Determinants of local public policies for farmland preservation and urban expansion: a french illustration

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Abstract:

We outline the determinants of local public policies for farmland preservation and urban expansion. We first rely on the literature and on a purposely-designed field study of municipalities in Southern France to propose a theoretical framework better suited to the French situation. The model considers aspects of land consumption, two interest groups as well as the median voter, and is then econometrically tested. We confirm the expected effects of certain socio-demographic determinants; highlight the impact of municipal budgetary considerations and the role of the agricultural sector. We also find more counter-intuitive determinants, like local political regime or unbalanced neighbouring relationships.

I INTRODUCTION

Urban sprawl associated with diminishing agricultural land and its highly debated socio-economic and environmental impacts is a worldwide issue (UN Habitat 2010). Agricultural production needs to increase, in order to feed the world in the future (FAO 2009). However, arable lands are not infinitely expandable and some competitive uses – like biofuel production - are already decreasing foodstuffs production. Moreover, given the current public support for environmental preservation, farming practices need to become more wildlife-friendly, with the consequent reduced productivity (Green et al. 2005). These trends explain the recent recommendations - at different institutional levels (for instance United Nations 2010; or Central State level in France) – in favour of farmland preservation. However, these recommendations do not seem sufficient to alter the trend to urban sprawl: first, because contradictory regulations and incentives sometimes emerge from the various institutions that make these land-sparing recommendations (see for example CAS 2011); second, because policies directly related to land consumption, like land use policies, are mainly produced by more local jurisdictions acting under a variety of rationales to counter or to favour sprawl. It is consequently crucial to outline the determinants of urban expansion policies in order to understand how local jurisdictions behave.

While many studies have addressed the question of growth control, few consider policy in terms of potential land consumption impacts. Thus, Rolleston (1987) and Solé-Ollé and Viladecans-Marsal (2012) (SOVM in the following) consider the relative areas authorized for urban development; Schmidt and Paulsen (2009) analyze the determinants of the amount of land preserved per capita; Lewis and Neiman (2002), Rolleston (1987) and Pirotte and Madre (2011) take into account density aspects and Brody, Carrasco, and Highfield (2006) develop an anti-sprawl measure quality index. In other studies, the policies considered have only an indirect and very ambiguous link to the land consumption issues previously identified by Pendall (1999), focusing instead on housing and demographic aspects.

Most of these studies deal with or are inspired by North American cases, in which both the geographic and institutional situation, and the commonly used regulatory tools differ from those of European, and particularly French, cases. Geographically, European cities have traditionally been much more compact than American cities, having developed a dense historical core shaped before the emergence of modern transport systems (Uhel 2006). They also usually have more mixed uses (Hirt 2012), dynamic urban centres and numerous small and medium surrounding towns (Catalán, Saurí, and Serra 2008). On the other hand, artificial land[i] represents a greater share of the territory in Europe (8.8% - Eurostat 2011) than in the USA (2.6% - USDA 2002). Moreover, land consumption per capita (493 million inhabitants in 2006) is increasing, with an expanding individual housing market and increased economic infrastructures and road networks (European commission 2011). As a result, urban sprawl is common throughout Europe, especially around smaller towns or in the countryside, along transportation corridors and in many parts of the coast, usually where there are river valleys.

Institutionally, land development regulations play an important role (e.g., Nivola 1999) and explain some differences from North America. The type of zoning that American planners and citizens are familiar with - separation of urban functions and predilection for single-family housing - is not so common in Europe (Hirt 2012). Indeed, the French type of planning, which has been influential throughout Europe, is inherited from Napoleon and characterized by a high level of codification and centralized governance: elected officials must set their land use regulation policies within the framework of national documents related to planning (Hirt 2012). In this form of planning, regulations can be very stringent with respect to building form (height, floor area ratios) but less so with respect to function, allowing mixed use in urban functions. Lastly, European taxation systems are generally based less on property values than on property revenues and added value, and central governments impact the design of taxation more powerfully by collecting and redistributing some local taxes to maintain equity among local jurisdictions. Thus, incentives to support activities that increase property values are lower in Europe than in the USA, because these activities will not strongly impact local finances (Jacobs 2008), and fiscal and monetary tools are therefore less used to control growth at municipal level. Overall, municipal land use regulations are the main tool used to control farmland conversion to urban use in France (Shone 2010; Fischel 1987; Derycke and Gilbert 2008; Charlot and Paty 2007; Charlot, Paty, and Visalli 2011; Comby and Renard 1996; Alterman 1997).

Because French municipal land use regulations are very different from North American ones, farmland preservation determinants are expected to differ. Consequently, by restricting the modelling only to determinants found relevant in the North American case, one might spuriously attribute to them the land use planning decisions observed in France and miss the actual drivers. However, there is currently no quantified validation of the determinants involved in decision-making related to land use policies in French jurisdictions, and the literature, particularly the quantitative literature, contains few studies of European cases, with the notable exception of SOVM (2012).

In this article, we focus on South-Eastern France, a region that, like many other Northern Mediterranean regions, has experienced strong and Europe-specific trends to urban sprawl. We widen and enrich the model developed by SOVM (2012) that considers the choice of policy as a function of the median voter (referred to as representative voter in SOVM) and of interest group utility variations, taking into account the role of electoral competition. Thus, we develop a theoretical framework compatible with the French historical, legal and jurisdictional context. It introduces density restriction considerations, considers the role of a pro-agriculture interest group and allows for an accurate characterization of the median voter, while considering geographical factors (including neighbouring relationship effects) and political factors, like local government's legitimacy, the consequences of supra-municipal zoning and of past municipal policies.

After describing the French institutional framework and reviewing the relevant theoretical and empirical literature (Section II), we set an original theoretical framework for local land use policy decision-making, derived from an extensive field survey (Section III). We then propose an appropriate econometric strategy and create a rich database on land uses, demographic and political characteristics at municipality level (Section IV). This database is used to empirically validate our model, while accounting for possible selection bias, and for the purposes of comparison with SOVM's model (Section V). We discuss the main results and conclude in Section VI.

II INSTITUTIONAL AND THEORETICAL FRAMEWORK

The French legal and institutional framework for land use plans

In France, the municipality is the smallest jurisdiction. There are 36,680 municipalities (vs. only 330 in the UK, for instance). The majority of municipalities are small: the average population of French municipalities (1,700 inhabitants) is lower than the average in the European Union (4,000 inhabitants) (INSEE 2009). French municipalities have to respect common patterns when creating or altering a land use policy. Given this common framework, the tools and policy levels used are far less diverse than in other countries, like the United States for instance (Schone 2010); the main tool for land use policies is the local land use plan.

Municipal councils draw up land use plans at municipal level. When a council proposes a new land use plan, it is generally drawn up with the technical support of private or public planning offices and takes into account the recommendations of several public organizations (board of trade, board of agriculture, government agencies, etc.). Then, the plan is subjected to government checks on compliance with law and to several public inquiries (from citizens and public/private organizations). Some non-land-use-specific central government regulations can impact land use: national policies on environment, housing, economic activities, transport and natural/technology risk and environmental zoning (with varying levels of restrictiveness). However, the central government also designs a land-use-specific framework that each municipality must respect when creating or altering land use plans. After the necessary amendments, the municipal council adopts the plan. Although land-use plans are only compulsory under specific conditions (of municipal population and of attachment to certain urban areas), most municipalities have one, except for very small rural municipalities.

A land use plan is constituted by a presentation of the municipal context, objectives and rationales, a map with the different zones and regulations detailing the rules for each type of zone. Regulatory tools such as "special permits", "planned unit development", "contract zoning" or "linkages" and transferable development rights are either rare or forbidden, as are criteria explicitly selecting inhabitants, like single-family zoning. Neither "growth caps", "population caps", "Ballot-box growth controls" nor protective covenants exist in France. The main types of zone are the "urban zone", covering the built-up and developable areas; the "future urbanization zone", developable in the middle or long term; the "agricultural zone", non-developable except for agricultural-activity-related buildings; and the "natural zone", non-developable (Schone 2010). In these plans, specific developable zones can be used to create a diffuse urban fabric where a minimum area is required to build a house. There are many of these diffuse urban fabric zones and they create significant urban growth. Thus, current central government policy limits urban expansion and favours urban renewal (DGUHC 2003), but although municipalities are subject to a common framework, they actually have substantial leeway to make decisions. Lastly, when a once-developable parcel is zoned as non-developable there is no compensation for any decline in property values, whereas the reverse situation is highly profitable to owners and developers since it involves very little extra outlay (Alterman 1997; Comby and Renard 1996).

The French situation: lessons from the literature

Existing quantitative models applied to studies based on French cases deal with the probability of adoption of a land use plan (Lecat 2006) without mentioning their guidelines, or with local tax choices (Schone 2010), while Pirotte and Madre (2011) explain the degree of dispersion of the three main French Metropolitan areas by the relative population growth of their constitutive municipalities in relation to their distance from the CBD. Further examples are Geniaux, Ay, and Napoléone (2011), who rely on development optimal timing literature on the one hand, and on econometrics modelling applied to Southern France on the other hand. They show that landowner anticipation of agricultural land use conversion is one of the key drivers of future development, especially when land use plans are frequently altered or perceived as subject to change.

