Laboratoire
d'Economie et de Gestion
UNIVERSITÉ DE BOURGOGNE & CNRS UMR 5118

Documents de travail

du Laboratoire d'Economie et de Gestion

Working Papers

Modelling local growth control decisions in a multi-city case:
Do spatial interactions and lobbying efforts matter?

Katharina SCHONE, Wilfried KOCH, Catherine BAUMONT

Université de Bourgogne & CNRS
UMR 5118 Laboratoire d'Economie et de Gestion
Pôle d'Economie et de Gestion, 2 boulevard Gabriel, 21000 Dijon, France

Modelling local growth control decisions in a multi-city case: Do spatial interactions and lobbying efforts matter?

Katharina SCHONE, Wilfried KOCH, Catherine BAUMONT

Résumé : Nous analysons les facteurs déterminant les décisions des communes françaises appartenant à une aire urbaine de prélever la taxe locale d'équipement, une participation financière demandée aux constructeurs pouvant être interprétée comme un instrument utilisé pour maîtriser la croissance urbaine. Cette décision est modélisée comme le résultat du jeu de pouvoir entre plusieurs groupes d'intérêt liés au foncier. En plus, les choix locaux sont considérés comme interdépendants, dû au fait que la décision d'une ville de contrôler sa croissance va augmenter la demande de logement dans ses villes voisines. La solution de notre modèle théorique s'apparente à un modèle spatial autorégressif, faisant de l'économétrie spatiale l'outil naturel pour l'estimation des interactions stratégiques au niveau local. Les résultats empiriques confirment nos prédictions. La décision de prélever la taxe locale d'équipement est influencée par le lobbying de groupes d'intérêt liés au foncier et sujet à des interactions stratégiques spatiales. Mais contrairement à l'opinion générale selon laquelle un contrôle strict de la croissance serait surtout le résultat de la pression exercée par les habitants-propriétaires, notre analyse révèle que les propriétaires-bailleurs sont la véritable force déterminante. Nos résultats donnent également de faibles indices pour la présence de « coalitions de croissance ».

Mots-clés : réglementation du foncier; maîtrise de la croissance ; groupes de pression ; économétrie spatiale

Abstract : Our article analyses the determinants of the decision of French municipalities to raise the "*taxe locale d'équipement*", a local development tax which can be regarded as a price measure to control growth. We model the decision to raise this tax as the result of a political struggle between different land-related interest groups. As a city's decision to control its development raises demand for housing in neighbouring cities, local growth control choices have to be considered as spatially interdependent. Our spatial econometric specification is directly derived from the theoretical model and thereby becomes a natural tool to estimate such strategic interactions between local governments. The empirical results confirm our predictions. The decision to raise the "*taxe locale d'équipement*" is influenced by the lobbying of land-related interest groups and subject to spatial strategic interaction. But against the general presumption that growth control choices are mainly determined by resident homeowners, our analysis reveals that the main driving force seems to be "absentee" homeowners which act as landlords. We find weak evidence for the presence of "urban growth machines" in France.

Keywords : land use regulation; growth control; lobbying; spatial econometrics

1   Introduction

In most industrialised countries local governments have extensive powers to manage and control their own geographic and demographic development, including a wide array of land related policies such as zoning rules, land taxation, impact fees or urban growth boundaries, sometimes summarized under the term "growth controls". These powers and their widespread use are generally justified as necessary corrections to market failure. In this perspective, growth controls are meant to limit the negative externalities related to urban growth (pollution, congestion …), to prevent urban sprawl and to guarantee a fair distribution of the fiscal burden entailed by urban growth. But at the same time, growth controls also greatly impact land and housing prices. There is now a large empirical literature on this question, which, to a large extent, concludes that growth controls raise housing prices and lower the value of undeveloped land (see Fischel, 1990, or Quigley and Rosenthal, 2005, for a review of results).   In view of these important financial consequences it seems quite plausible to assume that local landowners and homeowners will try to influence growth control decisions. Therefore, the decision to control the development of a community is probably not best described as being taken by a "benevolent dictator" with the only intention to maximise social welfare. On the contrary, it rather seems to be the result of a political struggle between different land related lobbies, each trying to influence (probably mainly self-interested) local decision makers.

Theoretical models that describe growth control decisions as the result of a struggle for influence between different interest groups include Brueckner (1995), Brueckner and Lai (1996), Glaeser et al. (2005) or recently Hilber and Robert-Nicoud (2009). The major opponents in this political struggle are the owners of developed land (resident homeowners and landlords), which benefit from control-induced rising real estate values, and the owners of undeveloped land, logically opposed to every kind of measure limiting the possibilities to develop their property.

At first view, the owners of undeveloped land, representing generally only a small percentage of the population, could be expected to have little influence on the local political decision process. But according to the still popular hypothesis first put forth by Molotch (1976) and Logan and Molotch (1987), they gain in influence by forming an "urban growth machine" with members of the local business elite, such as local employers, banks or building firms, who all have a natural interest in local expansionism. Building firms are naturally interested in maximising the number of new constructions, which simultaneously

raises profits for local banks that lend money to new homebuyers. Local employers support the growth machine because high construction rates help to keep housing prices down, which in turn permits them to pay their workers less.

This pro-growth pressure group finds itself confronted with the owners of already developed land. These can either live themselves in the house or apartment they possess or they can rent it out and act as landlords generally referred to as "absentee homeowners". Resident homeowners and landlords both favour growth controls, but for slightly different reasons. Resident homeowners try to influence local decision making in order to defend their local quality of life and to protect the value of their homes. Absentee homeowners seek financial gains from control induced rent increases.

It is still an open question which of these two subgroups has the greatest interest for growth controls and exerts the strongest influence on local political decisions. The general view holds that local politics tend to be dominated by resident homeowners: the fact that their house generally represents their biggest single asset and that they are without any possibility to spread risks turns them into "homevoters", a term coined by Fischel (2001). Brueckner and Lai (1996) and Hilber and Robert-Nicoud (2009), on the contrary, identify the "absentee homeowners" as the main driving force behind restrictive growth control politics. According to their analyses, resident homeowners can be imagined as paying rent to themselves, and for this reason a control-induced rent escalation would confer no benefits to them. Absentee homeowners, in contrast, would gain from rent increases, and so favour even more stringent growth controls than resident homeowners. Following the line of reasoning set out by Brueckner and Lai (1996) and Hilber and Robert-Nicoud (2009), a higher homeownership rate could even be associated with less stringent growth controls, for the simple reason that higher homeownership rates imply lower renter rates and therefore a weaker presence of landlords.

Compared to the numerous studies on the effects of growth controls, empirical evidence on its determinants is still scarce, and the existing analyses almost exclusively examine North American cities.[1] The existing studies generally conclude that a community's growth policy is strongly influenced by prior population growth and given population density (see for example Bates and Santerre, 1994; Evenson and Wheaton, 2003; Glaeser and Ward, 2009). Most studies also find that controls are more stringent in communities with a higher income level (Pogodzinski et Sass, 1994; Evenson and Wheaton, 2003; McDonald and McMillen, 2004).

---

[1] The earlier literature on the determinants of zoning choices is reviewed in Pogodzinski (1992).

Still, no consensus emerges from the existing literature regarding the influence of the homeownership rate: the results obtained by Pogodzinski and Sass (1994) and Glaeser and Ward (2009) point to a negative relationship between the homeownership rate and the stringency of controls. Dubin et al. (1992), on the contrary, find a positive relationship, whereas the results of Brueckner (1998) indicate no significant influence of the percentage of homeowners in the local population.

The influence of pressure groups other than the resident homeowners has only rarely been analysed. Lubell et al. (2005) and Glaeser and Ward (2009) discover a significant negative relationship between restrictive growth policies and the local importance of the construction sector, which can be interpreted as a proxy for the lobbying efforts undertaken by the members of an "urban growth machine".

Drawing on the aforementioned theoretical and empirical literature, our article makes two contributions to the analysis of the determinants of local growth control decision.

First of all, we present a theoretical model that clearly separates the interests of the two major opponents in the political struggle regarding this decision, i. e. the owners of developed and undeveloped land. Except for Hilber and Robert-Nicoud (2009), other models developed so far fail to take account of this fundamental opposition, as they consider the owners of land as one single interest group, no matter if their land is developed or not.

