Is there any 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 varieties 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.

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".

Although OATES' (1988) argument is greatly intuitive and involves important implications on the design of econometric models, 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. Using a data set on 19 Milwaukee county municipalities, they build a service index based on a sharp partition of municipal services into 550 sub-functions.[1] 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, their study reveals that the bigger is a locality, the more diversify will be the supply of municipal services.

However, beneath an apparent strong support to the zoo effect, this study suffers from econometric weakness. First in question, the small number of observations (19 observations) and second, the weakness of the econometric method used (correlation coefficients). Therefore, the first scope of this paper is to look for empirical evidences of the zoo effect, using modern econometric tools, and grounding our estimations on a data set of 2552 French inter-municipalities ("Etablissement Public de Coopération Intercommunale" in French). Grouping several municipalities to collectively finance and manage some local public services, those 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 a "substitution effect", which can be explained by the French institutional context. In essence, the smaller is municipality, the more competences it will be likely to transfer to the EPCI, *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

[1] 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)

[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)

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 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 methodolny and the econometric model. Section 5 exhibits our estimation results. Conclusions are dressed 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 services[3] *L* and with the range of services provided *R*:

[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

$$E = f(L,R) \quad (1)$$

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

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

Consequently, in presence of such a phenomenon, empirical studies would systematically underestimate the extend of economies of scale within the public sector. Indeed, OATES' (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 some consequences on the design of econometric models, it suffers from a lack of empirical evidences. Indeed, to our knowledge, the only one empirical study that exclusively deals with the zoo effect phenomenon has been led by SCHMANDT and STEPHENS (1960), even before OATES (1988) had formalized it. Using a data set on 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, their study reveals that the bigger is a locality, the more diversify will be the supply of municipal services.

"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.

[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)

However, beneath an apparent strong support to the zoo effect, this study suffers from econometric weakness. First in question, the small number of observations (19 observations) and second, the weakness of the econometric method used (correlation coefficients). Therefore, the scope of this paper is to look for empirical evidences of the zoo effect, using modern econometric tools, and grounding our estimations on a rich data set on French inter-municipalities.

3. The French institutional context

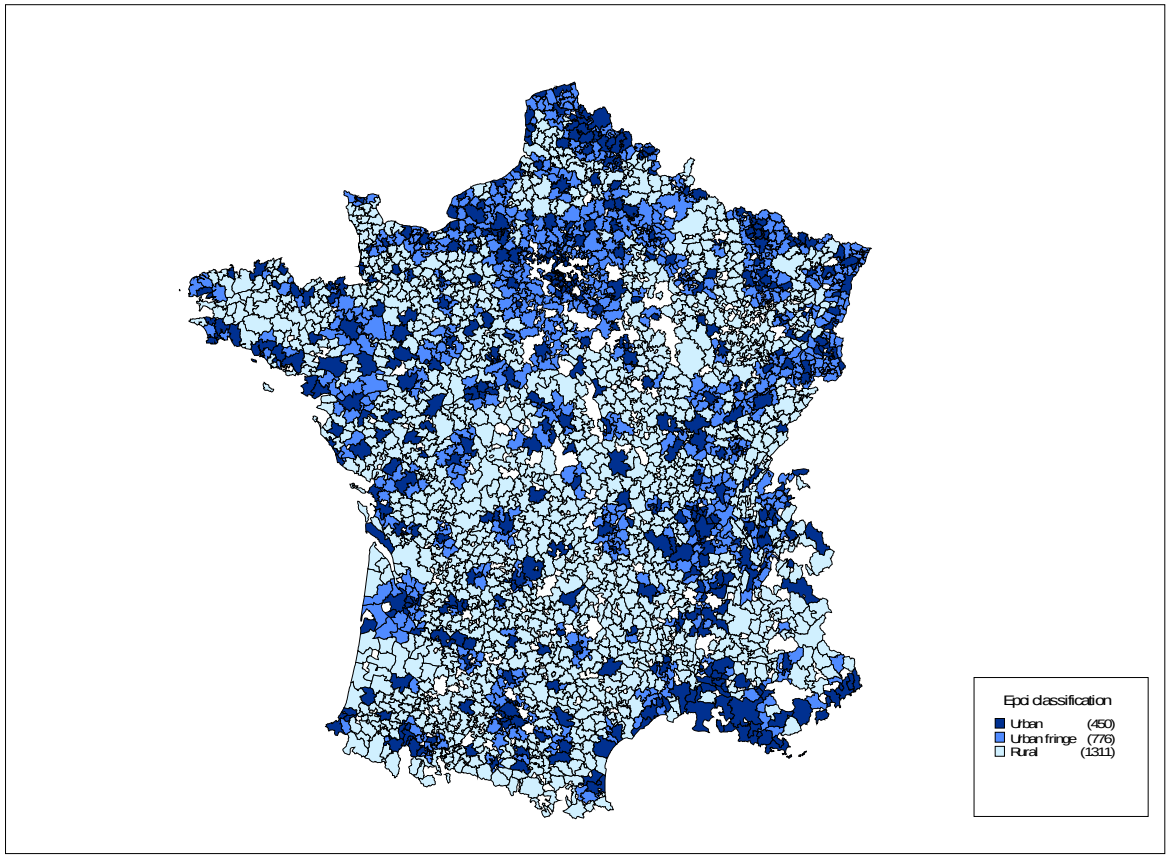
From the beginning of the 90's, laws reviving local cooperation in France follow one another.[6] Based on the volunteering principle, neighboring municipalities that desire to collectively finance and manage some public services may create an EPCI (Etablissement Public de Coopération Intercommunale). 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, EPCI 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 EPCI. Nowadays, 95% of French municipalities belong to one of those EPCI.