In addition, the literature contains several qualitative studies on French cases such as Charmes (2007, 2009), Vilmin (2002) and Castel (2007). According to these studies, the population of a municipality first grows because encouraging new inhabitants is seen as a way to revitalize the municipality and as a windfall for landowners, who are often influential in municipal councils. This more or less continuous growth phase leads to a socio-demographic, political and budgetary balance upheaval before the municipality reaches a demographic stabilization phase. This new phase is accompanied by the political will to maintain living conditions to the detriment of urban development and land value gains. Consequently, a development spillover to more remote municipalities occurs, so that a "municipal green belt" is maintained to a greater or lesser degree around each municipality (Charmes 2009). The final stage may be a modest growth phase linked to persistent demand for growth from landowners, which may be supported by collective constraints (to maintain local schools, to support the local business or services centre, etc.).

This "leapfrog development" phenomenon is, of course, not France-specific but is reinforced in the French case by the high degree of control over land use decisions given to each municipality, allowing them a lot of room for manoeuvre despite a common legal framework. Moreover, the majority of French municipalities have small populations (15% of the population live in 75% of the municipalities that have less than 1,000 inhabitants), leading to a close relationship between elected representatives and residents, which ensures that landowners' and homeowners' preferences are taken into account (Charmes 2007; Castel 2007). All this can result in "residential environment markets": each municipality offers its own residential environment basket and households "foot-vote" according to the proposed baskets rather than according fiscal considerations (Charmes 2007). Additional factors are that primary schools are still mainly financed by the central state, and that local taxes appear to have less effect on choice of household location than on choice of business location

(Derycke and Gilbert 2008; Charlot and Paty 2007; Charlot, Paty, and Visalli 2011). This sequence of events is observed in the outlying areas of every municipality sooner or later, depending on their distance from the core of the urban area, leading to what Castel (2007) calls a "*émiettement urbain*" (closest French equivalent to "leapfrog development"). In this view, preferences for open-space-related amenities and uncertainty on future profitability of urban development (as compared to the profitability of different kinds of agricultural uses) play an important role, theoretically formalized by Cavailhès *et al.* (2004) who did not, however, really consider the policies involved. The result of this process is that discontinuous urbanization rings are formed

The Solé-Ollé and Viladecans-Marsal (2012) model as a starting point

We rely on the SOVM (2012) model as a starting point for several reasons: it deals with the amount of land that became developable (measured in percentage of the already urbanized area) over a given period under municipal plans, as is common in France; it is applied to a Southern European area (Spain), like our own area of study; and the theoretical framework used combines most of the advances made in previous work. The amount of land becoming developable depends on a trade-off made by the elected mayor between increasing land rent and his/her expected utility of being re-elected. The land rent is a function of developers' (and land-owners') profit which increases with the amount of land devoted to urban development, especially when building demand is high and developable land supply is low at the time of decision. The probability of being re-elected depends on the median voter's utility variation, which in turn depends on the variation in the amount of land devoted to urban development and a set of preference shifters that measures the marginal disamenity effects of new development. The municipal government chooses the amount of land devoted to urban development so as to equalize the value of additional rents and the loss in utility derived from not being re-elected. According to this model, the weight on voter's welfare rises with the degree of political competition.

III ENRICHING THE THEORETICAL FRAMEWORK WITH A SPECIFIC FIELD STUDY

A France-specific field study

Our study area is the South-Eastern French region (Provence-Alpes-Côte-d'Azur - PACA), with 3.18 million hectares and 5 million inhabitants spread over 963 municipalities. The population and related urbanization is essentially located on the Mediterranean coast and in the Rhône Valley (see Figure 1), while other areas are plateaus and mountains. This area is part of Southern Europe, whose dense and compact cities with centres showing no sign of decline differ markedly from those of North America. In this region, urban sprawl has been developing at unprecedented rates since the 1980's (Uhel 2006) due to demographic growth along the coast, jobs based on new technologies (Dura-Guimera 2003) and tourism, which generates second-home urban development pressure. Being located in PACA ourselves enabled us both to collect and to access detailed databases, comparing them with a regional field survey.

Following expert advice from SAFER, we chose a sample of 39 municipalities representing the diversity of situations that can be encountered in the region (see Figure 2). Semi-directive interviews were conducted in each municipality with the elected official in charge of urban planning or, by default, with the technical officer in charge of urban planning.

These interviews were aimed at revealing specific local drivers or individual willingness to change land use plans. Our survey covered: first, the adoption, date of change or state of progress of the ongoing plan; second, the main objectives and priorities leading to adoption or change of the plan; third, the tools used in the plan (zoning types, zone rules); fourth, the main difficulties encountered in drawing up, amending or enforcing the plan or, conversely, the facilitating factors; and last, the relationships with neighbouring municipalities, higher jurisdictional levels and related public organizations on these issues. The recorded interviews were then studied using an analytical grid so as to classify municipal strategies depending on their willingness to expand developable area on the one hand and their willingness to densify on the other hand. Then, we outlined the contexts, objectives and rationales that led municipalities to adopt each type of strategy. From this field analysis, detailed in Delattre, Chanel, and Napoléone (2012), we obtained four main results, used to enrich the theoretical framework.

[FIGURE 1]

[FIGURE 2]

The enriched model

We consider the choice made by the incumbent[ii] at date t, concerning changes in land use policy in the next period (*t, t+1*): the decision not only on whether to increase the amount of developable land, but also by how much (**ΔUrbanland(*t,t+1*)**). We assume that this choice depends on the expected variations at date **t** implied in the **dominant groups' utility** (**$E_t[\Delta U_{dom}(t,t+1)]$**) and in **the median voter's utility** (**$E_t[\Delta U_{med}(t,t+1)]$**, the voters are the municipality's current residents). Although the current dominant groups do not represent the majority of voters, they can offer political support to the incumbent, especially for re-election.

First, the field survey leads to better and more accurate characterizations of the dominant groups and the median voter. While the interest group in SOVM (2012) is composed of developers and landowners who only have an interest in urban development, we assume here that the utility of the "dominant interest group" does not depend only on land rent maximization. Interest groups in favour of urban land rent maximization can be very strong, but farmers' groups too, although often made up of landowners, may be interested in farmland preservation. These kinds of interest group are, of course, present in municipalities where agricultural activity is very profitable (for example, world-famous vineyards), but not exclusively. Farmers in municipalities where urban land rent seems far higher than agricultural land rent may also support farmer-owned farmland preservation (in South-Eastern France, farmers own most of the parcels they cultivate). As observed during the field study, the decision of a farmer with landholdings to put pressure on the municipal council to obtain developable status for his parcels will not depend only on a comparison of the anticipated profits from agricultural activities with those from development (as usually presented for development timing). It will also depend on other local factors: "image" (organic farming, for example) and structure (local farmers' organizations), the probability of a child taking over the farm, the relative profitability of the holding compared to holdings' profitability in the same area/agricultural sector and its evolution over time. These aspects are rarely explicitly considered in land use policy modelling. Formally, we assume that the dominant groups' utility is composed of **the "pro-agriculture" group** (indexed by $\mathbf{d_a}$) and the **pro-development group** (indexed by $\mathbf{d_u}$).

In addition, we assume that the median voter's utility variation can also be decomposed into several aspects. Indeed, according to the literature and to statements by elected officials, the median voter can simultaneously be seen as a **resident, homeowner or renter,** (indexed by **r**), a **taxpayer and local public service user** (indexed by **f**), **an amenity**

“consumer” (indexed by **e**), **an adult of working age, working in the municipality or not** (indexed by **τ**).

Second, the balance between the induced variations in the median voter’s and dominant groups’ utility depends, if divergent, on electoral competition. SOVM (2012) show that a weak degree of electoral competition allows the elected officials to give the preferences of interest groups more consideration. Our field study brought to light more “audacious” political behaviour (in favour either of urban expansion or of densification, according to interest group) where electoral competition was weak. We assume that the incumbent assesses the level of electoral competition through the **expected vote margin** ($\mathbf{E_t(m_{t+1})}$) at the next municipal election. Because political studies on French municipalities show that the level of electoral competition is a relatively stable characteristic of municipalities over time, or at least that there is a positive significant relationship between electoral scores at successive municipal elections (Bages 2004; Nevers 1992; Jerôme-Speziari and Jérôme 2002), we assume that $\mathbf{E_t(m_{t+1}) = m_t}$.