Second, we extend the strategic reactions across cities' political decisions to the fact that cities' decisions to control their own development are spatially conditioned. More precisely, our analysis takes into account that a city's decision to set up growth controls generally creates spillover effects and increases demand for land and housing in other cities.[2] Local growth control choices will therefore be spatially interdependent and cities will engage in strategic interaction. These strategic interactions have first been integrated in a model on growth control decisions by Brueckner (1995) and Helsley and Strange (1995), but without modelling their spatial pattern. The only empirical test so far is provided by Brueckner (1998), who, using spatial econometric techniques, shows that Californian cities tend to impose more stringent growth controls when neighbouring cities are doing so. Although spatial econometrics have proven useful for the empirical analysis of strategic interactions between governments (Brueckner, 2003 ; Revelli, 2005), filling the gap between theoretical models and spatial econometric specifications remains a challenge (Behrens and Thisse, 2007).

---

[2] Empirical evidence for spillover effects to adjacent jurisdictions is given by Pollakowski and Wachter (1990) and Cho and Linneman (1993).

In the present article, we extend the analysis of Helsley and Strange (1995) and establish the equilibrium for the case of multiple interacting cities. Moreover, contrary to the existing literature, we integrate the fundamentally geographic nature of interdependences and present a spatial econometric specification that is directly derived from the theoretical model. We thus try to make a first step to bridging the gap between theoretical modelling and spatial econometric specifications.

The remainder of the article is divided into four parts. The next section introduces the theoretical model. Considering strategic interactions in prices, we model the internal as well as the external forces shaping a city's growth control decision, and derive a theoretically motivated estimation equation exhibiting spatial interactions. Our empirical test, presented in section 3, is thus naturally based on spatial econometric tools. Making use of standard as well as Bayesian spatial econometric methods, we analyse the factors influencing the decision of French local governments to raise the "*taxe locale d'équipement*" (or TLE for short), a local development tax which can be regarded as a price measure to control growth. To our knowledge, this is the first study of the determinants of growth control choices for the French case. The results of our empirical analysis, which are presented in section 4, confirm the existence of strategic interaction between nearby cities as well as the global influence of the pressure groups: landowners and homeowners for instance. The individual pressure of each group is investigated. Our results lend more support to Brueckner and Lai (1996) and Hilber and Robert-Nicoud (2009) who emphasize the influence of absentee homeowners, as to Fischel's homevoter hypothesis (Fischel, 2001). There is only weak evidence for the existence of "urban growth machines" in France. Section 5 contains some concluding remarks and suggestions for future empirical research.

2   Theoretical Model

Extending the work of Helsley and Strange (1995) to the multi-city case, we consider the strategic adoption of growth control policies in a closed system of cities. Municipalities aim at controlling urban extension through development fees which raise the settlement cost in the city and impact population moves across cities. Growth control choices are modelled as the result of a political struggle between different land-related lobbying groups, and considered as interdependent, due to their impact on residential location. Households move to another city when they perceive a utility difference at the expense of their actual city of residence, but their perception of what happens in other cities is supposed to be limited. This imperfect mobility due to limited perception is taken into account by the cities' reaction functions derived from our model.

2.1   Intra-urban equilibrium

The urban setting

We consider a system of monocentric cities $j \in \{0,1,...,J\}$, occupying linear strips of land. As traditionally assumed in monocentric urban models, each city has a single central business district (CBD) located in 0, that concentrates all employment. One unit of land at each distance to the CBD is devoted to residential occupation. Thus, every residential location in a city is characterised by its distance x to the CBD. Each city j extends up to a maximum distance of $\bar{x}_j$.

All n_j inhabitants of city j are renters. They are mobile between cities and work in the CBD, where they earn an income y_j. The total population N of the urban system is:

$$N = \sum_{j=0}^{J} n_j \qquad\qquad [1]$$

We assume that land consumption is inelastic and that each household consumes one unit of land. Population size thus equals the physical size of the city: $n_j = \overline{x}_j$.

The household behavior

The utility level of a city's inhabitants depends on their consumption of a numéraire C_j and of residential land, fixed to unity, as well as on the quality of life Q_j in their city of residence. Due to congestion or other disamenity effects, the quality of life in a city is supposed to decline with the size of the city. It is represented by the following function:

$$Q_j = -\beta n_j = -\beta \overline{x}_j \qquad [2]$$

where $\beta \geq 0$ represents the externality parameter. As Helsley and Strange (1995), we assume for simplicity that the utility function is additively separable, and that utility is transferable. Then, utility net of land consumption can be expressed as:

$$u_j = C_j - \beta \overline{x}_j. \qquad [3]$$

The budget constraint of a household living at distance x from the CBD of city j is:

$$y_j = C_j + tx + r(x) \qquad [4]$$

where tx stands for the commuting costs to the CBD and $r(x)$ for the rent per unit of land. The bid-rent function is downward sloping and linear as a consequence of fixed land consumption. Accordingly, and assuming that consumption is optimal, the indirect utility of a household living at distance x from the CBD is

$$v_j = y_j - tx - r(x) - \beta \overline{x}_j \qquad [5]$$

Intra urban equilibrium

The intra-urban equilibrium is attained when no household wants to change location anymore, i.e. when any two households of city j, localised at different distances x^A and x^B from the CBD, obtain the same utility level:

$$y_j - \beta \overline{x}_j - tx^A - r(x^A) = y_j - \beta \overline{x}_j - tx^B - r(x^B) \qquad [6]$$

which simplifies to:

$$r(x^B) - r(x^A) = tx^A - tx^B \qquad [7]$$

Then as usual, two households living in the same city but at different distances from the CBD attain the same utility level if the difference between their respective transport costs is exactly compensated by the difference between the land rents.

If the opportunity cost of urban land is zero, all cities naturally extend until $r(\overline{x}_j) = 0$. In contrast, a positive land rent at the boundary of the city means that the city actively controls its own growth.[3]

---

[3] As the model is static in nature, we actually do not analyse growth control policies, i.e. instruments restricting a city's growth, but policies that restrict its size. As the conclusions of the analysis are similar to the ones in a dynamic setting, many authors use the simpler static case to analyse growth controls (Brueckner, 1999).

2.2   Growth controls

Following Helsley and Strange (1995) one can distinguish growth control measures that directly limit population size through some land use regulations and *"price control"* measures designated to indirectly influence land prices. While Brueckner (1998) concentrates on the first kind of these measures, we are interested in the second one.

We define a price control as the instauration of an entry fee p_j to the city, i.e. a minimum land rent for everyone who wants to locate in city j. Thus, land rent at the boundary becomes $r(\overline{x}_j) = p_j$, and land rent can now be denoted as:

$$r(x) = p_j + t(\overline{x}_j - x) \qquad\qquad [8]$$

Substituting [8] in [5] we obtain the level of indirect utility in city j as a function of the characteristics of the city:

$$v_j = y_j - (\beta + t)\overline{x}_j - p_j \qquad\qquad [9]$$

According to [8], the growth control raises land rents everywhere in the city, inducing a part of the population to move to another city. The size of the controlling city declines, whereas the size of the other cities increases. The growth control thus affects the utility level of the controlling city's population in two different ways. On the one hand, the population decline raises the quality of life, which in turn increases the level of utility. On the other hand, the utility level is reduced by the rise of land rent caused by the growth control. In the remaining cities (that do not have set growth controls), the utility level has to decline, because the in-migration from the city having set the growth control reduces quality of life. In the resulting inter-urban equilibrium with growth controls, the prevailing utility level will therefore be lower than without growth controls. To reach this equilibrium, the negative utility effect in the active city has to dominate the positive effect.

2.3   Inter-urban equilibrium

Household behavior

Households move when they observe that they can attain a higher utility level in another city. The literature generally assumes that households are perfectly aware of any difference between any two cities' utility levels. Under this view, an inter-urban equilibrium is attained when city populations have adjusted so as to perfectly equalise utility levels everywhere. Contrarily to this assumption, we suppose that households have an imperfect perception of the utility levels attainable in all other cities. More precisely, we assume that households are unable to observe policy choices and living conditions (i.e. income levels) in all other cities of the urban system, whereas actual city sizes are considered as known.

The level of knowledge of a household living in city i concerning earnings and policy choices in city j is captured by the term w_{ij}. The household is perfectly aware of what happens in his own city ($w_{ii} = 1$), for all other cities his perception is imperfect ($w_{ij} < 1$ for $i \neq j$).

This drives a wedge between the utility actually realised in city j, given by equation [9], and the perception of city j's utility level by the inhabitants of city i:

$$\tilde{v}_{ij} = w_{ij}(y_j - p_j) - (\beta + t)\overline{x}_j \qquad [10]$$

A household moves to another city when the utility level in his place of residence is lower than his perception of the utility he could realise elsewhere. The less reliable a city i household's information on city j's income level and policy choice, the more he will base his judgement of the utility level in city j on the city's actual size, which is the only information he captures with no noise. In consequence, he will more easily move to cities he knows better, whereas changes in cities he knows less have to be important before he will consider relocating.

