Combining approaches to outline the determinants of local public policies for agricultural and natural land conservation

An econometric validation of a literature- and field-based theoretical model

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Abstract:

The objective of this paper is to outline the determinants of municipal land zoning in favor of farmland and natural land conservation through a parsimonious allocation of land to urban development. We first rely on an abundant theoretical and empirical literature, especially on Solé-Ollé and Viladecans-Marsal (2012), this study being the closest to our objectives as well as to the French legal and geographical context. We then propose a theoretical model better adapted to the French framework, starting from a field study we did over 39 municipalities of Southern-France. We estimate both models based on variables available in the PACA Region (South-Eastern France), and we obtained a first validation of our theoretical model. This also confirms the interest of combining a qualitative field-based approach and a quantitative one. Namely, the role of agricultural activity characteristics beyond agricultural land rent is outlined while it is generally not explicitly mentioned in existing theoretical and empirical formalized models. Last, the empirical validation introduces possible alternative interpretations and themes for considerations concerning specification improvements and tested hypotheses refinements that would make possible feedbacks toward the theoretical model and improved validation.

Introduction

Urban sprawl associated with diminishing agricultural land and very debated socio-economic and environmental impacts is a worldwide issue (UN Habitat, 2010). However, recent recommendations made - at different institutional levels (for instance the Central State level in France) - in favor of farmland conservation don't seem sufficient to alter sprawling trends. Indeed, beside contradictory regulations and incentives coming from the same institutions that make these land sparing recommendations (see e.g. CAS, 2011), policies directly related to land consumption, like land use policies, are mainly edited by more local jurisdictions that have a variety of rationales to counter or to favor sprawl. It's consequently crucial to understand these local jurisdictions'logics to outline the determinants of agricultural and natural land conservation local policies.

In this respect, theoretical and empirical works dealing with the determinants of urban growth and urban growth control are quite numerous. This profusion can be confusing especially because theories and empirical results are somehow contradictory. Moreover, most of the existing works do not directly consider the spatial aspects (in terms of land "consumption") of growth controls but rather consider housing and demographic aspects. Last, they generally come from or are applied to North-American contexts while urban sprawl is not limited to this area (Mimeo, Chanel *et al*). In this article, we focus on South-Eastern France, a region that has experienced, like many other North-Mediterranean regions, strong and Europe-specific trends to urban sprawl. However, the literature dealing with European cases is rare, especially the quantitative literature, and a noticeable exception is Solé-Ollé and Viladecans-Marsal (2012). This paper is all the more an interesting and recent starting point that it deals with the determinants of the amount of area devoted to urban development through a municipal plan as it is the case in France. Moreover, the theoretical framework used combines most of the advances gain thanks to previous works and it is applied to a Mediterranean area like our own area study.

Besides, we conducted a field study on 39 municipalities belonging to our study area (Chanel *et al., 2012*) that led us to formulate new hypotheses that could qualify and bring some complements to existing models.

In this article, we first briefly present the existing theoretical and empirical studies and our field analysis. As a result, we propose an original theoretical model and a set of hypotheses inspired from these bibliographical and field studies. Then, we econometrically test our model. As for the theoretical model formulation, we use the Solé-Ollé and Viladecans-Marsal (2012)'s study as a benchmark. So, we first apply their empirical model to our data and then test whether the model's explanatory performance is improved when our model is estimated.

I. A literature review and a field study as a theoretical model's starting point

I.1. Past literature

I.1.1. Theories and existing theoretical models

Theories on growth control determinants come from Political Economy and consider that the adopted policy is the one that maximizes the utility of dominants groups (Interests groups models as in Logan and Molotch, 1987) or majority groups (vote models as the median voter model and the Fischel's "Homevoter Hypothesis", Fischel, 2001). Intermediate models combining interest groups' influences and vote models as the Urban Regimes theory (Stone, 1993) or the «Political Market Framework » (Lubell *et al.*, 2009) are also considered as well as Tiebout sorting (Tiebout, 1956).