Third, what happens in neighbouring municipalities will affect the median voter’s, the interest groups’ and the elected officials’ perceptions of policy changes. Thus, if the surrounding municipalities have experienced changes that would have been beneficial to them if realized in their own municipality, the municipality will tend to adopt the same behaviour as its neighbours (mimicry). If neighbouring municipalities have experienced changes that would have been detrimental if realized in their own municipality, the municipality will tend to adopt different behaviour from that of its neighbours (differentiation). Lastly, if these neighbouring municipalities have experienced changes that have actual or potential spillover effects on the median voter’s municipality, the municipal government will adjust the policy in order to benefit or to protect the municipality from these effects. A change in a neighbouring municipality is even more likely to induce changes in a given municipality’s characteristics or policy if they are close, especially (and perhaps only), as the field study indicates, if the neighbouring population is the same or larger. The set of **characteristics taken into account with respect to neighbouring municipalities** is denoted by **v**.

Finally, other factors also need to be taken into account, like political ones: for instance, the number of years since the last land use policy change, the development opportunities still open under the current land use plan, the perception of past municipal experience (remaining vacant diffuse urban fabric zones, past housing development, etc.) in terms of desirable or undesirable consequences of land use regulation or contention over land use, the political leanings of the current elected officials. Political leanings appear to have more effect on choices related to density than on those related to expansion of developable area (even though the two aspects are linked if we consider population objectives). Avoidance of new pressure often explains the absence of major changes in land use policy, especially in municipalities where the stakes are high and/or where the issues traditionally cause friction. So it is important to take into account the “climate” in which elected officials evolve beyond their vote margin. Also worth considering are special local features, like a diffuse existing urban fabric (which can make coherent land use projects very cumbersome to implement alongside low density amenity conservation), regional demand for development (proximity of existing infrastructures and urban poles) or supra-municipal regulations that make some areas permanently non-developable. In fact, the interviewees frequently referred to these features. All **these political dimensions** are denoted by **p**.

IV ECONOMETRIC STRATEGY AND DATA

Econometric strategy

We first consider that, for a given period *(t, t+1),* the decisions on whether to make a change and by how much are made simultaneously. The dependent variable $\Delta Urbanland_i$ is higher than zero if municipality *i* increased its amount of developable area, and is zero otherwise. Consequently we opt for a Tobit model (Tobin 1958), left-censored in 0:

$$\Delta \text{Urbanland}_i^* = \gamma' Z_i + e_i \text{ with } e_i \sim N[0, \sigma^2_e],\ i = 1, .., N \qquad [1]$$

with ΔUrbanland$_i$* a latent variable; Zi , a set of explanatory variables and e_i an error term.

We observe:

$$\Delta \text{Urbanland}_i = \Delta \text{Urbanland}_i^* \text{ if } \Delta \text{Urbanland}_i^* > 0$$

$$\Delta \text{Urbanland}_i = 0 \text{ otherwise}$$

where ΔUrbanland$_i$ is the change in the amount of developable land of municipality *i* between *t* and *t+1*.

The maximum likelihood estimators of this model have the required statistical properties, but the model imposes by construction that the same set of variables $\mathbf{Z_i}$ explains both the decision to increase and the extent of the increase.

We then relax this constraint by approaching the modelling of the political choice as a two-stage model. First, the decision to increase the amount of developable land when altering the plan can be modelled as (selection equation):

$$\text{Increase}_i^* = \alpha' W_i + u_i \quad \text{with } u_i \sim N[0, \sigma^2_u] \qquad [2]$$

where **Increase$_i$*** is an unobserved latent variable, $\mathbf{W_i}$ is the set of variables explaining the decision to increase the amount of developable land and $\mathbf{u_i}$ is the error term. We observe the **Increase$_i$** variable such that:

Increase$_i$ = 1 if Increase$_i$* > 0

Increase$_i$ = 0 if Increase$_i$* ≤ 0

where Increase=1 if municipality increased its developable area between *t* and *t+1*.

Then, for municipalities showing a strictly positive increase in their amount of developable land, this increase can be modelled as (outcome equation):

$$\Delta \text{Urbanland}_i = \beta' X_i + \varepsilon_I \qquad [3]$$

where $\mathbf{X_i}$ is the set of variables explaining the degree of change and ε_i is the error term.

However, the pair **(ΔUrbanland$_i$, X$_i$)** is only observed if **Increase$_i$** = 1, and we need to take into account the fact that municipalities with increased developable land may not be randomly drawn from the overall sample. In other words, when computing the extent of the increase, we should account for the probability of an increase actually occurring, hence the value of a selection model whose guiding principle is the correlation between variables involved in the selection mechanism and unobserved individuals' heterogeneity. Ignoring this selection would lead to biased estimators[iii]. We prefer Heckman (1976)'s two-step estimation method, more robust to misspecification and showing fewer convergence difficulties than the one-step (full information) maximum likelihood estimation method, which is more efficient when the error terms' joint distribution actually follows a bivariate normal distribution. It consists in estimating equation [2] on the total sample with a binomial Probit model and then calculating the inverse Mill's ratio (**IMR**) using the estimated coefficients:

$$\hat{IMR}_i = \varphi(\alpha' W_i)/\Phi(\alpha' W_i) \quad [4]$$

where φ is the density function of the standard normal distribution and Φ is its cumulative distribution function.

In the second step, the following equation is estimated only for municipalities showing a strictly positive increase in their amount of developable land:

$$\Delta Urbanland_i = \beta' X_i + \rho\sigma_\varepsilon + \nu_i \quad [5]$$

with $\nu_i = \varepsilon_i - \rho\sigma_\varepsilon \hat{IMR}_i \sim N[0, \sigma^2_\varepsilon(1-\rho^2(\hat{IMR}_i \; (\hat{IMR}_i + \alpha' W)))]$ where σ^2_ε is the variance of ε_i ; $\rho\sigma_\varepsilon$ is the covariance between ε_i and u_i; ρ is their linear correlation coefficient.

If ρ significantly differs from 0, the relevant model is the Heckman Selection model, otherwise, it is the Two-part Model (Madden 2008). The latter can be estimated with a Probit model for the first equation and an independent OLS model for the second equation.

Data

The amount of land rendered developable by law between 1999 and 2006 (according to the digital land use plan maps) as a percentage of the 1999 built-up area[iv] (**ΔUrbanland)** is used as dependent variable, in line with SOVM (2012). As the law on development in the agricultural zone is very restrictive and well enforced even when related to agricultural activities, we consider the agricultural zone as a non-developable zone. Unfortunately, the densities authorized in the different zones are not available, and using a proxy such as residential densities at time t would have been problematic: observed densities in t might be the consequence of former policies *(t-k)*. Moreover, policy changes in t do not necessarily cause changes in density, especially rapid ones.

On the other hand, several types of data on municipalities' characteristics, population or land uses in the study area are available (see Table 1):

- Data on land use and urban fabric from an improved version of CORINE Land Cover database (OCCUPSOL 1999) and from the land registers for 2005 and 2010 from which we located buildings existing in 1999 (CADASTRE).

- Land use policy data (zoning) for 1999 and 2006 covering roughly 400 municipalities (Land Use Database = LUP DB). If the municipality made any change in the land use plan over this period (not necessarily inducing an increase in the amount of developable land), it is listed in the database of the National Directorate-General for Urbanism, Housing and Building (DGUHC).

- Socio-demographic and accessibility data from the National Institute of Statistical and Economic Studies (INSEE) for 1990 and 1999. For variables describing a growth rate (except for population trends), we calculate the difference between the value in 1999 and in 1990 as a percentage of the 1990 population to avoid zeros at the denominator[v].

- Data on agricultural holdings and types of agricultural activities for 2000 from the database of the *Mutualité Sociale Agricole* (agricultural social mutual fund) and from the bureau for statistics of the French Ministry of Agriculture and Fisheries (AGRESTE). We use the median farm turnover (profits + salary) as a proxy of the profitability of agricultural activity in the municipality. However, as turnover strongly depends on type of farming (for instance, for the same level of profitability, turnover is generally lower in livestock farming than in market gardening), we consider the relative difference between the median agricultural turnover of the municipality and the median turnover of municipalities where farms are mainly of the same type. Several studies show that under specific conditions, land use zoning "follows the market" (Wallace 1988; McMillen and McDonald 1989, 1991a,b; Thorson 1994). We could consider land prices but choose not to, for two types of reasons. First, the quality of price data is poor and the number of recorded sales is not sufficient in many municipalities, especially for developable areas. Second, land prices and public choice on land use issues are determined by the same characteristics (Pogodzinski and Sass 1994), so that using these characteristics and prices jointly in the same model would likely result in increased endogeneity and/or collinearity issues. Hence, we prefer to consider characteristics that are likely to describe the profitability of urban development and agricultural activity. The percentage of change in the number of farmers is computed similarly to the percentage of change in data from INSEE (i.e. with the 1990 population as denominator), since some municipalities showing no farmers in 1990 had farmers in 2000. We also consider a dummy standing for at least one organic farmer in the municipality (*Organic*).

- Municipal budgetary data for 2000 from the French Ministry of Finance.

- Relief is taken from the National Topographic and Equipment Data Base (BDTopo®) and the state environmental and risk zonings from the Regional Department of the Environment, Planning and Housing (DREAL).