As in models of yardstick competition (Salmon, 1987; Besley and Case, 1995), households judge their own local government on the basis of a comparison with the local governments of other jurisdictions. But contrarily to the yardstick competition case, households in our model do not vote at the ballot box, but they "vote with their feet" as in

Tiebout (1956), i.e. their comparison of political choices in their hometown and in other towns does not condition electoral but mobility choices. Therefore, our model is actually not one of yardstick competition but fits better in the category of what Brueckner (2003) calls "resource flow models".

Inter urban equilibrium

An inter-urban equilibrium is attained when no household perceives any utility differences between its place of residence and the other cities any more:

$$y_i - p_i - (\beta + t)\overline{x}_i = w_{ij}(y_j - p_j) - (\beta + t)\overline{x}_j \qquad \forall i, j \qquad [11]$$

Combined with [1] and summed up over all cities j, equation [11] can be expressed as:

$$(J+1)y_i - (J+1)p_i - (J+1)(\beta+t)\overline{x}_i = \sum_{j=0}^{J} w_{ij}y_j - \sum_{j=0}^{J} w_{ij}p_j - (\beta+t)N \qquad [12]$$

With $w_{ii} = 1$ and under the assumption that city 0 is passive $(p_0 = 0)$ [4], this simplifies to:

$$\overline{x}_i(p_i, p_j) = \frac{1}{(J+1)(\beta+t)}\left(Jy_i - \sum_{\substack{j=0 \\ j\neq i}}^{J} w_{ij}y_j - Jp_i + \sum_{\substack{j=1 \\ j\neq i}}^{J} w_{ij}p_j + (\beta+t)N \right) \qquad \forall i, j \qquad [13]$$

Equation [13] indicates the population sizes guaranteeing an inter-urban equilibrium contingent on the characteristics and the growth control choices made by all cities in the urban system.

---

[4] The city indexed 0 has to be passive, as we examine a closed system of cities and suppose that land consumption is fixed.

If the local government in city i decides to set stricter growth controls by increasing the development fee p_i, land rents will rise, lowering the utility level in i. Thus, a part of its population will decide to move to another city and population size will decline. On the contrary, an increase in the degree of severity of growth controls in another city j will have the inverse effect on population size in i, its magnitude depending again on the parameters β and t, and the population's level of knowledge of political choices in j.

An increase in the revenue of the residents of city i augments the local utility level, making the city more attractive than the other cities in the urban system. Following [13], this will cause in-migration to city i and increase the city's population until a new inter-urban equilibrium is reached, in which the general utility level is higher than before. Thus, under mobility, an increase in revenues in one single city makes households in the whole urban system better off. If revenues rise in any other city, city i becomes less attractive in comparison, encouraging a part of its population to leave. The magnitude of the population decline in city i depends on the magnitude of parameters β and t, and on the extent to which the residents of i become aware of the higher revenues realised elsewhere.

2.4   Local public decision making in the presence of interdependencies

We assume that local politicians are opportunistic and that they seek to maximise their own personal welfare. This means that they will cater their political decisions in favour of the interest groups that are able to procure them the highest benefits.[5] We do not make any supposition about the exact kind of benefits politicians are seeking.

As in Grossman and Helpman (1994), we assume that the promises of an interest group to local politicians are conditional on the political choices of the government and proportional to the benefits the group obtains once the policy is implemented. In this case, the local government's objective function can be written as the weighted sum of the respective interests of these groups.

---

[5] For simplicity, we assume that local politicians completely ignore the well-being of the local population.

In the political struggle for a city's decision to set an entry fee p_i, the two major opponents are the owners of developed land and the owners of undeveloped land. The former benefit from control-induced rent-increases, whereas the latter are logically opposed to every form of restriction limiting the possibilities to develop the land they possess.

The goal pursued by the owners of developed land is the maximisation of the aggregated land rent:

$$R_i = \int_0^{\bar{x}_i} r(x)dx = p_i\bar{x}_i + \frac{1}{2}t\bar{x}_i^2 \qquad [14]$$

As growth controls limit city size, they disable landowners next to the city limit from developing their land and from realising a positive land rent. These owners of land that remains undeveloped due to the instauration of growth controls are thus strictly opposed to them. We suppose that these owners of undeveloped land still have a stake in the city's decision making process, even if they are formally no longer part of the city, and for the sake of simplicity, we further assume that their benefits are proportional to city size $\bar{x}_i$.

The local government maximises the weighted sum of these opposing interests:

$$\pi_i = z_i^u \bar{x}_i + z_i^d R_i = z_i^u \bar{x}_i + z_i^d \left(p_i\bar{x}_i + \frac{1}{2}t\bar{x}_i^2 \right) \qquad [15]$$

As explained above, the weights z_i^u and z_i^d accorded to the interests of the owners of undeveloped and developed land depend on their respective lobbying efforts, i.e. on their promises to the local government.

The inter-urban political equilibrium

All active cities simultaneously and non-cooperatively choose the boundary rents p_i that maximise their respective objective functions π_i. In a Nash equilibrium, their choices of

development fees are mutual best responses. Substituting [13] in [15], we obtain the objective function of the government of city i as a function of its own fee p_i and of the fees chosen by the other active governments. Maximisation of this objective function with respect to p_i gives city i's optimal growth control choice depending on the growth control choices made by the other cities:[6]

$$p_i = -a\frac{z_i^u}{z_i^d} + bJy_i - b\sum_{\substack{j=0\\j\neq i}}^{J} w_{ij}y_j + b\sum_{\substack{j=1\\j\neq i}}^{J} w_{ij}p_j + c \qquad [16]$$

with: $\qquad a = \dfrac{1}{(J+1)2\beta + (J+2)t} > 0$

$$b = \frac{(J+1)\beta + t}{J(J+1)(\beta+t)\left((J+1)2\beta + (J+2)t\right)} > 0$$

$$c = \frac{\left((J+1)\beta + t\right)(\beta+t)N}{J(J+1)(\beta+t)\left((J+1)2\beta + (J+2)t\right)} > 0$$

The sufficient condition for a maximum is verified as long as $z_i^d > 0$, i.e. as long as the local government does not completely ignore the interests of the owners of developed land.

The best response of city i to a change in the growth control politics of any other city j is given by the partial derivative of [16] with respect to p_j:

$$\frac{\partial p_i}{\partial p_j} = bw_{ij} \geq 0 \qquad [17]$$

Equation [17] indicates that the growth control choices of two cities are strategic complements: if city j enacts more stringent controls, this will encourage a part of its

---

[6] Details are given in appendix A1.

population to move to another city. Thus, the growth controls implemented in j increase the growth pressure in the rest of the urban system, and in response to this, other cities will be tempted to set stricter controls, too.

The intensity of city i's response to a political change in j depends on w_{ij}, that is the extend to which city i residents are aware of policy changes in j. Only if households living in city i take notice of a policy change in j, they will consider to migrate, and only in this case will the local government in i react to a policy change in j.

Interactions between local growth control decisions within the urban system are formally expressed by the matrix form of equation [16]:

$$\mathbf{p} = c\mathbf{\iota} - a\mathbf{z} + b\mathbf{J}\mathbf{y} - b\mathbf{W}\mathbf{y} + b\mathbf{W}\mathbf{p} \qquad [18]$$

where $\mathbf{p}$ is the $J \times 1$ vector of the cities' growth control choices, $\mathbf{z}$ is a $J \times 1$ vector of relative lobbying efforts with representative element $z_i \equiv \dfrac{z_i^u}{z_i^d}$, $\mathbf{y}$ is the $J \times 1$ vector of household income, $\mathbf{\iota}$ is a $J \times 1$ vector of ones and $\mathbf{W}$ the $J \times J$ matrix of the terms w_{ij}, representing the population's level of knowledge of what happens in other cities.

3   Empirical framework

In our theoretical framework, we emphasize that a city's population cannot be perfectly informed about political choices and living conditions in all other cities, and we show how this perception conditions their location choices and thereby the intensity of strategic interactions between cities regarding growth control choices.

It seems quite natural to us to assume that the residents of a city more easily notice what happens in nearby cities compared to more distant ones, due for example to their trip

habits and to information provided by regional newspapers and other local media. If one wants to accept this hypothesis, strategic interactions between cities will then take on a spatial pattern. Under this hypothesis, the matrix $\mathbf{W}$ can be understood as a spatial weight matrix. Our theoretically derived equation [18] can then be interpreted as a spatial autoregressive model (Anselin, 1988), making spatial econometrics a natural tool for its estimation.

Our empirical study concerns growth control decisions in 351 French Metropolitan Areas. The present section details our estimation approach and the data used to test the presence of spatial strategic interactions across cities and the impact of lobbies on local political decisions regarding growth control choices.