In order to take into account spatial specificities of EPCIs in our study, we distinguish urban, suburban and rural inter-municipalities (see Section 4 for more details on the method and data used). This caution will allow us to consider some spillover effects of local public goods and policies in more detailed analyses of our results. Thus, spatial repartition of inter-municipalities appears uniform and covering the quasi-totality of metropolitan France (see Map 1).

[6] Three laws show 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 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) Redondant avec l'intro…

MAP 1. Distribution of inter-municipal jurisdictions with their spatial position on the rural-urban gradient



(Data source: INSEE-INRA, DGCL)[8]

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 EPCI does not vary much from one space to another, with a National average of 13.2 (14.3 in the urban space, 12.4 in the suburban space and 13.2 in the rural space).

[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 EPCI on the rural-urban gradient

	Communauté urbaine	Communauté d'agglomération	Communauté de communes	**TOTAL**
Urban	14	158	278	450
Suburban	0	3	773	776
Rural	0	2	1309	1311
National	14	163	2360	2537

(Data source: INSEE-INRA, DGCL)

In practice, municipalities democratically decide what competences will be transferred to their EPCI 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 EPCI. However, this notion of inter-municipal interest greatly varies from an inter-municipality to another. Consequently, the number of competences transferred to an EPCI 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 EPCI's 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 EPCI 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 EPCIs by jurisdictional form and by space on the rural-urban gradient[10]

		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 "substitution 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, 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 on the rural-urban gradient. More specifically, we expect that the zoo effect is less intense for suburban than urban inter-municipalities. Because of spillover effects and easy-riding behavior, 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 EPCIs, but more marginally since easy-ridding opportunities become scarcer as the distance with the urban area increases. However, we note that member municipalities' population is smaller as we as we turn to suburban and rural areas. Then, citizens would better control government's actions and demand model better fits data than supply ones (JOSSELIN *et al.*, 2009). Consequently, in order to preserve a strong link with citizens' preferences, 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

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

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 EPCIs than urban and even suburban EPCIs. Furthermore, since rural inter-municipalities generally group small municipalities, the substitution 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:

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

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 zoo effect (*ZE*) and the substitution effect (*SE*), such as by assumption:

$$\frac{dh}{dPopEPCI} = \frac{\partial h}{\partial ZE}\frac{dZE}{dPopEPCI} \geq 0 \quad \text{and} \quad \frac{dh}{dRRSM} = \frac{\partial h}{\partial SE}\frac{dSE}{dRRSM} \geq 0$$

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

- *R* is the number of competences exerted by an EPCI. Quarterly updated, this data base is provided by the DGCL. For each EPCI, 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 EPCI. For an EPCI 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 EPCI grouping *N* municipalities *j* with a population Pop_j *RRSM* is defined as follows :

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

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

Next, in order to build our three groups distinguishing urban, suburban and rural EPCIs, we use the ZAUER ("zoning in urban areas and labor areas of the rural space") created by the INSEE and INRA. More precisely, since this data base locates municipalities on the rural-urban gradient, we affect an EPCI to the group that gather the majority of its inhabitants. Then, adding the whole sample of observations, we can run our estimations on four groups.