- We use the Quetelet Network's database on the 2001 municipal election results, the website of the Ministry of the Interior for the results of Parliamentary elections (the 2002 legislative elections) and the National Department of Urbanism, Housing and Building (DGHUC)'s database for disputes on land use policy changes between 2004 and 2007. To capture "the political leanings" of the residents, we use the first-round legislative election results from the Interior Ministry rather than the results of the municipal election, because in most small municipalities, candidates do not show a political leaning. Because green and centre parties were under-represented, we considered green parties as left-wing and centre parties as right-wing.

To take into account neighbour effects, we compute two variables for each municipality: the population in neighbouring municipalities (*PopNeighb*) and how it changes (*ΔPopNeighb*). In accordance with the field observations, only neighbouring municipalities larger than the municipality considered are included in the computations[vi]. This calculation takes into account all the municipalities of the study area (963 municipalities) and municipalities belonging to French administrative departments having a common border with the study area, in order to limit border effect issues. The only remaining possible border issue is therefore the Italian border, but the absence of big cities on the Italian side and the fact that the Alps act as a natural border make this unlikely.

Lastly, in accordance with field observations, we consider a dummy *Azur* equal to 1 if the municipality is located on the *Côte d'Azur*, an area with more intensive tourism than the rest of the region.

The explanatory variables all describe either the municipal situation in 1999 (or if not available, in 2000, 2001 or 2002, except for the variable *Disputes* for any land-use-policy-related disputes between 2004 and 2007) or the evolution of a characteristic during years before 1999 or 2000 (mainly between 1990 and 1999-2000). Thus, these characteristics and their evolution can be considered as potential determinants, but not as consequences, of both the decision to increase the amount of developable land and the extent of this increase, measured between 1999 and 2006. This decreases the likelihood of endogeneity issues.

We are left with 327 municipalities after database cleaning. Table 1 presents the variables, their sources, and the *specific* aspects of the theoretical framework they are intended to test.

[TABLE 1]

V RESULTS

The overall estimation methodology controls for collinearity, for outliers (using Cook's distance and Bonferroni outlier tests), for spatial dependence, and estimates a heteroskedasticity-consistent covariance matrix. The best models are selected based on Akaike's information criteria.

The results of the **Tobit model** are given in Table 2 along with the marginal effects. Although all the municipalities made at least one change in their land use plan between 1999 and 2006, about 17.5% made no increase in their amount of developable land and are hence left-censored. No collinearity or spatial dependence issues are found (p-values greater than 0.31), the test of joint nullity of the coefficients is rejected (p-value<0.0001) but the pseudo R^2 is very low (0.034). We observe a significant positive effect of *AvailableLand* (but an unsignificant effect of *VacantLand*), *ΔPopNeighb*, *Disputes* and *Organic* and a significant negative effect of *BuiltUp, Income* and *VoteMargin.* The results from the Tobit model are considered in a comparative way when presenting and discussing the results from the two-stage model, in order to highlight similarities and differences.

[TABLE 2]

Regarding **the two-stage model**, the Likelihood Ratio test of independence between the selection and the outcome equations does not reject independence (p-value= 0.442), so that a Two-Part model is estimated (see Tables 3 and 4).

[TABLE 3]

The Probit equation is satisfactory: the test of joint nullity of the coefficients is strongly rejected (p-value < 10^{-5}), McFadden pseudo R^2 is 0.321, the proportion of correct predictions is 86% and the three spatial error autocorrelation tests show its absence (p-values greater than 0.90). Average marginal effects are computed as the average of individual marginal effects for every variable, taking account of the discrete nature of the variable when relevant.

First, it is interesting to note that although the population (*Population*) and the population change (Δ*Pop*) of the municipality do not have a significant effect (but are maintained as control variables), their counterparts for neighbouring municipalities (*PopNeighb and* Δ*PopNeighb*) have significant positive effects. Thus, even more than municipal characteristics, the supra-municipal local context seems to impact the decision (as previously observed by Nguyen 2009). The larger these neighbouring municipalities are, and the closer to the municipality under consideration, the greater the effects. While the evolution of the municipal population does not have a significant effect, the evolution of the population under 14 (Δ*Under14*) has a negative one. In fact, a 10 percentage point increase in its population under 14 means a 13.2% decrease in the probability of a municipality's increasing its amount of developable land. This may be related to school (and child-related services) overcrowding issues.

Municipal *Cashflow*, which is generally used as an indicator of a healthy budgetary situation, has a negative effect. This suggests that increasing the amount of developable land is seen by municipalities, whether rightly or wrongly (see e.g. Castel 2007; Guengant 1992; Burchell et al., 1998, 2002; Carruthers and Ulfarsson 2003; Camagni, Gibelli, and Rigamonti 2002), as a way to improve an unhealthy budgetary situation. Conversely, municipalities in a good fiscal position do not feel the need to offer more land for development, not requiring more revenue.

As in the Tobit Model, income per unit of consumption (*Income*) has a negative effect that may represent the preference of higher-income people moving into the municipality for preserving openland amenities. According to the Probit estimation, a 1,000-Euro increase in income decreases the probability of increasing the amount of developable land by 2,4%.

Looking at the political variables, a 10 percentage point increase in the score of municipal elected officials in the 2001 elections (*VoteMargin*) decreases by 2.6% the probability of increasing the amount of developable land, and this effect is also observed to be significant and negative in the Tobit model. When a municipal council decides to make a change in the land use plan, there is usually strong landowner pressure to make their parcels developable, this pressure sometimes being supported by residents for diverse reasons (e.g. to achieve property ownership or to allow adult children to live in the municipality). Thus, not increasing the amount of developable land (for instance, in order to comply with national recommendations) requires a "political courage" more likely to exist if the council has a strong majority. Moreover, the fact that a left-wing party obtained the highest score in the first round of the 2002 legislative election (*Left*) decreases by 15% the probability of increasing the amount of developable land. In France, while the social anchoring of right-wing parties persists (especially among the self-employed), the people who generally vote for left-wing parties do not all belong to the working class traditionally motivated by social progress and "materialistic" values (purchasing power, wages, equity); left-wing voters also include upper-class/graduates more recently motivated by "post-materialistic" values such as ecology or cultural liberalism. Left-wing voters are also usually younger than right-wing voters (Michelat and Tiberj 2007). It can therefore be assumed that left-wing voters are more likely to be in favour of affordable and/or smaller, denser housing, which may have an indirect effect on the decision to increase the amount of developable land, particularly if these voters share an ecological preference for non-built-up land and amenity preservation.

We observe a negative effect of farms' relative turnover (*Turnover*) but a positive effect of the proportion of farmers in the population (*Farmers*). A 10-percentage point increase in the proportion of farmers means a 24% increase in the probability of a municipality's increasing its amount of developable land. This suggests that when farms are more profitable than the median profitability of the sector, an increase is less likely; but the proportion of farmers appears to be a proxy for the proportion of landowners and for the weight of their interests. However, changes in the percentage of farmers never had a significant effect.

Finally, the dummy *Azur* has a strongly significant negative effect: municipalities located on the Côte d'Azur are 26% less likely to increase their amount of developable land than municipalities located elsewhere in the PACA region. Indeed, municipalities located on the Côte d'Azur are generally very space-constrained because of their high proportion of urbanized land, specific regulations and strongly-sloping land, suggesting that increase is less likely when potential developable land is scarce. Besides, the strong pressure for development they face because of their location may make them reluctant to undertake any major land use change that would exacerbate these pressures.

We now turn to the determinants of the amount of developable land for municipalities showing a strictly positive increase.

[Table 4]

The outcome equation does not show spatial-dependence problems (p-values>0.67) and has an adjusted R^2 of 0.29, which is acceptable given the small size of the sample and the fact that the dependent variable is expressed as a percentage. To limit non-linearity issues, we carry out a Box-Cox power transformation of the endogenous variables (Box and Cox, 1964).

As in the Tobit model, the municipality's population (*Population*) and larger neighbouring municipalities' populations (*PopNeighb*) do not have significant effects, but are kept in the model as control variables. Population change in larger neighbouring municipalities *(ΔPopNeighb)* has a positive significant effect, while the municipality's population growth *(ΔPop*) has a significant negative effect: municipalities tend to "adapt" to their larger neighbours' recent population growth by rendering land developable, but this increase in developable land is smaller in municipalities that have themselves just experienced population growth: in this case, new urban development is probably deflected to smaller and more peripheral areas that have experienced lower population growth in former years. This finding agrees with qualitative French studies previously mentioned. Along the same lines, the proportion of urbanized land (*BuiltUp*) has a significant and negative effect, as in the Tobit model, suggesting that municipalities reject further growth when they reach a given size or urbanization threshold. This variable was also negative but not significantly in the Probit model (p-value =0.381), which underlines the advantage of different set of explanatory variables when modeling the decision to increase and the extent of the increase. As expected, *ΔVacantH*, the change in the share of vacant housing units, also has a significant negative effect.