3.1   Spatial patterns of interactions in a multi-city case

Giving the weight matrix $\mathbf{W}$ a spatial interpretation, the matrix of cities' reaction functions (equation [18]) becomes a spatial autoregressive model, which formally links the dependent variable $\mathbf{p}$ to its spatial lag $\mathbf{Wp}$ on the right hand side, besides other explanatory variables $\mathbf{z}$, $\mathbf{y}$ and $\mathbf{Wy}$. In this type of model, a change in an explanatory variable for a single city can potentially affect the dependent variables in all other cities, and this will cause feedback effects on the first. When calculating the marginal impacts, one has to take account of these feedback loops (Ertur and Koch, 2007 ; LeSage and Pace, 2009).

Concerning lobbying efforts, the marginal impacts can be expressed as:[7]

$$\frac{\partial p_i}{\partial z_i} = -a\sum_{s=0}^{\infty} b^s w_{ii}^{(s)} < 0 \qquad\qquad [19]$$

$$\frac{\partial p_i}{\partial z_j} = -a\sum_{s=0}^{\infty} b^s w_{ij}^{(s)} < 0 \qquad\qquad [20]$$

---

[7] Details are given in appendix A2.

where $w_{ij}^{(s)}$ is the element of row i and column j of $\mathbf{W}^s$, i.e. the matrix $\mathbf{W}$ to the power of s.[8] As indicated by equations [19] and [20], the marginal impacts of relative lobbying efforts in i or j on growth control choices in i are negative. Recalling that $z_i = z_i^u / z_i^d$ decreases with the lobbying effort of homeowners z_i^d and increases with the lobbying effort of landowners z_i^u, we can conclude that the marginal impact of the landowners' lobby on growth control choices is negative, whereas the marginal impact of the homeowners' lobby is positive. Thus, if the lobbying of the owners of undeveloped land in city i becomes relatively more intensive, compared to the lobbying effort of the owners of developed land, the local government will respond by setting stricter controls. As explained above, this will increase the growth pressure in the rest of the urban system and encourage other local governments to set stricter controls, too, as indicated by [20]. This in turn will cause feedback effects on city i and will reinforce the impact of the local lobbying groups on the growth control choices made in i, as shown in [19].

Turning to the marginal impact of city's income, we obtain the following expressions:

$$\frac{\partial p_i}{\partial y_i} = 1 + (bJ - 1)\sum_{s=0}^{\infty} b^s w_{ii}^{(s)}$$

[21]

$$\frac{\partial p_i}{\partial y_j} = (bJ - 1)\sum_{s=0}^{\infty} b^s w_{ij}^{(s)}$$

[22]

Equations [21] and [22] describe the marginal impacts of income city i and in city j on the growth control choices in city i. These can be expected to be positive as long as J is not too small, that is as long as competition between cities with respect to household location choices is large enough. If the income level in i increases, the city will become more desirable and attract new residents. This gives its local government the power to raise p_i, and as growth control choices have been identified as strategic complements following equation [17], this will encourage other cities to increase controls as well. Therefore, growth

---

[8] For example, $\mathbf{W}^2$ represents the neighbours of city i's neighbours, $\mathbf{W}^3$ stands for the neighbours of the neighbours' neighbours, and so on. Although the diagonal elements of the matrix $\mathbf{W}$ are zero, those of $\mathbf{W}^2$ will generally not be zero, reflecting the fact that city i will be a neighbour of its neighbours.

control choices in city i will in general become stricter with rising income in i or in any other city j.

3.2   Econometric issues

In order to estimate growth control choices in equilibrium we rewrite equation [18] as follows:

$$\mathbf{p} = \alpha_0 \mathbf{\iota} + \alpha_1 \mathbf{z} + \alpha_2 \mathbf{y} + \gamma \mathbf{W} \mathbf{y} + \rho \mathbf{W} \mathbf{p} + \varepsilon \qquad [23]$$

where ε is a $J \times 1$ vector of error terms and the parameters from the theoretical model have been replaced by $\alpha_0 \equiv c$, $\alpha_1 \equiv -a$, $\alpha_2 \equiv bJ$ and $\rho = -\gamma \equiv b$. Equation [23] is a spatial lag specification whose OLS estimation is affected by simultaneity bias, resulting in biased and inconsistent parameter estimates (Anselin, 1988). To overcome this problem, we estimate our model using Maximum Likelihood (ML) estimation. In addition, we perform Bayesian Markov Chain Monte Carlo (MCMC) methods in order to check the robustness of our results to heteroscedasticity and potential outliers. [9] The regularity conditions of the maximum likelihood estimators are described in Lee (2004) and the Bayesian heteroscedastic MCMC estimation method is developed by LeSage (1997).

The elements of weight matrix $\mathbf{W}$ are specified so as to reflect our prior expectation that the residents of a city more easily notice what happens in nearby cities compared to more distant ones. To encounter the risk of arbitrariness, we present results for three different specifications for $\mathbf{W}$. Our base specification assumes that the inhabitants of every city observe what happens in the same number of neighbouring cities, setting the number of neighbours arbitrarily to five. Thus, we set $w_{ij}^* = 1$ for the elements indicating the interactions between city i and its five nearest neighbours, and $w_{ij}^* = 0$ for all others. In order to check the robustness of our results, we also perform estimations using two other matrices with varying weights based on the distance between cities. The first one of these two states that a

---

[9] The underlying functions are kindly provided by James LeSage in his Econometric Toolbox for Matlab (http://www.spatial-econometrics.com).

household's perception of another city's living conditions and political choices diminishes directly with the distance between the two cities. Every element w_{ij}^* of the un-standardised matrix $\mathbf{W}^*$ is equal to $w_{ij}^* = 1/d_{ij}$, where d_{ij} represents the great-circle distance between the cities i and j. Finally, in the third case we use the inverse of squared distance, $w_{ij}^* = 1/d_{ij}^2$, which means that we suppose that the household's perception of what happens in other cities is very sensitive to distance.

The weight matrices are row standardised, so that the sum of every line is equal to 1. Therefore, the elements of the standardised matrix are:

$$w_{ij} = \frac{w_{ij}^*}{\sum_j w_{ij}^*}$$

With this standardisation, the term $\sum_j w_{ij} p_j$ simply represents the weighted average of the other cities' growth control choices as observed by the residents of city i.

By convention, w_{ii} is set to zero $\forall i$. Note that contrary to this, in the theoretical part we have supposed that the population perfectly observes what happens in its own town which means $w_{ii} = 1$. However, the theoretically derived equation for cities' growth control choices (equation [16]) excluded the city's own policy choice in the term representing the weighted growth control choices of the other cities. This is the same as including the case $i = j$, but giving it the weight zero. Thus, our theoretical model and the empirical framework are compatible.

3.3 The spatial level of analysis

Concerning the appropriate geographical level of analysis, there is so far no consensus in the empirical literature on growth controls. While Evenson and Wheaton (2003) or Glaeser and Ward (2009) study land use regulations on the level of municipalities (cities and towns), Malpezzi et al. (1998), Mayer and Somerville (2000) and Glaeser et al. (2005) all choose Metropolitan Areas as the level of their analysis.

In theoretical models as ours, every city possesses its own CBD to which the inhabitants commute for work. Thus, as Brueckner (1998) remarks, it would not be adequate to use the model as a theoretical foundation for the estimation of interactions between the different communities of a single metropolitan area. Every city in the model has to be interpreted as an entire metropolitan area. We therefore retain as the spatial level of our empirical analysis the French "*aires urbaines*" which include all municipalities belonging to the same local labour market and roughly correspond to Metropolitan Areas in the United States.

The analysis is taken out for all 354 French "*aires urbaines*", except Paris, Bastia and Ajaccio. The latter have been discarded because of their isolated location (on the island of Corsica) and because of missing data for Ajaccio. The metropolitan area of Paris has been excluded from the analysis because TLE computation differs there from other urban areas: in fact, for nearly all municipalities belonging to the Ile de France region the rate of the TLE is augmented by an additional one percentage point, and in addition, the lump-sum values per square meter to which the rates of the TLE are applied differ between the municipalities of the Ile de France region and those of the rest of France.