These theories can be formalized through micro-economic models inspired from the New Urban Economy: in a jurisdiction centered on a Central Business District (CBD) each individual expresses location preferences towards the surrounding urbanization under budget constraint. When the jurisdiction is subject to an exogenous population growth, groups of individuals express preferences towards the policy that maximizes the utility given their intrinsic characteristics: sensitivity to public services cost and provision changes and to rural or urban amenity changes (according to their socio-political characteristics) but also sensitivity to land rent changes (according to their "land status": landowner, homeowner, owner of vacant and/or built land, renters…). The policy can also be adopted in reaction to neighboring jurisdictions' policy changes to prevent spillover effects ("*strategic interaction*", Brueckner, 1995, 1998). The adopted policies, according individuals' preferences and weights associated to majority and interest groups, can also be very diverse: total prohibition of new development, density restrictions or lot-and-house size minima, city boundary at a distance x of the CBD… Given this variety of possible hypotheses combinations, the literature shows a wide diversity of results (see e.g. Frankena and Scheffman, 1981; Cooley and LaCavita, 1982; Engle *et al.*, 1992; Richer, 1995; Brueckner and Lai, 1996; Brueckner, 1995 and 1998; Glaeser *et al.*, 2005; Hilber and Robert-Nicoud, 2006; Solé-Ollé and Viladecans-Marsal, 2012; , for a summary, see Chanel *et al., 2012*).

I.1.2. Empirical literature

Quantitative and qualitative empirical studies confront these theoretical models to various national or regional contexts and jurisdictional levels

- *Quantitative empirical models*

Numerous econometric studies link the adoption of policies to socio-demographic (including land and houses ownership aspects), geographical and environmental, fiscal,

political and institutional characteristics of the jurisdictions. The policies and the way they are described in models are as diverse as the presence or the number of growth control policies; the restrictiveness towards allowed land-uses in the different zones or the authorized and observed densities or the other urban development constraints (houses 'characteristics…); the probability of appearance and success of a referendum on open-space conservation by land purchase with public funds; the relative area devoted to urban development; the presence and characteristics of anti-sprawl specific measures (Rolleston, 1987; McDonald and McMillen, 1990; Dubin *et al.*, 1992; Richer, 1995; Brueckner, 1998; Lewis and Neiman, 2002; Romero and Liserio, 2002; McDonald and McMillen, 2004 ; Howell-Moroney, 2004 ; Brody *et al.*, 2006; Kline, 2006; Kotchen, 2006; Lecat, 2006; Nelson, 2007; Hilber et Robert-Nicoud, 2006 and 2009; Lubell *et al.*, 2009; Nguyen, 2009; Schmidt and Paulsen, 2009; Pirotte and Madre, 2011; Solé-Ollé and Viladecans-Marsal, 2012; see *mimeo* Chanel *et al.* for a more detailed presentation).

However, despite the huge amount of studies, only a few consider the policy in terms of land consumption potential impacts. Thus, Rolleston (1987), Schmidt et Paulsen (2009), Solé-Ollé and Viladecans-Marsal (2012) consider relative areas allowed to urban development, Lewis and Neiman (2002), Rolleston (1987) and Pirotte et Madre (2011) take into account density aspects and Brody *et al.* (2006) develop an anti-sprawl measures quality index . In other studies, the considered policies have only an indirect and very ambiguous link to land consumption aspects as previously denoted by Pendall (1999).

Even when we restrict to studies that consider land consumption related policies, expected and observed effects of explanatory variables on similar endogenous variables are mitigated or insufficiently comparable. For instance, Rolleston (1987) observes a negative effect of the percentage of ethnic minorities on the adoption of minimum lot sizes while Lewis and Neiman (2002) observe an insignificant effect and this is the only comparable explanatory variable between the two studies. By the way, Solé-Ollé and Viladecans-Marsal (2012) and Rolleston (1987) use a similar endogenous variable (the percentage of land devoted to urban development) but no really comparable explanatory variables. This is in accordance to the diversity of theoretical frameworks and hypotheses as well as to the diversity of empirical contexts.

Last, most of these studies deal with or are inspired by North-American cases. Currently, to the best of our knowledge, there is no quantified validation of the determinants involved in decision making related to land consumption policies by French jurisdictions. Indeed, existing quantitative models applied to French study 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 regarding to their distance to the CBD.