Regarding residents' characteristics, *UpperClass* and *Over75* have a significant negative effect. The percentage of upper class residents is a proxy for a high-income, graduate population. So a high proportion of wealthier, more educated residents does not lead to large increases in developable land, probably for reasons of rural amenity preservation. A high percentage of over-75s has the same effect, but in this case due to elderly households' preference for smaller, more centrally-located housing units. These varying rationales for low increases consequently have different implications for housing supply and density. Finally, one "standard" variable, the percentage of homeownership (*Homeowner*), does not have a significant effect, but has been added because it appears to contribute to the validity conditions of the model (residual normality).

The municipal debt outstanding (*DebtOutstand*) has a significant positive effect, implying that in-debt municipalities may also expect to obtain new tax revenue by taking in new residents, especially richer ones with a preference for large lots and who consequently require extensive developable areas.

Left has a negative and significant effect, as in the Probit equation, and certainly for the same reasons. *Disputes* has a significant positive effect, as in the Tobit model. However, it is not clear whether disputes about land use policies are a cause or a consequence of the increased amount of developable land[vii]: increasing the amount of developable land can be either a source of disputes or a means of solving them.

Surprisingly, *Organic* has a significant positive effect in the outcome equation, as in the Tobit model, which raises questions about how to account for the relationship between organic farming, land use policy and urban development, as well as for local agriculture's image. This issue is discussed in the next section.

Overall, the Two-Part model provides better insights into the determinants of the public decision and shows that these determinants differ at the two "stages" of the decision. Indeed, the Tobit model "ignores" the effect of some variables highlighted in the Two-Part model (*PopNeighb, ΔVacantH, Farmers*, *Turnover,* fiscal variables, age variables as well as *Azur* and *Left*). However, the Tobit results confirm the effects observed in the Probit and/or the outcome equations for 6 variables (*BuiltUp, Disputes, ΔPopNeighb, VoteMargin, Income, Organic)* and enable us to assess the effect of the amount of land still available (*AvailableLand*) in 1999.

Finally in order to assess the contributions of our theoretical model and empirical validation methods, we apply an "as close as possible" SOVM model to the PACA Region municipalities (see Appendix). Compared to this model, our model provides a higher number of significant variables and better explanatory power, improvements that can reasonably be attributed to the enrichment of the initial SOVM model and to the adaptations made so as to model the specific French situation.

VI DISCUSSION AND CONCLUSION

An abundant theoretical and empirical literature exists on American land use policies but not on European ones, although historical, geographical and legal contexts suggest that processes should differ. In Europe, municipal land use regulations are an important tool to control farmland conversion to urban use. Hence, by identifying the determinants of French urban expansion policies as well as a set of empirical regularities, we believe our approach serves to validate the SOVM (2012) theoretical framework and adapt it to other contexts.

Several of our findings on the median voter's and dominant groups' utility are revealing. First, three factors are revealed about the median voter. *Income* and *UpperClass* have negative effects on respectively the probability of increasing the developable area and on the extent of the increase. High-income and highly-educated households usually show a preference for preserving openland amenities, and are more likely to actively support slow growth (i.e. limited increases in developable area and low-density development) for the sake of amenities and sometimes for exclusionary reasons, in agreement with most of the North American work on this topic (see e.g. Fischel 1987; Richer 1995; Brueckner 1998; Brody 2006; Nguyen 2009). Moreover, the respectively negative and positive effects of municipal *Cashflow* and debt outstanding (*DebtOutstand*) suggest that jurisdictions in a weak budgetary position are more likely to be pro-development. This positive effect of the municipal debt is also observed by SOVM (2012) for Spanish municipalities. However, another explanation for this positive effect might be that a municipality engages in a high level of capital expenditure (water treatment plants, sports facilities, etc.) leading to debt in order to encourage development, and then changes the zoning/plan designation to actually get the development. Interestingly, *BuildingTax,* an equivalent to the US property tax, is never significant whatever the equation (Probit, outcome and Tobit).

Second, *Homeowner* is not significant. However, this finding is not very contradictory to many other theoretical frameworks and observations, such as Fischel's (2001) "Homevoter hypothesis" and Hilber and Robert-Nicoud's (2006) model and empirical validation[viii]. Actually, while the absence of a significant effect may raise questions about the role of the "homeowner" outside the USA (suggesting that this role is less important in France because of differences in the local tax system and in public services financing, for instance), it could also suggest that homeowners care more about density than about the spatial extension of the urbanized area of their municipality. Thus, they may prefer low-density development that preserves their immediate environment and the social homogeneity of the municipal population; this preference may or may not involve urban extension, depending on the desired population growth.

Third, determinants not usually considered - such as agriculture-related characteristics - have significant effects. Thus, the proportion of farmers appears to be a proxy for the proportion of landowners and for the weight of their interests. In contrast, when farms are more profitable than the median profitability of the sector, an increase in developable area is less likely, which confirms our hypothesis about the role of relative agricultural profitability and its use as a proxy for agricultural interest groups. However, this relative profitability only has a significant effect in the first step of the decision, which confirms what the field study suggested: relative profitability is an important but not sufficient argument for farmland preservation. This is why it is important to also consider local agricultural organizations and agriculture's image. However, the data available only allow us to assess the presence of organic farming in the municipality and the unexpected positive effect of *Organic* in the Tobit model and outcome equation raises questions about how to account for local agriculture's image and the relationship between organic farming, land use policy and urban development. Indeed, our variable *Organic* is a dummy variable: given the absence of organic farming in most of the municipalities of our sample, it was not suitable to use a continuous variable (such as the percentage of organic holdings), although a continuous variable would have better accounted for the importance of organic farming in the municipality. Moreover, a good image of agriculture, namely good relationships between residents and farmers, is not exclusive to organic farming. This unexpected effect calls for a deeper analysis of relationships between organic farming adoption and urban expansion. For instance, is the adoption of organic farming a farmers' strategy in municipalities that show an old and recurring tendency to increase their developable area, namely in municipalities in urban or close to urban areas, where demand for organic food can be higher? This is in agreement with some studies showing that a more likely reason why organic farming is located close to urban areas is to make relatively expensive land (because of urban pressure) more profitable while benefiting from urban demand for organic food (see e.g. Eades and Brown 2006; Frederiksen and Langer 2004; Beauchesne and Bryant 1999; Stagl 2002; Christensen, Denver, and Krarup 2007; Allaire *et al.,* 2013). A comparative analysis of dates of land use plan changes and conversion to organic farming, as well as a qualitative analysis of farmers' strategies, could provide additional answers.

Regarding "political" variables, we find that mayors with a comfortable majority (*VoteMargin*) find it easier to take restrictive planning decisions[ix], in contrast with the SOVM results, where the vote margin has a strongly significant positive effect on the increase in developable land. An interesting question, in fact, is why our findings here differ from the effects observed by SOVM: is it because of institutional context differences? Because of vote margin characterization methods? *Left* has also a negative effect, in accordance with the rationale proposed by Kahn (2011). He observes that Californian cities experiencing an increased proportion of liberal voters have a lower new housing permit growth rate and that this is correlated with a higher proportion of city hybrid vehicle registrations (the latter being used as a proxy for city residents' environmentalism). The proportion of liberal voters also has a negative effect on the number of new housing permits in general and on the number of new housing permits for single-family housing.

The municipality's physical capacity to extend their developable area influences the extent of the increase in developable land: the more they have, the less parsimonious they are, as suggested by the positive effect of *AvailableLand* and the negative effect of being located on the Côte d'Azur, a very space-constrained area. Moreover, we suggest, like SOVM, that whatever the amount of physically available land, when the remaining vacant developable land is scarce, pro-development groups have more at stake and consequently there is greater lobbying. Our results are therefore slightly inconsistent with the hypothesis we (and SOVM) put forward concerning the effect of development opportunities, since the variable assessing the scarcity of remaining vacant developable land never has a significant effect.

Both the fraction of municipal area urbanized (*BuiltUp*) and recent municipal population growth also have significant negative effects, in accordance with arguments related to optimal size (see e.g. Cooley and LaCivita 1982) and preservation of remaining natural/agricultural amenities (Schläpfer and Hanley 2003). Another interpretation of this variable's effect is given in Hilber and Robert-Nicoud (2006), according to whom "*land use constraints are the outcome of a political economy game between owners of developed land – who have an interest in tight regulation – and owners of undeveloped land – who prefer flexible zoning laws and lax regulations [.So,] in general equilibrium, [they] show that a planning board – which maximizes aggregated land rents – will choose a high regulatory tax if the location is already highly developed (i.e., owners of developed land are relatively more influential) but will choose a low tax if the location is little developed (i.e., if owners of undeveloped land have a greater influence on planning decisions)*".