3.4   The growth control variable

Focusing on the price dimension of growth control policies in French cities, we analyse the "*taxe locale d'équipement*" (TLE) collected by municipalities. The TLE is a local development tax similar to North American impact fees, which has to be paid by the developer when he is granted a building permit by the municipality. It aims at making developers contribute to the costs of public equipments and infrastructures, but unlike impact fees in the United States, the revenues generated by the TLE are not bound to the financing of amenities for the new developments (i.e. there are no "rational nexus" conditions).[10] The amount to be paid by the beneficiary of the building permit is based on an administratively assessed value of the building. This is determined on a lump-sum basis as the product of the net built surface and a constant value per square meter, which depends on the type of

---

[10] Besides that, the TLE does not necessarily apply to large urban development zones ("*zones d'aménagement concerté*"), where the sharing of infrastructure and other public amenity costs can be directly negotiated between the municipality and the developer. Unfortunately, data concerning these negotiated contribution schemes is not easily available.

building (agricultural, industrial, residential,…) and currently varies between 95€ and 640€ (98-704€ in the greater Paris region). The so determined estimated value of the building is multiplied by the rate of the TLE decided by the municipality (which can also vary between building types). This rate can be raised up to 5% by the city council. It is the political choice regarding this rate that our analysis is interested in.

Our data concerns the year 2001 and stems from the French ministry in charge of land use and town planning. In order to construct the dependent variable for our analysis, we first have calculated for every municipality belonging to one of the 351 metropolitan areas in our sample the simple average of the rates fixed in the different building categories. Thereafter, we have aggregated these data by calculating the weighted average for each metropolitan area, weighting every municipality by its respective population.

3.5   The explanatory variables

Following equation [23], a city's choice of the TLE-rate depends on the income level of its population, on their knowledge of the earnings and policy choices in other cities, and it also varies with the pressure exerted by the land related interests.[11] The income is measured as the median of the fiscal revenues per household in 2000, published by INSEE-DGI[12].

As explained above, we distinguish two land based interest groups: the owners of developed land, favouring strict growth controls and the owners of undeveloped land, which are strictly opposed to controls. The empirical model derived from our theoretical model indicates that the relevant variable is the *relative* strength of the lobbying efforts undertaken by these two groups. To stick as close as possible with this theoretically derived closed form solution, we present results using the ratio of the pressure both groups exert, but in order to obtain more detailed and informative results, we also conducted analyses with separate variables for each group.

As we do not have any direct measures of the lobbying activities of the different groups, we approximate them by the presence of each group in the urban area. In a first series of estimations, we consider the economic activities generated by the two lobbies. The pressure exerted by the "absentee" owners of developed land (landlords), is approximated by the relative importance of real estate activities in the local economy. In fact, we suppose that

---

[11] Summary statistics for all variables used in our analyses are presented in table 1.
[12] INSEE is the French National Statistical Institute and DGI is similar to the US Internal Revenue Service.

a large percentage of the landlords confers the administration of their property to a realtor, and as the remuneration of these realtors is generally calculated as a percentage of the rent the property procures to its owner, the realtors pursue the same interest as the owners, i.e. the maximisation of this rent. Thus, we approximate the influence of the "absentee" homeowners by the percentage of real estate activities in local employment.

Following Lubell et al. (2005) and Glaeser and Ward (2009) we assume that the pressure exerted by the "growth machines" lobby, including owners of undeveloped land, may be taken into account by the activity in the construction sector. Accordingly, we use the percentage of local employees working in the construction sector. The data for both variables stems from the French Unemployment Insurance Agency *Unédic* and refers to the year 2000.[13]

In a second series of estimations, we replace these two measures for the lobbying of land based interests groups by two alternative variables. The lobbying of the owners of developed land is now represented by the homeownership rate in the local population, and the pressure exerted by the owners of undeveloped land is approximated by the percentage of farmers in the local active population. These are census data provided by the French National Statistical Institute INSEE and refer to the year 1999.

In order to obtain more detailed and informative results concerning the influence of the interest groups, we extend the benchmark model to absolute lobbying efforts for each group instead of the relative one. Thus, in total we have four different specifications with regard to the influence of lobbying: a first one with the ratio of real estate to construction activities, a second one using the ratio of the relative importance of farmers to homeowners, a third one with two distinct variables for real estate and construction activities, and a forth one with two separate variables for farmers and homeowners.

The model developed above highlights the importance of the political determinants of growth controls, but this doesn't preserve that other factors may play a role, too. Empirical studies on the non political determinants of growth controls in North American Cities have stressed the impact of prior population growth and population density (Bates and Santerre, 1994; Evenson and Wheaton, 2003; Glaeser and Ward, 2009). In addition, it seems that the fiscal stress in indebted municipalities mitigates political growth management decisions (Diaz and Green, 2001). In our robustness analysis we therefore introduce three supplementary explanatory variables, which are the population density, the rate of population growth

---

[13] Employment as measured by *Unédic* comprises all employees of industrial or commercial private sector establishments that employ at least one person under a labour contract.

between 1990 and 1999 and the average debt per capita in the municipalities of the metropolitan area. These three variables should all be positively correlated with the average rate of the TLE. In more densely populated metropolitan regions, the negative externalities related to growth should be felt more intensely by the local population, and in highly indebted metropolitan regions, the pressure to make new residents contribute to the financing of new infrastructure should likewise be stronger. In metropolitan areas that experienced strong prior population growth we expect both, the desire to limit negative externalities and to fairly distribute infrastructure costs, to be stronger.

The population density is measured as the number of inhabitants per square kilometre in the metropolitan area. It is based on population data from the census of 1999 and on data on the surface of the municipalities provided by the French National Geographic Institute (IGN). The data concerning public debt per capita in 2000 stems from the French Ministry of the Interior. This variable describes the weighted average of the debt per capita in the municipalities belonging to the metropolitan areas under study.[14]

4   Empirical results

Compared to other empirical studies of local strategic interactions concerning growth controls (Brueckner, 1998) or other public policies (Case et al., 1993 ; Revelli, 2001) using spatial econometrics, our empirical model is formally derived from the theoretical modelling of control growth decision making. Our benchmark estimation is based on equation [23], which constitutes a spatial autoregressive model.

In our benchmark case, the empirical model is estimated by Maximum Likelihood using the five-nearest-neighbours weight matrix. However, the assumption of spatial interactions needs to be tested, that is we have to control not only whether the spatial parameter ρ is significantly different from 0 but to test the null hypothesis of absence of

---

[14] For lack of detailed data concerning the exact levels of debt, we have approximated the debt of a municipality by the average debt of the municipalities in the region belonging to the same size category as the municipality under question. For every French region we disposed of the average debt per capita of municipalities for the following size categories: less than 500 inhabitants; 500-1.999 inhabitants; 2.000-3.499 inhabitants; 3.500-4.999 inhabitants; 5.000-9.999 inhabitants; 10.000-19.999 inhabitants; 20.000-49.999 inhabitants; 50.000-99.999 inhabitants; 100.000-299.999 inhabitants and more than 300.000 inhabitants. Due to the regionalisation, this approximation has the advantage that the level of debt can more easily be regarded as exogenous to TLE choices.

spatial interdependencies in the non spatial model. This is done by performing the Moran's I test developed by Cliff and Ord (1981).

We further check the robustness of our benchmark results in three directions, testing the consistence of estimates to alternative spatial patterns, to additional explanatory variables and to potential heteroscedasticity and outlier problems.

4.1   Benchmark results

Results of Ordinary Least Squares estimation of the non-spatial model are displayed in the left part of table 2 (columns (1) to (4) according to the set of explanatory variables used). We perform the Moran's I test of Cliff and Ord (1981), using the basic five-nearest-neighbours $\mathbf{W}$ matrix. The hypothesis of positively spatially autocorrelated error terms cannot be rejected at the 1% level. From an empirical point of view, this means that OLS results are at least inefficient and probably biased, too. From a theoretical point of view, this result underscores the fact that cities cannot be considered as "isolated islands" and it is consistent with the spatial dimension of strategic interaction between jurisdictions highlighted by our theoretical model.

The results of Maximum Likelihood Estimation of the spatial autoregressive model, using the five-nearest-neighbours weight matrix, are summarized in the right part of table 2 (columns (5) to (8) according to the set of lobbying variables used). They largely confirm our theoretical model. All estimated parameters have the expected signs, and almost all are significantly different from zero. The estimate of the spatial autocorrelation parameter ρ is significantly different from zero, indicating that cities engage in strategic interaction with neighbouring cities. As ρ is positive, cities' growth control choices are indeed strategic complements, as predicted by equation [17]. The estimate associated with city's own income is positive and highly significant, whereas the parameter estimate of income in neighbouring cities is significantly negative. Nevertheless, this is consistent with our expectation that rising income in neighbouring cities has a positive marginal impact on the growth control choices of a given city, as suggested by equation [22]. These results follow other prior results showing that controls are more stringent in communities with a higher income level (Pogodzinski et

Sass, 1994; Evenson and Wheaton, 2003; McDonald and McMillen, 2004) but extend them to the case of spatial interactions with neighborhing cities.

