varepsilon_i$$

$$\Leftrightarrow R_i = A_i \times PopEPCI_i^{\beta_1 + \beta_2 \ln(PopEPCI_i)} = A_i \times e^{[\beta_1 + \beta_2 \ln(PopEPCI_i)] \ln(PopEPCI_i)}$$

$$\text{with } A_i = e^{\beta_0} RRSM_i^{\beta_3} Pop60_i^{\beta_4} e^{\lambda W \varepsilon_i}$$

Then, in order to identify the form of the relationship between R_i and $PopEPCI_i$, we compute the first and second derivatives:

$$\frac{dR_i}{dPopEPCI_i} = A_i \frac{\beta_1 + 2\beta_2 \ln(PopEPCI_i)}{PopEPCI_i} e^{[\beta_1 + \beta_2 \ln(PopEPCI_i)] \ln(PopEPCI_i)},$$

$$\frac{d^2 R_i}{d^2 PopEPCI_i} = A_i \frac{2\beta_2 - [\beta_1 + 2\beta_2 \ln(PopEPCI_i)] + [\beta_1 + 2\beta_2 \ln(PopEPCI_i)]^2}{PopEPCI_i} e^{[\beta_1 + \beta_2 \ln(PopEPCI_i)] \ln(PopEPCI_i)}$$

Next step, we compute the value(s) of $PopEPCI_i$ that make then null under the hypothesis that A_i and $PopEPCI_i$ are strictly positive:

$$\frac{dR_i}{dPopEPCI_i} = 0 \text{ for } PopEPCI_i = e^{-\frac{\beta_1}{2\beta_2}} \text{ that we denote by } x^1,$$

$$\frac{d^2 R_i}{d^2 PopEPCI_i} = 0 \text{ for } PopEPCI_i = e^{-\frac{\beta_1}{2\beta_2} + \frac{1}{4\beta_2}(1-\sqrt{1-8\beta_2})} \text{ and } PopEPCI_i = e^{-\frac{\beta_1}{2\beta_2} + \frac{1}{4\beta_2}(1+\sqrt{1-8\beta_2})} \text{ that}$$

we respectively denote by x_1^2 and x_2^2 .

We first note that the second derivative admits some values of $PopEPCI_i$ that make it null iff $\beta_2 < 0.125$, and second that $x^1 < x_1^2 < x_2^2$ if $0 < \beta_2 < 0.125$, which is the case with our ML estimations at the National level (Table 5, column 1). Moreover, considering our estimated

values for β_1 and β_2 coefficients ($\hat{\beta}_1 = -0.168 < 0$ and $0 < \hat{\beta}_2 = 0.018 < 0.125$), we observe that the first derivate is negative before x^1 and positive after, and coherently that the second derivate is positive for $0 < PopEPCI_i < x_1^2$, negative for $x_1^2 < PopEPCI_i < x_2^2$, and positive for $x_2^2 < PopEPCI_i$. In that way, we are able to dress the following variation table of the function h :

$PopEPCI$	x^1	x_1^2	x_2^2
Variations of h	decreasing	increasing	increasing
Form of h	convex	convex	concave
			increasing
			convex

Yet, our estimation results suggest that none of French inter-municipalities group a population less than x^1 (the smallest inter-municipality groups 207 inhabitants while $x^1 \approx 106$), or even more than x_2^2 (the biggest inter-municipality groups 1,253,178 inhabitants while $x_2^2 \approx 4.358 \times 10^{13}$). Therefore, our function h is increasing on the whole sample of data, but concave for smallest inter-municipalities (those with $PopEPCI_i < x_1^2 \approx 301$) and convex for others.

References

- BERGSTROM T.C. and GOODMAN R.P. (1973). Private Demands for Public Goods. *The American Economic Review*, 63(3), 280-296.
- BORCHERDING T.E. and DEACON R.T. (1972). The Demand for the Services of Non-Federal Governments. *The American Economic Review*, 62(5), 891-901.
- BRENNAN G., BUCHANAN J. (1980). *The power to tax*. Cambridge: Cambridge University Press.
- BREUNIG R. and ROCABOY Y. (2008). Per-capita public expenditures and population size: a non-parametric analysis using French data. *Public Choice*, 136(3), 429-455.
- CHARLOT S., PATY S. and PIGUET V. (2009). The Effects of Fiscal Cooperation on Local Taxation: The French Case. *Working paper*.
- CORNES R. and SANDLER T. (1984). Easy riders, joint production, and public goods. *The Economic Journal*, 94(375), 580-598.
- JOSSELIN J.M., ROCABOY Y., TAVERA C. (2009). The Influence of Population Size on the Relevance of Demand or Supply Models for Local Public Goods: Evidence from France. *Papers in Regional Science*, 88(3), 563-574.
- LE GALLO J. (2002). Économétrie spatiale : l'autocorrélation spatiale dans les modèles de régression linéaire. *Economie et Prévision*, 155(4), 139-157.
- LEPRINCE M., GUENGANT A. (2002). Interactions fiscales verticales et réaction des communes à la coopération intercommunale. *Revue Economique*, 53(3), 525-535.
- OATES W.E. (1988). On the Measurement of Congestion in the Provision of Local Public Goods. *Journal of Urban Economics*, 24(1), 85-94.
- REITER M., WEICHENRIEDER A. (2003). Are Public Goods Public? A critical survey of the Demand estimates for local public services. Mimeo.
- SCHMANDT H.J., STEPHENS G.R. (1960). Measuring Municipal Output. *National Tax Journal*, 13(4), 369-375.
- (De) TOCQUEVILLE A. (1935). *De la démocratie en Amérique*. Paris: M.Th Génin.