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 EPCI. 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 EPCI with *PopEPCI*, *Surf* actually measures the impact of the population density on the number of competences exerted by an EPCI. Therefore, inter-municipalities where the population density is relatively low (i.e. for a given population level, the surface area is relatively important), there would be less economies of scale possible and municipalities would be inclined to conserve their decision-making powers and do not transfer their competence to the EPCI. 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 EPCIs.[12] Consequently, we suppose a negative impact of Surf on

[12] 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 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

the number of public services provided by rural inter-municipalities, and more marginal for urban and suburban ones. *(Data source: INSEE, 2006)*

- *U* is the unemployment rate of the EPCI 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 EPCI, 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 EPCI 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 $Pop60_i$.

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

Here, we must underline a weakness of the data we use. Indeed, because of the availability of the data, we use three different bases all dated from a different year: 2008 for endogenous variable, 2006 for our explaining variables, and 1999 for EPCIs' spatial position on the rural-urban gradient. Nevertheless, we reasonably assume that it will not bias our

characteristic of urban EPCIs. Yet, none of the competences that an EPCI can exert appears as particularly sensitive to congestion effects.

estimation results. Indeed, even if suburbanization movements have been observed since 1999 in France, they remain marginal in comparison of 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 EPCI, we also reasonably suppose that the socio-economic situation observed in 2006 prevails to the competences exerted by EPCIs at the 01/01/2008, day of the first update of BANATIC file.

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

$$\ln(R_i) = \beta_0 + \beta_1 \ln(PopEPCI_i) + \beta_2 \ln(RRSM_i) + \beta_3 \ln(Surf_i) + \beta_4 \ln(U_i) + \beta_5 \ln(Pop15_i) + \beta_6 \ln(Pop60_i) + \varepsilon_i \quad (5)$$

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):

$$\ln(R_i) = \beta_0 + \beta_1 \ln(PopEPCI_i) + \beta_2 \ln(RRSM_i) + \beta_3 \ln(Surf_i) + \beta_4 \ln(U_i) + \beta_5 \ln(Pop15_i) + \beta_6 \ln(Pop60_i) + \varepsilon_i \quad (6)$$

$$\text{such as } \varepsilon_i = \lambda W \varepsilon_{-i} + \nu_i$$

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

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

$$\ln(R_i) = \beta_0 + \rho \ln(WR_{-i}) + \beta_1 \ln(PopEPCI_i) + \beta_2 \ln(RRSM_i) + \beta_3 \ln(Surf_i) + \beta_4 \ln(U_i) + \beta_5 \ln(Pop15_i) + \beta_6 \ln(Pop60_i) + \varepsilon_i \quad (7)$$

As using OLS provide inconsistent and biased estimators we use Maximum-Likelihood for the two models.

5. Estimation results

Our estimation strategy is as follows. We first 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 $[\ln(PopEPCI)]^2$ in our explanatory variables (see Table 3). We then derive from the best specification the Lagrange multiplier tests for the whole sample and the three sub-samples taking into account the rural-urban gradient (see Table 4). First, the SARMA test will allow us to test the general hypothesis of the presence of spatial dependency in our model.[13] Then, comparing significativity 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):

> 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.

We detect the existence of spatial correlation in the residuals for each sample except for the rural sample, where we found a spatially dependent variable (see table 4). We then implement the maximum likelihood (ML) to estimate a SEM (spatial error) or a SAR (spatial autoregressive) model.