Our results also confirm the hypothesis that local growth control choices are influenced by the relative lobbying-activities of land-based interest groups. More precisely we consider the relative pressure of landowners compared to homeowners, measured either by the ratio of real estate to construction activities (column (5)) or by the ratio of farmers to homeowners (column (6)). In both cases the coefficients have the expected negative sign. In conjunction with the positive value of the spatial parameter ρ, this result implicitly suggests a negative marginal impact of the landowners' lobby on growth control choices, and a positive marginal impact of the homeowners' lobby. At first sight, our estimations are more supportive of the hypothesis of a lobbying struggle between homeowners and farmers (the parameter estimate in model (6) is highly significant), than of a struggle for influence between real estate agents and constructors (the parameter estimate is only significant at the 10% level in estimation (5)).

4.2   Landowners and homeowners distinct pressures

In estimations (7) and (8), we split up the respective ratio into two distinct variables, in order to measure more precisely the pressures exerted by the owners of developed land and by the owners of undeveloped land.

When lobbying activities are approximated by real estate and construction activities (estimation (7)), the coefficient of the variable representing the landlords' lobby is positive as expected and highly significant, suggesting successful pressure of absentee homeowners for stricter growth controls. On the contrary, the impact of the lobbying activities exerted by the constructor sector, representing the urban "growth machine", is negative as expected, but only significant at the 10% level.

When lobbying efforts are measured by the homeownership rate and the percentage of farmers in the local active population (estimation (8)), both parameter estimates are different from zero at the 99 % significance level. The estimate for the agricultural lobby has the expected negative sign, but surprisingly the sign of the parameter estimate for the homeowner lobby is negative as well. Recalling that no consensus emerges from the existing literature regarding the pressure exerted by resident homeowners, this result meets

Pogodzinski and Sass' (1994) and Glaeser and Ward's (2009) findings, but contradicts the positive influence detected by Dubin et al. (1992) or the non significant effect found by Brueckner (1998).

4.3   Robustness analysis

Supplementary analyses were conducted in order to check the robustness of our results in three directions.

First of all, we question the way spatial strategic interactions have been modelled and we extend the results to two alternative spatial patterns. We repeat our Maximum Likelihood Estimation using two alternative weight matrices: the inverse distance and the squared inverse distance between cities. Contrarily to a pattern of interactions spatially bounded to a set of given neighbouring cities as for the five-nearest neighbours weight matrix, these alternative weight matrices assume that all cities in the system belong to the set of neighbours. Influence on neighbours' political choices is now supposed to decrease with distance or even more rapidly with squared distance. Results are reported in table 3. With little exception, the results remain qualitatively the same. All coefficients take on the same sign as before and remain strongly significant, with the exception of the variable associated with lagged revenue, which is less significant with the inverse distance matrix, and the variable representing the "urban growth machine", which is no longer significant.

In a second series of robustness checks, we extend the benchmark model to additional variables which are supposed to account for alternative determinants of growth control decisions. In doing so we also verify that the estimated parameter representing the spatial strategic interaction is not artificially increased because of omitted spatially correlated variables. As specified above, we introduce three supplementary variables, which are the population density, the rate of population growth between 1990 and 1999 and the average debt per capita of the municipalities of the metropolitan area. According to the value of the log-likelihood functions and the Akaike and Schwarz information criteria, the inclusion of these variables substantially ameliorates the explanatory strength of the estimations.

The parameter estimates of all supplementary variables have the expected positive sign and are significantly different from zero at the 99 % significance level. Higher population densities, higher prior growth rates or higher levels of debt all seem to be associated with more stringent growth controls. Note that the inclusion of these variables does not decrease the significance of the variables derived from our theoretical model. Most parameter estimates become smaller in magnitude, but the results still indicate highly significant and positive spatial interactions between jurisdictions and the relative pressure of owners of developed and undeveloped land also still exerts sizeable influence on growth control choices. Compared to the results of our benchmark model, the negative influence of the "growth machine" becomes slightly more significant.

In a final series of estimations reported in table 5 we applied Bayesian methods to the benchmark as well as to the extended model. Reflecting our prior belief in the presence of heteroscedasticity and potential outliers, we set the value for the hyperparameter r to 4. Besides that, we use a Uniform prior $U[-1,1]$ for the spatial autocorrelation parameter ρ as suggested by LeSage (1997), and diffuse priors for the other model parameters. We make 25.000 draws of which we discard 15.000 for burn-in.

The results remain remarkably stable, indicating that heteroscedastcity and outliers do not seem to constitute serious problems. In some cases, the significance levels are slightly modified, but no important changes do occur, neither in significance nor coefficient magnitudes.

5   Conclusion

In this paper, we model a city's decision to control urban growth as the result of a political struggle between the owners of developed and undeveloped land. Assuming furthermore that a city's decision to control its development raises housing demand in neighbouring cities, local growth control choices have to be considered as spatially interdependent. The resulting inter city equilibrium formally takes the form of a spatial autoregressive specification.

The empirical estimation of this equilibrium solution confirms the predictions of our model. French municipalities' choices regarding the local rates of the "*taxe locale d'équipement*" are subject to positive spatial strategic interaction between jurisdictions. This is in line with the results of Brueckner (1998), who also finds evidence that growth control choices of nearby agglomerations are strategic complements.

The inter-city equilibrium also highlights the influence of the pressure exerted by the owners of undeveloped land relative to that of the owners of developed land, predicting a negative impact on growth control policies. This as well is broadly confirmed by our empirical estimation of the factors influencing local decisions regarding the "*taxe locale d'équipement*": the relative strength of their lobbying activities seems to have considerable influence on the growth control rates chosen, even if other motivations for growth controls as the protection of amenities or fiscal motivations also seem to play a role.

As there is no consensus in the existing literature as to the identity of the interest group dominating the political struggle concerning local growth control decisions, we have further investigated this question in a series of empirical estimations in which we split up the variable of relative lobbying strength and consider each group individually. Concerning the influence of the owners of developed land, our results indicate that the real estate agents, who are supposed to act on behalf of the absentee homeowners, indeed favour more stringent growth controls, whereas the resident homeowners do not seem to be the driving force for the instauration of growth controls. Accordingly, our results do not support the "homevoter" hypothesis of Fischel (2001) and are more in favour of Brueckner and Lai (1996) and Hilber and Robert-Nicoud (2009), who highlight the importance of "absentee" homeowners. Concerning the role played by the owners of undeveloped land, as expected our results suggest that farmers succeed in preventing stringent growth controls. Concerning urban "growth machines", we find weak evidence for their successful lobbying against growth controls. Clearly, this question has to be further investigated in order to understand to what extend the "growth machine" phenomenon actually plays a role in today's local politics in France or in European cities or if it only concerns North American cities.

References

Akaike, H., 1974. A new look at the statistical model identification. IEEE Transactions on Automatic Control 19, 716-723.

Anselin, L., 1988. Spatial econometrics: Methods and models. Dordrecht: Kluwer Academic Publishers.

Bates, L. J., Santerre, R. E., 1994. The determinants of restrictive residential zoning: Some empirical findings. Journal of Regional Science 34, 253-263.

Behrens, K., Thisse, J.-F., 2007. Regional economics: A new economic geography perspective. Regional Science and Urban Economics 37, 457-465.

Besley, T., Case, A., 1995. Incumbent behaviour: Vote seeking, tax setting and yardstick competition. American Economic Review 85, 25-45.

Brueckner, J. K., 1995. Strategic control of growth in a system of cities. Journal of Public Economics 57, 393-416.

Brueckner, J. K., Lai, F.-C., 1996. Urban growth controls with resident landowners. Regional Science and Urban Economics 26, 125-143.

Brueckner, J. K., 1998. Testing for strategic interaction among local governments: The case of growth controls. Journal of Urban Economics 44, 438-467.

Brueckner, J. K., 1999. Modeling urban growth controls.In: Environmental and public economics: Essays in honor of Wallace E. Oates. A. Panagariya, P. R. Portney and R. M. Schwab. Cheltenham: Edward Elgar.

Brueckner, J. K., 2003. Strategic interaction among governments: An overview of empirical studies. International Regional Science Review 26, 175-188.

Case, A., Rosen, H. S.,Hines, J. J., 1993. Budget spillovers and fiscal policy interdependence: Evidence from the states. Journal of Public Economics 52, 285-307.

Cho, M., Linneman, P., 1993. Interjurisdictional spillover effects of land use regulation. Journal of Housing Research 4, 131-163.

Cliff, A. D., Ord, K., 1981. Spatial processes: Models and applications. London: Pion.

Diaz, D., Green, G. P., 2001. Fiscal stress and growth management effort in Wisconsin cities, villages, and towns. State and Local Government Review 33, 7-22.