- *Qualitative empirical models*

Literature shows several qualitative studies on French cases. Thus, Charmes (2009), inspired by Vilmin (2006)'s work, summarizes the suburbanization process experienced by periphery municipalities in France in four steps:

(i)- The suburbanization initiation through the extension of a neighboring city's area of influence and the increase in housing demand. Welcoming new population is then seen as a way to revitalize the municipality and as a windfall for landowners often influential in municipal councils. This leads to a single-family houses proliferation around the village core and along the roads.

(ii) - The growth phase, more or less continuous, leading to a socio-demographic, political and budgetary balance upheaval.

(iii) - a demographic stabilization phase associated with a political assertion of the living conditions maintenance to the detriment of urban development and land value gains.

(iv) - A modest growth phase linked to the persistence of demands in favor of growth from landowners that can be supported by collective constraints (to maintain local school, to comfort a position of local commercial or equipment pole…).

Theses logics are sooner or later observed in each periphery municipalities according their distance to the central city and lead to what Castel (2007) calls an "*émiettement urbain*" (urban fragmentation) as represented in figure 1. In this kind of analysis, preferences for open-space related amenities and incertitude on future profitability of urban development (compared to the profitability of different kinds of agricultural uses) play an important role and give the possibility for formation of discontinuous urbanization rings. This has been theoretically formalized by Cavailhès *et al.;* 2004. However, that formalization doesn't really take into account individual municipalities and doesn't consider the policy aspects.

[FIGURE 1]

Thus, when the population of a municipality grows (phase *ii*), we observe a diffuse urban development around municipality instead of a densification, and then a development carry-over on more remote municipalities still in phase *i* so that a "*municipal green belt*" is more or less maintained around each municipalities (Charmes, 2009). This "*leapfrog development*" phenomenon is of course not France-specific but is reinforced in the French case, by a strong and equal power (i.e. regardless the municipality's size) given to the municipalities on land use decisions that beneficiate from a wide margin of manoeuvre (Charmes, 2009) in spite of a common legal framework (see section1.2.1). Moreover, as a majority of the French municipalities are really small, the consideration of the landowner's preferences first and of the homeowner's preferences then are also reinforced by a strong elected official - residents proximity (Charmes, 2007; Castel, 2007). Eventually, one can speak of "residential environment markets": each municipality offers a specific residential environment cocktail on which a Tiebout-like sorting would occur rather than on fiscal aspects (Charmes, 2007). By the way, the Tiebout "feet-voting" model in which local taxes play an important role doesn't seem applicable to France *per se* because of a lower residential, geographical and social mobility that implies a lower housing turnover and so an housing market unable to reflect tax and local services capitalization phenomena. Moreover, primary school is still mainly financed by the central state and it seems that local taxes have less effects on household location choice than on firms' localization choices (Dericke and Gilbert, 2008; Charlot and Paty, 2007; Charlot *et al*., 2011).

In short, if qualitative empirical studies on French cases suggest a relative degree of adequacy with theoretical models, the latter could be improved to better take into account land consumption issues and regional specificities (as jurisdictional level of decision, role of agricultural activity…) and then quantitatively tested. To contribute to such a model, that would allow assessing the pertinence of theoretical propositions mostly inspired by Anglo-Saxon cases with different legal frameworks, we undertook a field study.

I.2. Brief description of the field study

1.2.1. The French legal and institutional framework for land use plans

It is first useful to present the French legal framework regarding land use policies. Indeed, French municipalities should respect some common patterns when elaborating a land use plan. Given this common (but moving) framework, used tools and policy levels are far less diverse than in other countries such as United States for instance (Schone, 2010). Thus, in France land use plans are elaborated at the municipal level by municipal councils elected every 6 years. If a council proposes to make a new land use plan, it will be elaborated thanks to the technical support of private or public planning offices and by taking into account the recommendations of several public organizations (Chamber of commerce, of agriculture, local government agencies…). Then, the plan is submitted to a public inquiry and to State control of the plan coherence and legal compliance. After possible amendments, the plan is adopted by the municipal council. Such land use plans are only compulsory under specific conditions (regarding municipal population and belonging to certain urban areas) but most of municipalities have one, excepted very small rural ones.