Regarding neighbouring effects, the positive effects of the population of the neighbouring municipalities found in the three equations can be explained by the fact that municipalities close to larger cities tend to meet the strong demand for housing they face by virtue of their proximity to an employment centre. Together with the effect of recent municipal population growth, this result suggests that urban development is shifted from municipalities that have experienced population growth to smaller and more peripheral areas that have experienced lower population growth in previous years. These results are in agreement with qualitative French analyses (Vilmin 2002; Castel 2007; Charmes 2007, 2009) and point to the need to qualify hypotheses commonly formulated in the North American literature. Indeed, the negative effect of *ΔPop* also confirms the findings of empirical studies such as those of Lewis and Neiman (2002), Protash and Baldassare (1983) or Donovan *et al.* (1994), while the positive effect of *ΔPopNeighb* contradicts the assumption that the population pressure felt by a city will induce greater restrictiveness towards urban development (see e.g. Brueckner 1998; Nguyen 2009).

Possible extensions could include taking fuller account - in both the theoretical framework and the empirical validation - of interactions between elected officials, interest groups and voters, or enriching the database, namely by taking into account density restrictions and by using panel data to better fit the theoretical framework. Moreover, the role of agriculture's image should be explored further since, while agriculture in the past did not always allow for soil protection, organic farming now appears to be an ally in environmental protection and in the preservation of agricultural areas with high profitability. The tendency of urban development to shift towards the peripheral municipalities as a consequence of municipal land use regulations is also a phenomenon that deserves attention. Finally, transposing this work to other geographical and legal contexts by relying on on-site interviews to calibrate the theoretical framework would be an interesting avenue of research.

Appendix: Transposing the Solé-Ollé and Viladecans-Marsal model to PACA Region.

The Solé-Ollé and Viladecans Marsal model explains the amount of land that became developable during the studied term of office (2003-2007) expressed as a percentage of the 2003 built-up land area (*ΔUrbanLand)*. Among the explanatory variables, *VoteMargin* is the incumbent's margin of votes in 2007, *VacantLand* the amount of land assigned for development but still vacant in 2003 as a ratio of the 2003 built-up land area and *OpenLand* the amount of land neither built up nor assigned for development as a ratio of the 2003 built-up land area. Dummy control variables include belonging to an urban area (vs. non-urban), belonging to a suburb, being on the coast, and whether the mayor belongs to a left-wing party (*Left*). A last set of variables measures demand increase, disamenity effects of growth, residents' preferences and local demographic and employment shocks (% aged 25–40, % immigrants, % employed in manufacturing, and % employed in the top 5 industries in the region, % commuters, % homeowners, left-wing municipal government dummy, % graduates, % unemployed, population size and per capita income) as well as amenity and productivity factors (an "amenity index" and a measure of road accessibility).

In their empirical application, SOVM find a significant and negative effect of *VacantLand*, a significant and positive effect of *VoteMargin*, *OpenLand*, belonging to an urban area, being part of the suburbs rather than of the core of the urban area and being on the coast. The positive effect of *VoteMargin* is even greater when the municipality is suburban or on the coast, has a high percentage of commuters or homeowners and has a left-wing mayor.

We compare our theoretical framework with SOVM's model, by estimating an "as close as possible" SOVM model on our data (detailed results upon request). We drop the % graduates from the model because of collinearity issues with Income.

No spatial dependence is found in the outcome nor in the Tobit equations. The percentage of urbanized land (*BuiltUp*) is used as an opposite proxy for *Openland* and has a negative and very significant effect (p-value < 10^{-5}) in both the outcome and the Tobit equations, in accordance with SOVM (2012) and with the effect observed in our outcome equation. The only other significant effects in the outcome equation are for *Left* (p-value = 0.06) and *Homeowner* (p-value =0.031). The effect of *Left* is negative, as in our model. The effect of *Homeowner* is positive, while it is not significant in our model. This positive effect suggests that suburban homeowners and residents care more about density (they would prefer low density development) than about the spatial extension of the urbanized area of their municipality. The only other significant effect in the Tobit model is for *VoteMargin* and is negative (p-value =0.032), as in our Tobit and Probit models. As left-wing parties won the first round of the legislative elections in only 31 municipalities, it is not possible to test whether in this subsample the effect of the *VoteMargin* is significant, as tested and found by SOVM.

Compared to SOVM's empirical model, our theoretical framework leads to a higher number of significant variables (10 vs. 3 in the outcome equation, 7 vs. 2 in the Tobit model), a higher adjusted R-squared (0.2859 vs. 0.1282) or pseudo R-squared (0.0344 vs. 0.0151) as well as lower Akaike and Bayesian criteria (AIC: 1003 vs. 1195 and BIC: 1056 vs. 1256).

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TABLES (see next page)

Variable	Definition	Link with theor. frame.	Mean	Stand . Dev.	Min.	Median	Max.	Missing
AvailableLand	Less than 35 % slope vacant land (no buildings, no infrastructure) not under strict (i.e. prohibiting any development) central government environmental or risk zoning as fraction of municipal area (%)	p, d_u	76.87	20.12	3.65	84.43	98.86	24
Azur	Municipality is located on the *Côte d'Azur*(=1)	v, p	0.24	0.18	0	0	1	24
BuildingTax	Municipal revenues from housing tax and built property tax as fraction of operating revenues in 2000 (%)	f	27.12	8.28	0.72	27.62	55.51	0
BuiltUp	Municipal area urbanized in 1999 (%)	d_u, e, f,	19.33	17.21	0.35	13.74	88.35	24
CashFlow	Municipal cash flow as fraction of operating revenues in 2000 (%)	f	14.60	8.55	-24.60	14.03	47.08	0
DebtOutstand	Municipal debt outstanding as fraction of operating revenues in 2000 (%)	f	84.48	45.61	0.00	79.40	319.05	0
ΔFarmers	Difference in number of farmers between 2000 and 1990 as fraction of 1990 population (%)	d_a	-0.75	1.11	-7.58	-0.50	3.97	16
ΔPop	Change in population between 1990 and 1999 (%)	-	12.19	10.83	-23.46	11.02	52.46	24
ΔPopNeighb	Kernel distance weighted mean of population change in bigger municipalities (%)	v	4.40	3.68	-0.10	3.67	20.81	24
ΔUnder14	Difference in number of under-14s between 1999 and 1990 as fraction of 1990 population (%)	f, r	1.54	5.20	-22.22	1.13	37.61	24
ΔUrbanland	Area rendered developable from 1999 to 2006 as fraction of 1999 built-up area (%)		14.88	24.69	0.00	6.72	158.66	0
ΔVacantH	Difference in number of vacant housing units between 1999 and 1990 as fraction of 1990 housing units (%)	r, d_u	0.09	5.54	-23.77	-0.13	67.31	24
Disputes	At least one dispute about land use plan changes between 2004 and 2007 (=1)	p	0.19	0.15	0	0	1	24
Farmers	Fraction of farmers in the 2000 population (%)	d_a, d_u	2.48	2.59	0.00	1.56	12.91	24
Homeowner	Fraction of principal residence homeowner occupancy in 1999 (%)	r, e, f	63.05	10.18	32.27	64.77	82.61	0
Income	Median annual income per unit of consumption in 2000 (€)	r, e, f	14114	2456	66687	13712	22866	24
Increase	Municipality increased its developable area between 1999 and 2006 (=1)	-	0.83	0.14	0	1	1	24
Left	Left-wing party (extreme left, left or green) received the highest number of votes in the municipality in 2002 legislative election (=1)	p	0.12	0.11	0	0	1	24
Organic	At least one organic farmer in municipality (=1)	d_a	0.29	0.21	0	0	1	24
Over75	Fraction of population over 75 in 1999 (%)	r	7.26	2.70	2.58	6.81	18.13	1
PopNeighb	Kernel distance weighted mean of population of bigger municipalities	v	5685	5560	0	3727	31388	24
Population	Population in 1999	-	10702	51062	145	2847	797491	24

Turnover	Municipality's farm median turnover - farm median turnover among municipalities with the same main type of farming, as fraction of farm median turnover among municipalities with the same main type of farming in 2000 (%)	d_a	-29.81	76.81	-96.60	-51.68	522.70	24
UpperClass	Fraction of managers and professionals in 1999 (%)	r, e, f	4.62	2.52	0.00	4.15	15.58	0
VacantLand	Less than 35 % slope vacant land not under strict central government environmental or risk zoning AND already zoned as developable in 1999, as fraction of 1999 developable zone (%).	p, d_u	61.42	15.41	0.00	63.08	91.95	0
VoteMargin	For municipalities over 3500 inhabitants: score in 2001 municipal election winning list * participation rate (%)[x] For municipalities under 3500 inhabitants: Sum of the votes received by the list that gathered the highest number votes in % of the total number of votes at the first round 2001 municipal election* participation rate (%)	m	56.17	18.21	23.10	52.67	96.61	24

Table 1: Descriptive statistics of the variables used in the models (n=327)