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

TABLE 3. 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)*
Intercept	1.402***	2.396***	2.697***	0.611***	0.309	0.729*	1.679***	0.618	1.890***	1.668***	0.556	1.694***
	(<.0001)	(<.0001)	(<.0001)	(0.0017)	(0.828)	(0.0964)	(<.0001)	(0.530)	(<.0001)	(<.0001)	(0.4360)	(<.0001)
ln(*PopEPCI*)	0.155***	-0.057	-0.104	0.226***	0.282	0.230***	0.122***	0.363	0.119***	0.1301***	0.392**	0.132***
	(<.0001)	(0.3802)	(0.1224)	(<.0001)	(0.282)	(<.0001)	(<.0001)	(0.102)	(<.0001)	(<.0001)	(0.0188)	(<.0001)
[ln(*PopEPCI*)]²	-	0.011***	0.014***	-	-0.003	-	-	-0.014	-	-	-0.015	-
	-	(0.0011)	(<.0001)	-	(0.831)	-	-	(0.276)	-	-	(0.1154)	-
ln(*RRSM*)	0.076**	0.093***	0.055	-0.025	-0.025	-0.025	0.148*	0.140	0.085	0.212***	0.206***	0.186***
	(0.0261)	(0.0072)	(0.1365)	(0.6821)	(0.685)	(0.6949)	(0.0886)	(0.109)	(0.382)	(0.0001)	(0.0002)	(0.0021)
ln(*Surf*)	-	-	0.024**	-	-	0.001	-	-	0.024	-	-	0.010
	-	-	(0.0383)	-	-	(0.6791)	-	-	(0.350)	-	-	(0.6106)
ln(*UnemployRate*)	-	-	-0.034*	-	-	-0.001	-	-	-0.038	-	-	-0.052**
	-	-	(0.0678)	-	-	(0.9932)	-	-	(0.307)	-	-	(0.0294)
ln(*PopUnder15*)	-	-	0.097*	-	-	0.036	-	-	0.148	-	-	0.090
	-	-	(0.0860)	-	-	(0.8412)	-	-	(0.240)	-	-	(0.1907)
ln(*PopOver60*)	-	-	0.107***	-	-	0.097	-	-	0.107	-	-	0.044
	-	-	(0.0087)	-	-	(0.4161)	-	-	(0.127)	-	-	(0.4447)
R^2	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%.

TABLE 4. Lagrange Multiplier tests

	National	**Urban**	**Suburban**	**Rural**
LM_{ERR}	650.200 (<.0001)	10.339 (0.0013)	7.522 (0.0061)	291.686 (<.0001)
LM_{LAG}	513.889 (<.0001)	4.927 (0.0264)	3.765 (0.0523)	314.860 (<.0001)
RLM_{ERR}	136.475 (<.0001)	7.570 (0.0060)	4.938 (0.0263)	2.657 (0.1031)
RLM_{LAG}	0.165 0.6848	2.159 (0.1418)	1.181 (0.2771)	25.830 (<.0001)
SARMA	650.3645 (<.0001)	12.498 (0.0019)	8.703 (0.0129)	317.517 (<.0001)

p-value in parentheses.

TABLE 5. Spatial Error Model and Spatial Autoregressive Model estimation results

	National SEM	**Urban** SEM	**Suburban** SEM	**Rural** SAR
Intercept	3.105*** (<.0001)	0.874** (0.0453)	1.915*** (<.0001)	0.276 (0.2349)
ln(*PopEPCI*)	-0.168*** (0.0080)	0.237*** (<.0001)	0.118*** (<.0001)	0.095*** (<.0001)
[ln(*PopEPCI*)]²	0.018*** (<.0001)	- -	- -	- -
ln(*RRSM*)	0.067* (0.0590)	-0.011 (0.8585)	0.082 (0.4013)	0.148*** (0.0078)
ln(*Surf*)	-0.003 (0.8144)	-0.003 (0.9045)	0.033 (0.2094)	0.019 (0.2880)
ln(*UnemployRate*)	0.002 (0.9040)	0.027 (0.6379)	-0.043 (0.2425)	-0.019 (0.3888)
ln(*PopUnder15*)	0.049 (0.3612)	0.091 (0.6129)	0.186 (0.1409)	0.024 (0.7061)
ln(*PopOver60*)	0.098** (0.0145)	0.094 (0.4234)	0.110 (0.1182)	0.030 (0.5651)
λ	0.599*** (<.0001)	0.283*** (0.0008)	0.329*** (0.0174)	- -
ρ	- -	- -	- -	0.589*** (<.0001)
Ln Likelihood	-733.7	-190.4	-291.5	-315.9
Observations	2537	450	776	1311