Dubin, J. A., Kiewiet, D. R., Noussair, C., 1992. Voting on growth control measures: Preferences and strategies. Economics and Politics 4, 191-213.

Ertur, C., Koch, W., 2007. Growth, technological interdependence and spatial externalities: theory and evidence. Journal of Applied Econometrics 22, 1033-1062.

Evenson, B., Wheaton, W. C., 2003. Local variations in land use regulations. Brookings-Wharton Papers on Urban Affairs 2003, 221-260.

Fischel, W. A., 1990. Do growth controls matter? A review of empirical evidence on the effectiveness and efficiency of local government land use regulation. Cambridge, MA: Lincoln Institute of Land Policy.

Fischel, W. A., 2001. The homevoter hypothesis: How home values influence local government taxation, school finance, and land-use policies. Cambridge: Harvard University Press.

Glaeser, E. L., Gyourko, J., Saks, R., 2005. Why have housing prices gone up? American Economic Review 95, 329-333.

Glaeser, E. L., Ward, B. A., 2009. The causes and consequences of land use regulation: Evidence from Greater Boston. Journal of Urban Economics 65, 265-278.

Grossman, G. M., Helpman, E., 1994. Protection for sale. American Economic Review 84, 833-850.

Helsley, R. W., Strange, W. C., 1995. Strategic growth controls. Regional Science and Urban Economics 25, 435-460.

Hilber, C., Robert-Nicoud, F., 2009, On the origins of land use regulations. Mimeo, London School of Economics and University of Geneva.

Lee, L.-F., 2004. Asymptotic distributions of Quasi-Maximum Likelihood estimators for spatial econometric models. Econometrica 72, 1899-1926.

LeSage, J., 1997. Bayesian estimation of Spatial Autoregressive Models. International Regional Science Review 20, 113-129.

LeSage, J., Pace, R. K., 2009. Introduction to spatial econometrics. Boca Raton: Chapman & Hall/CRC.

Logan, J. R., Molotch, H. L., 1987. Urban fortunes: The political economy of place. Berkeley: University of California Press.

Lubell, M., Feiock, R., Ramirez, E., 2005. Political institutions and conservation by local governments. Urban Affairs Review 40, 706-729.

Malpezzi, S., Chun, G., Green, R. K., 1998. New place-to-place housing price indexes for U.S. metropolitan areas and their determinants. Real Estate Economics 26, 235-274.

Mayer, C. J., Somerville, C. T., 2000. Land use regulation and new construction. Regional Science and Urban Economics 30, 639-662.

McDonald, J. F., McMillen, D. P., 2004. Determinants of suburban development controls: A Fischel expedition. Urban Studies 41, 341-361.

Molotch, H. L., 1976. The city as a growth machine: Toward a political economy of place. American Journal of Sociology 82, 309-332.

Pogodzinski, J. M., 1992. The effects of fiscal and exclusionary zoning on household location: A critical review. Journal of Housing Research 2, 145-160.

Pogodzinski, J. M., Sass, T. R., 1994. The theory and estimation of endogenous zoning. Regional Science and Urban Economics 24, 601-630.

Pollakowski, H. O., Wachter, S. M., 1990. The effects of land-use constraints on housing prices. Land Economics 66, 315-324.

Quigley, J. M., Rosenthal, L. A., 2005. The effects of land use regulation on the price of housing: What do we know? What can we learn? Cityscape 8, 69-137.

Revelli, F., 2001. Spatial patterns in local taxation: Tax mimicking or error mimicking? Applied Economics 33, 1101-1107.

Revelli, F., 2005. On spatial public finance empirics. International Tax and Public Finance 12, 475-492.

Salmon, P., 1987. Decentralisation as an incentive scheme. Oxford Review of Economic Policy 3, 24-43.

Schwarz, G., 1978. Estimating the dimension of a model. The Annals of Statistics 6, 461-464.

Tiebout, C. M., 1956. A pure theory of local expenditures. Journal of Political Economy 64, 416-424.

White, H., 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. Econometrica 48, 817-838.

Table 1: Summary statistics

	Mean	Std. dev.	Min	Max
TLE rate	2.30	1.108	0.00	5.00
Revenue per household (in 1000 €)	21.29	1.983	15.38	32.18
Measures of lobbying intensity				
% real estate activities	1.45	1.327	0.00	9.41
% construction	8.04	2.633	0.00	21.17
% homeowners	55.51	6.166	36.78	81.83
% farmers	1.02	0.691	0.00	3.79
Supplementary variables				
Population density (in 1000 inhabitants / km²)	2.20	1.688	0.28	11.73
Public debt (in 1000 €)	0.84	0.207	0.40	1.89
Population growth 1990-99	2.82	5.046	-10.24	25.57

Table 2: Basic results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimation method	Ordinary Least Squares				Maximum Likelihood			
Weight matrix	-				Five-nearest neighbours			
Constant	-0.689	0.821	-1.070*	2.649***	0.557	1.625**	0.334	2.924***
	(-1.161)	(1.384)	(-1.709)	(3.607)	(0.819)	(2.346)	(0.50)	(3.786)
Revenue	0.143***	0.100***	0.135***	0.102***	0.181***	0.157***	0.167***	0.160***
	(5.241)	(3.757)	(5.008)	(4.050)	(6.994)	(6.141)	(6.77)	(6.407)
Relative lobbying strength 1	-0.005*				-0.004***			
	(-1.941)				(-3.100)			
Relative lobbying strength 2		-0.357***				-0.226***		
		(-9.301)				(-5.959)		
Landlord lobby			0.397***				0.264***	
			(8.089)				(8.08)	
Growth machine lobby			-0.011				-0.028*	
			(-0.461)				(-1.73)	
Homeowner lobby				-0.035***				-0.023***
				(-4.142)				(-3.114)
Agricultural lobby				-0.550***				-0.359***
				(-8.001)				(5.294)
Lagged revenue					-0.167***	-0.170***	-0.143***	-0.174***
					(-4.442)	(-4.625)	(-3.97)	(-4.114)
Lagged TLE					0.647***	0.593***	0.566***	0.575***
					(15.826)	(13.511)	(12.62)	(13.197)
R^2 adj.	0.088	0.198	0.2804	0.264				
Log-Likelihood					-318.54	-306.203	-293.78	-295.80
Pseudo-R^2					0.092	0.255	0.345	0.315
AIC	2.271	2.137	2.032	2.055	1.838	1.768	1.7024	1.714
BIC	2.304	2.170	2.076	2.099	1.882	1.812	1.7574	1.769
Moran	16.1***	13.9***	11.9***	13.1***				

Notes: t-values in parentheses. Asterisks indicate significance at the 10% (*), 5% (**) or 1% (***) level. Estimations use the heteroskedasticity consistent covariance matrix estimator of White (1980). AIC is the Akaike (1974) information criterion. BIC is the Schwarz (1978) information criterion. Moran is the Moran's I test adapted to estimated residuals (Cliff and Ord, 1981). The spatial autocorrelation tests were carried out using the 5 nearest neighbours weight matrix.

Table 3: Alternative weight matrices

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Estimation method		Maximum	Likelihood			Maximum	Likelihood	
Weight matrix		Inverse	distance			Squared inverse	distance	
Constant	2.352	6.616**	2.483	10.262***	0.251	1.530*	-0.043	2.905***
	(0.743)	(2.172)	(0.851)	(3.357)	(0.313)	(1.889)	(-0.053)	(3.231)
Revenue	0.157***	0.137***	0.150***	0.150***	0.168***	0.147***	0.155***	0.152***
	(5.270)	(4.854)	(5.587)	(5.456)	(6.145)	(5.518)	(5.984)	(5.785)
Relative lobbying strength 1	-0.004***				-0.004***			
	(-2.857)				(-2.665)			
Relative lobbying strength 2		-0.299***				-0.230***		
		(-7.347)				(-6.015)		
Landlord lobby			0.326***				0.258***	
			(9.450)				(7.597)	
Growth machine lobby			-0.022				-0.021	
			(-1.258)				(-1.268)	
Homeowner lobby				-0.027***				-0.022***
				(-3.441)				(-2.862)
Agricultural lobby				-0.474***				-0.376***
				(-6.539)				(-5.433)
Lagged revenue	-0.262	-0.419***	-0.277*	-0.534***	-0.152***	-0.168***	-0.127***	-0.178***
	(-1.608)	(-2.696)	(-1.866)	(-3.515)	(-3.225)	(-3.652)	(-2.804)	(-3.918)
Lagged TLE	0.968***	0.968***	0.967***	0.967***	0.756***	0.699***	0.660***	0.651***
	(43.079)	(43.096)	(41.783)	(41.82)	(15.419)	(13.212)	(12.836	(11.818)
Log-Likelihood	-349.79	-328.709	-313.36	-316.26	-324.67	-310.52	-300.36	-301.70
Pseudo-R²	0.098	0.238	0.339	0.315	0.105	0.228	0.345	0.302
AIC	2.016	1.896	1.814	1.831	1.873	1.792	1.7399	1.748
BIC	2.060	1.940	1.869	1.886	1.917	1.836	1.7949	1.803

Notes: (see also the notes to table 2)
Pseudo−R² is the linear correlation coefficient between the observed explained variable and the estimated explained variable.