Variable	Coef.	P>|t|	dy/dx	P>|t|	Mean
AvailableLand	0.239**	0.023	.1138**	0.023	76.8731
BuiltUp	-0.341***	0.003	-0.1623***	0.002	19.3267
Disputes (=1)	8.589**	0.038	4.337**	0.047	0.1914
ΔUnder14	-0.635	0.117	-0.3021	0.117	1.5735
ΔPop	-0.217	0.361	-0.1031	0.361	12.2645
ΔPopNeighb	3.011***	<0.001	1.4320***	<0.001	4.4091
ΔVacantH	-0.5312	0.206	-0.2528	0.204	0.0912
Income	-0.0017*	0.071	-0.0008*	0.067	14140.9
Left (=1)	-6.644	0.211	-2.9852	0.185	0.1221
Organic(=1)	6.749*	0.059	3.3132*	0.063	0.2937
PopNeighb	0.00012	0.664	0.00006	0.663	5703.51
Population	6.60E-06	0.512	3.14E-06	0.510	10705.8
VacantLand	-0.1996	0.252	-0.0949	0.252	61.6977
VoteMargin	-0.411***	0.001	-0.1953***	0.001	56.0799
Intercept	45.614***	0.008	-	-	1
/sigma	24.830	<0.001	-	-	-

Note. P-values: *** if < 0.01, ** if <0.05 and * if<0.1
dy/dx: Average marginal effects over the sample (=1 for a discrete change of dummy variable from 0 to 1)
F(14, 289) = 3.91; Prob > F = 0.0000; Log pseudolikelihood = -1193.8011; Pseudo R^2 = 0.0344
Tests for spatial error autocorrelation:
Moran I statistic standard deviate = -0.3313, p-value =0.7404 (Alternative = "Two sided") with a population weighted kernel distance matrix (k=2, h=20km)
Moran I statistic standard deviate = -1.0112, p-value = 0.3119 (Alternative = "Two sided") with a weighted kernel distance matrix (k=2, h=20km)

Table 2: Results of the Tobit equation (n= 303 observations, 53 left-censored at ΔUrbanland<=0 and 250 uncensored)

Variable	Coef.	Rob. Std. Err.	P>|t|	dy/dx	Std. Err.	P>|t|
Azur (=1)	-1.17***	0.25	0.0E	-0.26***	0.07	0.00
CashFlow	-0.02*	0.01	0.08	-3.2E-3*	1.9E-3	0.09
ΔUnder14	-0.09**	0.03	0.01	-0.013**	0.01	0.01
ΔPop	0.01	0.01	0.31	2.0E-3	2.0E-03	0.31
ΔPopNeighb	0.11**	0.04	0.01	0.02**	0.01	0.01
Farmers	0.16**	0.07	0.03	0.024**	0.01	0.02
Income	-1.6E-4***	5.2E-05	2.0E-	-2.4E-5**	1.0E-05	0.01
Left (=1)	-0.70**	0.28	0.01	-0.15*	0.08	0.06
Turnover	-2.3E-3*	1.1E-03	0.05	-3.4E-4*	1.7E-4	0.05
PopNeighb	7.1E-5**	2.7E-05	0.01	1.1E-5**	0.0E+00	0.01
Population	2.0E-5	1.4E-05	0.16	2.9E-6	0.0E+00	0.12
VoteMargin	-0.02**	0.01	0.02	-2.6E-3**	1.2E-03	0.03
Intercept	3.75***	0.91	0.0E			

Note. P-values: *** if < 0.01, ** if <0.05 and * if<0.1

dy/dx: Average marginal effects over the sample (=1 for a discrete change of dummy variable from 0 to 1)

Log pseudolikelihood = -95.429421 Wald chi2(12) = 65.15 Prob > chi2 = < 0.00001

McFadden pseudo R^2: 0.321 Max_LL pseudo R^2: 0.257

Correct predictions: 86.14%

Cragg & Uhler's pseudo R^2: 0.426 AIC =216.859 BIC: 265,137

Kelejian and Prucha (2001)'s Moran test for spatial error autocorrelation performed:

- on the population weighted kernel distance matrix (k=2, h=20km): I^2= 0.01048225, p-value= 0.918

- on the weighted kernel distance matrix (k=2, h=20km): I^2= 0.008051674, p-value= 0.929

Pinkse and Slade (1998)'s Lagrange Multiplier tests for spatial error autocorrelation performed on the (standardized) population weighted kernel dist. mat. (k=2, h=20km): LM_{PS}=0.0151519 p-val.= 0.902

Table 3: Results of the Probit equation (n=303 observations)

Variable	Coef.	Rob. Std.	Pr(>|t|)
BuiltUp	-4.21E-02***	8.84E-03	3.40E-06
DebtOutstand	7.35E-03***	2.62E-03	5.46E-03
ΔPop	-2.46E-02*	1.28E-02	5.62E-02
ΔPopNeighb	9.00E-02*	4.67E-02	5.53E-02
ΔVacantH	-7.02E-02***	2.01E-02	5.66E-04
Disputes	6.91E-01*	3.62E-01	5.73E-02
Homeowner	1.72E-02	1.42E-02	2.25E-01
Left	-8.46E-01*	4.35E-01	5.29E-02
Organic	7.69E-01***	2.42E-01	1.66E-03
Over75	-1.63E-01***	5.48E-02	3.31E-03
PopNeighb	-4.24E-07	2.38E-05	9.86E-01
Population	-9.69E-08	1.02E-06	9.25E-01
UpperClass	-1.46E-01***	5.46E-02	8.18E-03
Intercept	3.23E+00***	1.11E+00	3.97E-03

Note. P-values: *** if < 0.01, ** if <0.05, * if<0.1
Dependent variable = ((ΔUrbanland^0.17)-1)/0.17)
LogLikelihood= -1238.243;Residual standard error: 1.771 on 234 degrees of freedom
Multiple R-squared: 0.3235,Adjusted R-squared: 0.2859
F-statistic: 8.608 on 13 and 234 DF, p-value: 2.944e-14
Shapiro-Wilk normality of residuals: W = 0.9958, p-value = 0.7473
Linearity test (power2:6): RESET = 0.6399, df1 = 5, df2 = 230, p-value = 0.6695
Moran I statistic standard deviate -0.4204, p-value = 0.6742 (Alternative = “Two sided”) with a population weighted kernel distance matrix (k=2, h=20km)
Moran I statistic standard deviate = -0.2582, p-value = 0.7962 (Alternative = “Two sided” sided) with a kernel distance matrix (k=2, h=20km)

Table 4: Results of the outcome equation (n=248 observations)

TITLES OF FIGURES

Figure 1: Population by municipality in study area (by quartile of number of inhabitants in 1999, INSEE).

Figure 2: Municipalities where semi-directive interviews were conducted (C.V.S.D= Châteauneuf-Val-Saint-Donat)

FOOTNOTES

[i] Artificial land covers urban (continuous or discontinuous urban fabric), business and industrial areas, transportation infrastructures, mines, quarries, landfills, construction yards, green spaces (urban green spaces, sport and leisure facilities) as opposed to farmland, natural and forest areas, wetlands and water bodies (CORINE Land Cover nomenclature, CEC, 1995).

[ii] We consider this choice to depend on one single elected representative, even though it is actually made through municipal council decisions and votes.

[iii] Indeed, the self-selection problem is that if u_i, the unobserved effect involved in the decision to make an increase is correlated to ε_i, the individual heterogeneity of the model explaining the amount of the increase, then the β estimators are not convergent since $E[\Delta Urbanland_i|X_i, \varepsilon_i, Increase_i=1] \neq E[\Delta Urbanland_i|X_i,\varepsilon_i] = \beta' X_i + \varepsilon_i$. This possible correlation should be explicitly taken into account by assuming a joint distribution between the decision-to-increase process and the decision on the amount of increase process (Chanel and M'Chirgui 2009): $[\varepsilon_i,u_i] \sim N_2[(0,0),(\sigma^2_\varepsilon, \rho\sigma_\varepsilon, 1)]$ where σ^2_ε is the variance of ε_i ; $\rho\sigma_\varepsilon$ is the covariance between ε_i and u_i ; ρ is their linear correlation coefficient and σ^2_u, the variance of u_i, is normalized to 1 to allow identification.

[iv] In some municipalities, part of the land zoned as developable in 1999 became non- developable between 1999 and 2006, sometimes resulting in an actual net decrease in the developable area. However, we did not take such changes into account. Indeed for many of these municipalities, the urban fabric of the zones that became non-developable was actually diffuse, corresponding to the same diffuse urban fabric zones needing to be replaced and which were replaced by

non-developable zones. Other cases of developable land becoming non-developable arose when the developable zones were oversized (generally in the 70's or 80's); even in the 2000's, it remains very unlikely that a landowner would apply to develop one of these parcels. Thus, making a developable zone non-developable again is almost never a political act in favor of urban growth containment, and while the qualitative approach allows us to identify exceptional cases, the quantitative approach does not.

[v] Indeed, if the 1990's value is 0, we cannot compute the evolution variable with the usual calculation of growth change.

[vi] These variables are computed as follows. $PopNeighb_i$ = Population * W1 where population is the vector of the variable "Population" and W1 is a row-standardized distance matrix where diagonal elements are equal to zero and non-diagonal elements are equal to $\exp(-(dij/h)^k)$, with d_{ij} the distance between municipalities i and j, h=20km and k=2 if $Population_j > Population_i$, 0 otherwise. $\Delta PopNeighb_i = \Delta Pop * W2$ where population is the vector of the variable "ΔPop" and W2 is a row-standardized distance matrix where diagonal elements are equal to zero and non-diagonal elements are equal to $Population_j * \exp(-(d_{ij}/h)^k)$ with d_{ij} the distance between municipalities i and j, h=20km and k=2 if $Population_j > Population_i$, 0 otherwise.