A land use plan is constituted by a presentation report explaining the municipal context, objectives and rationales, a map with the different zones and a regulation that details rules enforced within each type of zones. The main types of zones are the *urban zone* that covers the build-up and developable areas, the *future urbanization zone* that will be developable at middle or long term, the *agricultural zone* that is undevelopable except for agricultural activity related buildings and the *natural zone*, undevelopable. Before the SRU ("*Urban Renewal and Solidarity")* law of 2000, specific zones, generally devoted to diffuse urban fabric were also allowed. In these zones, anybody was allowed to build a house provided that s/he has the minimum required area (decided by the municipal council for each zone of this type), an access to road and that s/he takes over connection to water and electricity networks as well as individual sewage. According to the State's willingness to limit urban expansion and to favor urban renewal, the SRU law made the creation of such zones impossible. Municipalities larger than 10000 or belonging to certain urban areas have to replace them by urban, future urbanization, agricultural or natural zones while other municipalities can keep them until the next major change of their plan. In urban and future urbanization zones, the municipality has to take over connection to road, to water and electricity and most of the time to collective sewage system. Other major's changes brought by the SRU law were somehow stripped back by the 2003 UH law ("*Urbanism and Housing*"

law) like the SRU law's prohibition of minimum lot sizes: since the UH law, such minima are possible again "*when justified by the preservation of traditional urban patterns or landscape aspects or by individual sewage technical constraints*" (DGUHC, 2003). Consequently, if municipalities are subject to a common framework, they have a relatively wide margin of manoeuvre (Charmes, 2009).

1.2.2. Study of area and methodology

Our area of study is the Provence-Alpes-Côte-d'Azur Region (PACA Region) located in South-Eastern France. This 3,18 million hectares region is divided into 963 municipalities. The population and so the urbanization is essentially located on the Mediterranean coast and in the Rhône Valley while other areas are plateaux and mountains. Among the municipalities for which we dispose of the digitalized 2006 land use plan maps and according to expert judgment[1], we choose a sample of 39 municipalities representing the diversity of situations that can be encountered in the region. Half an hour long semi-directive interviews were conducted in each municipality among the elected official in charge of urbanism (or the mayor if s/he is the one actually leading the urbanism projects) or, by default, among the technical officer in charge of urbanism. The objectives of these interviews were to outline : first, the adoption, minor ("modifications") and major ("revisions") changes' dates or, as appropriate, the state of progress of the being elaborated plan ; second, the main objectives and priorities that led to adopt or change the plan; third, the tools used in this plan (zoning types, zone rules) ; fourth, the main difficulties encountered while elaborating, amending or enforcing the plan or on the contrary the facilitators and last, the relationships with neighboring municipalities, higher jurisdictional levels and related public organizations on these aspects.

The recorded interviews where then studied thanks to an analytical grid that allowed us to make a classification of municipal strategies along a cons-to-pro-urban spatial expansion axis and along a cons-to-pro-density axis. Then, for each types of municipal strategy, we outlined the contexts, objectives and rationales that led municipalities to adopt such strategies. This field analysis, widely detailed in Mimeo Chanel *et al.*, allowed to develop a theoretical framework with associated hypotheses presented in section II and quantitatively tested in section III.

[1] From employees of the"SAFER" which is an organization that deals with farmland (and natural and forest land) transcations.

II. Theoretical model and associated hypotheses

The proposed model is inspired by our field analysis and by the literature review. In particular, we use the Solé-Ollé et Viladecans-Marsal (2012) as a starting point.

II.1. The Solé-Ollé and Viladecans-Marsal (2012) 's model as a starting point

This recent article has two major advantages: first, it deals with the determinants of the amount of area that became developable over a given period through municipal plans in Spain, a Mediterranean touristic area like our own, and second, it uses a theoretical framework that combines most of the lessons learned from previous works (mentioned in section I). In this model, the amount of land that became developable (measured in percentage of the already urbanized area) depends on a trade-off made by the elected mayor between an expected "political rent" and its expected utility of being reelected. Expected "political rent" is an increasing function of developer's (and land-owner's) profit which in turn increases with the increase in the amount of land devoted to urban development especially when building demand is high and developable land supply is low at the decision time. The probability of being reelected 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. This reelection probability can be expressed as a linear function of the median voter utility variation ΔU: the median voter will vote for the incumbent if it's utility variation plus the average popularity of the incumbent is superior to the reservation utility level of the voter. As the average popularity of the incumbent is distributed uniformly on $[-1/2\psi, 1/2\psi]$ with ψ, the swing voters density or the election degree of competition, the municipal government chooses the amount of land devoted to urban development so as to equate the value of additional rents and the loss in utility derived from not being reelected. According to this model, the weight on voter's welfare rises with the degree of political competition.