Table 4: Alternative determinants of growth control decisions

	(17)	(18)	(19)	(20)
Estimation method		Maximum Likelihood		
Weight matrix		Five-nearest neighbours		
Constant	0.230	1.548*	0.152	2.879***
	(0.307)	(1.956)	(0.201)	(3.346)
Revenue	0.116***	0.087***	0.111***	0.088***
	(4.351)	(3.289)	(4.367)	(3.409)
Relative lobbying strength 1	-0.003**			
	(-2.115)			
Relative lobbying strength 2		-0.197***		
		(-4.804)		
Landlord lobby			0.212***	
			(6.738)	
Growth machine lobby			-0.036**	
			(-2.321)	
Homeowner lobby				-0.020***
				(-2.901)
Agricultural lobby				-0.347***
				(-4.863)
Lagged revenue	-0.116***	-0.122***	-0.101***	-0.128***
	(-3.229)	(-3.445)	(-2.899)	(-3.671)
Lagged TLE	0.528***	0.481***	0.462***	0.455***
	(11.296)	(9.918)	(9.445)	(9.425)
Population density	0.100***	0.032	0.094***	0.012
	(4.130)	(1.169)	(4.038)	(0.424)
Public debt	0.633***	0.616***	0.609***	0.580***
	(2.902)	(2.860)	(2.877)	(2.752)
Population growth	0.053***	0.060***	0.046***	0.060***
	(5.359)	(6.271)	(4.791)	(6.406)
Log-likelihood	-282.67	-273.84	-263.37	-264.77
Pseudo-R²	0.394	0.472	0.492	0.523
AIC	1.651	1.600	1.546	1.554
BIC	1.728	1.677	1.634	1.642

Notes: (see the notes to tables 2 and 3)

Table 5: Bayesian estimation

	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
Estimation method				Markov Chain Monte Carlo				
Weight matrix				Five-nearest neighbours				
Constant	0.447	1.552**	0.155	2.766***	0.056	1.408*	0.069	2.297***
	(0.673)	(2.219)	(0.227)	(3.547)	(0.072)	(1.741)	(0.089)	(2.686)
Revenue	0.187***	0.166***	0.171***	0.166***	0.117***	0.085***	0.108***	0.087***
	(6.767)	(6.216)	(6.224)	(6.249)	(4.289)	(3.057)	(3.965)	(3.191)
Relative lobbying strength 1	-0.011***				-0.007*			
	(-2.756)				(-1.954)			
Relative lobbying strength 2		-0.232***				-0.202***		
		(-6.533)				(-4.767)		
Landlord lobby			0.280***				0.216***	
			(7.570)				(6.029)	
Growth machine lobby			-0.038**				-0.042***	
			(-2.208)				(-2.756)	
Homeowner lobby				-0.021***				-0.015**
				(-2.881)				(-2.197)
Agricultural lobby				-0.377***				-0.357***
				(-5.769)				(-4.792)
Lagged revenue	-0.164***	-0.174***	-0.135***	-0.176***	-0.111***	-0.116***	-0.096***	-0.117***
	(-4.278)	(-4.613)	(-3.606)	(-4.765)	(-2.995)	(-3.114)	(-2.689)	(-3.160)
Lagged TLE	0.636***	0.583***	0.550***	0.562***	0.502***	0.453***	0.447***	0.432***
	(15.477)	(13.017)	(12.135)	(12.375)	(10.483)	(9.135)	(9.100)	(8.638)
Population density					0.122***	0.048	0.111***	0.031
					(5.056)	(1.635)	(4.523)	(1.065)
Public debt					0.718***	0.701***	0.705***	0.710***
					(3.202)	(3.092)	(3.233)	(3.203)
Population growth					0.053***	0.063***	0.048***	0.062***
					(5.477)	(6.527)	(4.815)	(6.492)
Pseudo-R²	0.077	0.255	0.339	0.316	0.386	0.469	0.491	0.517
# of draws	25000	25000	25000	25000	25000	25000	25000	25000
# of draws omitted	15000	15000	15000	15000	15000	15000	15000	15000

Notes: (see the notes to tables 2 and 3).

Appendix

A1. Derivation of equation [16]

With the partial derivative of [13],

$$\frac{\partial \overline{x}_i}{\partial p_i} = -\frac{J}{(J+1)(\beta+t)},$$

optimization of [15] leads to

$$\frac{d\pi_i}{dp_i} = \frac{-Jz_i^u}{(J+1)(\beta+t)} + z_i^d \left[\overline{x}_i \left(1 - \frac{Jt}{(J+1)(\beta+t)} \right) - \frac{Jp_i}{(J+1)(\beta+t)} \right] = 0$$

$$\Leftrightarrow$$

$$-Jz_i^u + z_i^d \left[\overline{x}_i \left((J+1)\beta+t \right) - Jp_i \right] = 0$$

Substituting [13] into this equation, one obtains

$$Jz_i^d p_i = -Jz_i^u + z_i^d \left(\frac{(J+1)\beta+t}{(J+1)(\beta+t)} \right) \left[Jy_i - \sum_{\substack{j=0 \\ j\neq i}}^{J} w_{ij} y_j - Jp_i + \sum_{\substack{j=1 \\ j\neq i}}^{J} w_{ij} p_j + (\beta+t)N \right]$$

$$\Leftrightarrow$$

$$p_i \left[1 + \frac{(J+1)\beta+t}{(J+1)(\beta+t)} \right] = -\frac{z_i^u}{z_i^d} + \frac{(J+1)\beta+t}{J(J+1)(\beta+t)} \left[Jy_i - \sum_{\substack{j=0 \\ j\neq i}}^{J} w_{ij} y_j - Jp_i + \sum_{\substack{j=1 \\ j\neq i}}^{J} w_{ij} p_j + (\beta+t)N \right]$$

$$\Leftrightarrow$$

$$p_i = \frac{-1}{(J+1)2\beta+(J+2)t} \cdot \frac{z_i^u}{z_i^d}$$

$$+ \frac{(J+1)\beta+t}{J(J+1)(\beta+t)\big((J+1)2\beta+(J+2)t\big)} \left[Jy_i - \sum_{\substack{j=0 \\ j\neq i}}^{J} w_{ij} y_j + \sum_{\substack{j=1 \\ j\neq i}}^{J} w_{ij} p_j + (\beta+t)N \right]$$

which is equivalent to [16].

A2. Calculation of marginal impacts

In order to calculate the marginal impacts of the remaining variables, we resolve equation [18] for $\mathbf{p}$. If $b \neq 0$ and if $1/b$ is not an eigenvalue of $\mathbf{W}$, we obtain:

$$\mathbf{p} = c(\mathbf{I}-b\mathbf{W})^{-1}\boldsymbol{\iota} - a(\mathbf{I}-b\mathbf{W})^{-1}\mathbf{z} + (\mathbf{I}-b\mathbf{W})^{-1}(bJ-b\mathbf{W})\mathbf{y}$$

The solution of this reduced form equation gives the cities' growth control choices in the Nash equilibrium. The partial derivatives are given by:

$$\frac{\partial \mathbf{p}}{\partial \mathbf{z}} = -a(\mathbf{I}-b\mathbf{W})^{-1}$$

$$\frac{\partial \mathbf{p}}{\partial \mathbf{y}} = (\mathbf{I}-b\mathbf{W})^{-1}(bJ\mathbf{I}-b\mathbf{W})$$

These two equations define $n\times n$ marginal impacts of variables on cities' growth control choices.

Using the following relation

$$(\mathbf{I}-b\mathbf{W})^{-1} = \sum_{s=0}^{\infty} b^s \mathbf{W}^s,$$

and under the condition that $b<1$ and $0<w_{ij}<1$, we obtain:

$$\frac{\partial \mathbf{p}}{\partial \mathbf{z}} = -a \sum_{s=0}^{\infty} b^s \mathbf{W}^s$$

$$\frac{\partial \mathbf{p}}{\partial \mathbf{y}} = \mathbf{I} + (bJ-1) \sum_{s=0}^{\infty} b^s \mathbf{W}^s$$