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

Considering a linear model estimating on the whole sample using OLS, we first find a positive and significant parameter for the population size of the inter-municipality (Table 3, column 1). However, we also validate the quadratic form with a positive and significant sign for $[\ln(PopEPCI)]^2$, while $\ln(PopEPCI)$ is not significant anymore (Table 3, columns 2-3). Then using ML, $\ln(PopEPCI)$ again appears significant but with a negative sign, while the coefficient for $[\ln(PopEPCI)]^2$ remains significantly positive (Table 5, column 1). 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 EPCIs (those with $PopEPCI_i < 301$) and convex for others (see Appendix for more details). This result may reflect either a substitution effect, or some other effects (like a congestion effect) that diminish the gains released by a collective management of local public services.

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 population increases.

However, as argued before, our aim is to assess the extent of this effect taking into account the rural- urban gradient. The estimation results show that the linear model is the best specification for each subsample. Using OLS and ML, we then find a positive and very significant parameter associated with population size for urban, suburban and rural communities. However, the value of this coefficient decreases as we turn to suburban and rural areas. As expected, this suggests that the zoo effect is more intense in urban areas than in suburban areas and rural areas. Suburban inter-municipalities would take advantage of spillover effects on local public goods and behave as a easy-rider, whilst rural ones 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 the suburban and rural areas than in the urban communities.

We now turn to the estimation results associated with the "substitution effect", i.e. the fact that a high proportion of small localities in an inter-municipality will favor the transfer of municipal competencies to the inter-municipal group. This effect is taken into account using variable RRSM. The parameter associated with this variable is positive and significant (at 1%) 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. 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 is given by a complementarity/continuity behavior of rural EPCIs in relation to urban and suburban areas: they would adjust their choices to the public services already provided by neighboring urban or suburban EPCI(s). Two cases are considered: (1) if there *are* substantial spillover effects, rural EPCIs would provide public services that *are not* already provided by neighboring urban or suburban EPCI(s) 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 EPCIs would provide public services already *are* already provided by neighboring urban or suburban EPCI(s) 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.

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 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. This result reveals that EPCIs' socio-economic characteristics are not relevant in the number of competences they exert, which is more

puzzling for inter-municipalities in suburban or rural areas. Indeed, they generally group municipalities smaller than 5000 inhabitants (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, EPCIs are not subject to any voting process. In comparison, it would be interesting to study the impact of EPCIs' political characteristics – such as the political color or political fragmentation. Yet, such information is not available.

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" 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-municipality allows one to diversify 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).

Otherwise, we notice that for a similar problem, BREUNIG and ROCABOY (2008) conclude in favor of non-parametric methods that allowed them to identify a U-shaped relationship between per-capita public expenditures and population at the municipal level, result that was not revealed by parametric methods. Therefore, the next step will be to lead an accurate test on the linearity hypothesis of the relation "number of competences-population" using those econometric methods.

Appendix

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:

$$\ln(R_i) = \beta_0 + \beta_1 \ln(PopEPCI_i) + \beta_2 \ln(RRSM_i) + \beta_3 \ln(Surf_i) + \beta_4 \ln(U_i) + \beta_6 \ln(Pop60_i) + \lambda W\varepsilon_{-i}$$

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

$$\text{with } A_i = e^{\beta_0} RRSM_i^{\beta_3} Pop60_i^{\beta_7} e^{\lambda W\varepsilon_{-i}}$$

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

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

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

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:

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

$\frac{d^2R_i}{d^2PopEPCI_i} = 0$ for $PopEPCI_i = e^{-\frac{\beta_1}{2\beta_2} + \frac{1}{4\beta_2}(1-\sqrt{1-8\beta_2})}$ and $PopEPCI_i = e^{-\frac{\beta_1}{2\beta_2} + \frac{1}{4\beta_2}(1+\sqrt{1-8\beta_2})}$ 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 iif $\beta_2 < 0.125$, 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	increasing
Form of *h*	concave		concave	convex	concave

Yet, our estimation results suggest that none of French inter-municipalities group a population less than x^1 (the smallest EPCI groups 207 inhabitants while $x^1 \approx 106$), or even more than x_2^2 (the biggest EPCI 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 EPCIs (those with $PopEPCI_i < x_1^2 \approx 301$) and convex for others.

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