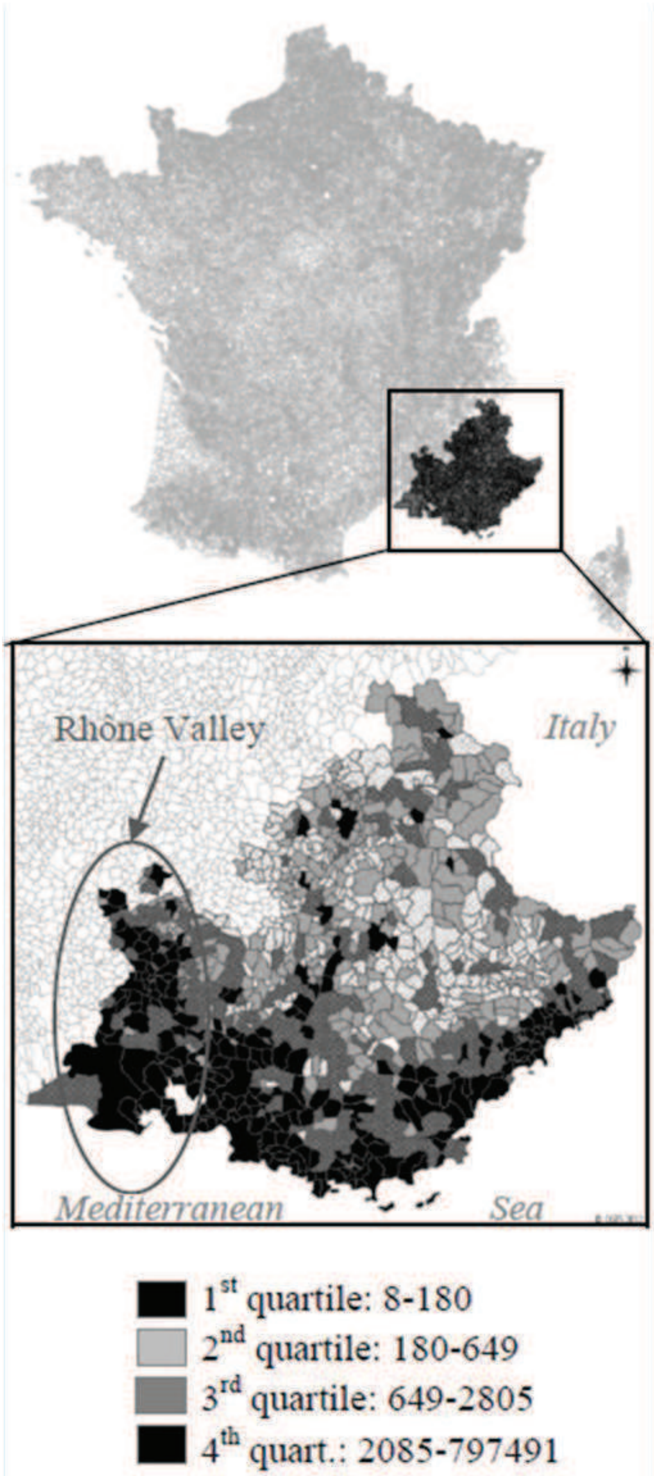
[vii] Data for this variable are for the 2004-2007 period, while we are studying policy change between 1999 and 2006.

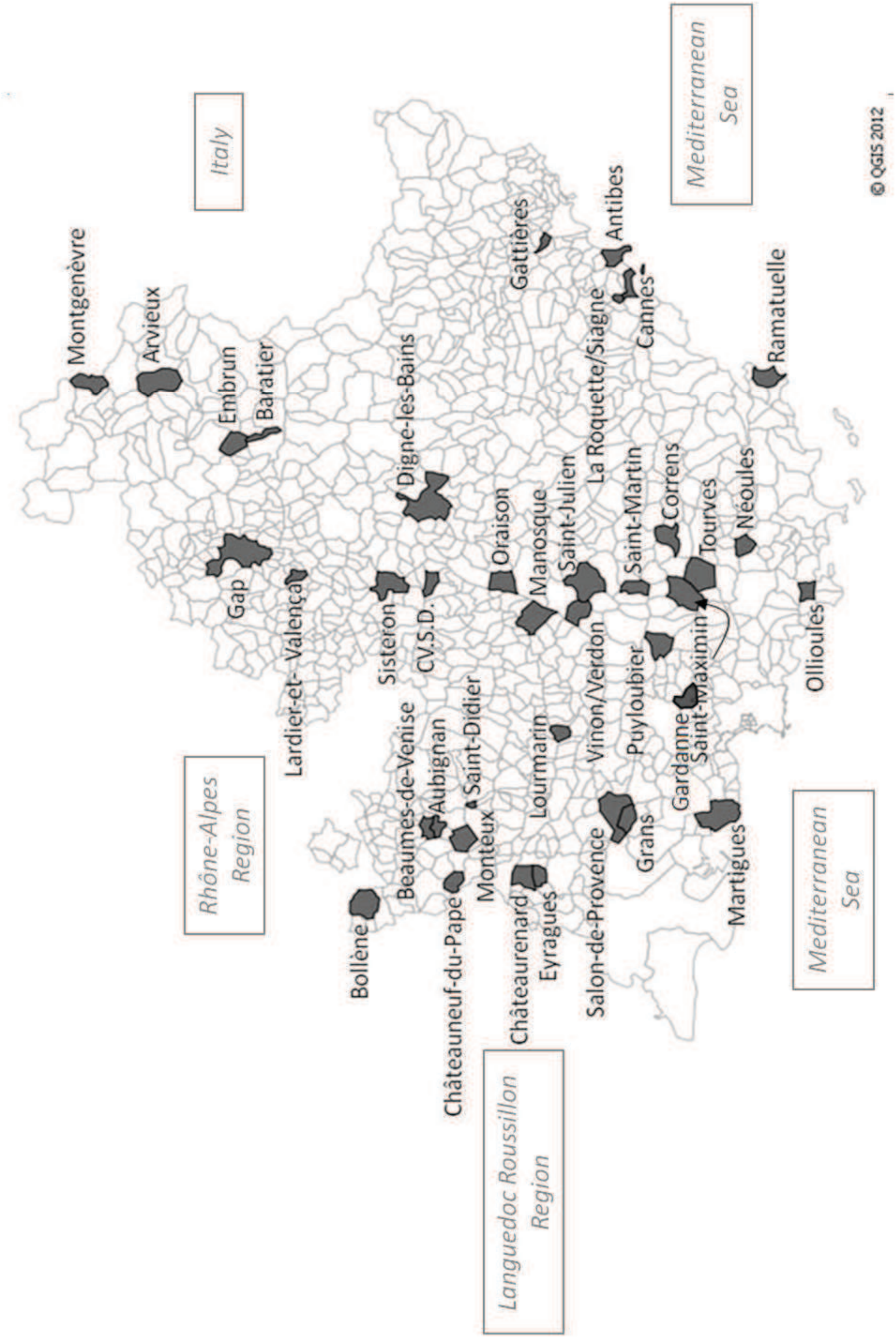
[viii] Hilber and Robert-Nicoud (2006) offer an explanation for a paradoxical observation: US metro area homeownership rates are strongly negatively related to regulatory restrictiveness. Their explanation is "*articulated around the*

heterogeneity of tenancy durations among the different classes of agents and [the fact] that small groups of agents with high stakes benefit most from collective action. [This implies that] while homeowners favor land use restrictions, the homeownership rate should have a negative impact on land use restrictions […] because a larger fraction of homeowners is matched with a smaller fraction of landlords (and tenants)]".

[ix] Our field study emphasizes the "support" role of central government institutions: in some "tight" situations (low local government legitimacy), some municipal councils use State constraints to justify unpopular decisions that preserve farmland.

[x] If the winning list has been elected in the second round with more than 50% of votes, then its score is reduced to 50% before multiplying by the participation rate to show the stronger "legitimacy" of lists elected at the first round.


Rhône Valley
Italy
Mediterranean
Sea
1st quartile: 8-180
2nd quartile: 180-649
3rd quartile: 649-2805
4th quart.: 2085-797491



Italy
Montgenèvre
Arvieux
Embrun
Baratier
Gap
Lardier-et-Valença
Digne-les-Bains
Sisteron
C.V.S.D.
Gattières
Antibes
Cannes
La Roquette/Siagne
Oraison
Manosque
Saint-Julien
Vinon/Verdon
Saint-Martin
Correns
Tourves
Néoules
Ramatuelle
Ollioules
Puyloubier
Saint-Maximin
Gardanne
Grans
Martigues
Salon-de-Provence
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