II.2. Enriching the Solé-Ollé and Viladecans-Marsal (2012)'s model

II.2.1. The amount of land devoted to urban development and the density limitations

The field analysis confirmed the importance of not only taking into account the amount of land devoted to urban development (***Δurb***) but also density aspects (***ΔD)***.

II.2.2. The role of electoral competition

Our field observations lead us to agree with Solé-Ollé and Viladecans-Marsal (2012) and to assume that the relative importance the elected municipal will give to the variation of median voter's and "dominant[2]" interest group's utility ($\Delta U_{dom.\ grp}$ and $\Delta U_{med.vot}$) depends on the vote margin, ***m*** (see equations 1 and 2). By the way, except in some cases, the political "color" of the elected council doesn't seem to play a major role all the more that a majority of small municipality's councils doesn't' have one. However, left parties seems marginally more favorable to dense urban extension for affordable housing and jobs creation, right parties would be marginally more favorable to stop urban extension or to low density urban extension while green parties would be in favor of stopping urban extension with existing urban fabric densification. This consideration over political color slightly differs from Solé-Ollé and Viladecans-Marsal's ones.

$$(\Delta urb, \Delta D) = max\ [f(\Delta U_{dom.\ grp}, \Delta U_{med.vot}, m)] \qquad (Eq.1)$$

$$with\ \Delta U_{dom.\ grp} = \phi(\Delta urb, \Delta D)\ \ and\ \Delta U_{med.vot} = \omega(\Delta urb, \Delta D) \qquad (Eq.2)$$

- *Hypotheses associated with equations 1 and 2:*

Hm1: Elected officials give more importance to the median voter's utility when the vote margin is weak.

Hm2**:** Left parties favor urban extension and densification; right parties favor the stop of urban extension and/or low-density urbanization and green parties favor densification and the stop of urban extension.

II.2.3 The role of "dominant" interest groups

In Solé-Ollé and Viladecans-Marsal (2012), the interest group is compounded of developers and landowners who only have an interest in urban development. However, according to our field study, we suggest that the utility of the "dominant interest group" doesn't only depend on the land rent maximization (see equation 3). Indeed, if interest groups in favor of urban land rent maximization are present and even sometimes very strong, especially in municipalities where land ownership is concentrated among a few number of landowners (land elites, "old" local families) and where demand for new buildings is high, they are not the only type of interest groups. Thus, farmers groups, although often compounded of land owners can also have interest to farmland preservation either by (seldom!) wanting their land not to be developable or more often by not making pressure on the municipal council to get their land developable and by keeping on cultivating them (namely with permanents crops if in adequate agricultural area) rather than converting them to speculative shrubs (or in "waiting" non-permanent crops). These kinds of interest groups are of course present in municipalities where agricultural activity is very profitable (ex: worldwide famous vineyards) but not only. For instance, farmer-owned farmland preservation can also be supported by farmers in municipalities where urban land rent seems far higher

[2] i.e. a group whose individuals are not a majority but beneficiate of some power on elected officials thanks to the political support they can bring

than agricultural land rent. The qualitative field study suggests that elements like relatively high agricultural benefits but also strong agricultural cooperative and agricultural employment dynamic, probability of farm take-over, farmers' age…or elements associated with good agriculture "image", can favor the emergence of such interest groups. These interest groups are all the more likely to be satisfied that their preferences converge with the median voter's preferences but only considering the median voter's preferences seems insufficient to explain farmland preservation as really economically active ones (i.e. not only maintained for "open-space" aspects). Other non-majority but quite active interest groups having an interest in non urban land preservation or in urban development can be observed as pro-environment, hunters, local business (merchants, building or housing estate companies) groups but according to the field study, these groups are rarer and/or less influent. Consequently, we only consider a "pro-agriculture" group and a pro-development group whose relative importance will depend on a set denoted ***d*** of elements such as the degree of landownership concentration, the agricultural profitability, the kind of agricultural productions, the number of jobs in agriculture …

$$\Delta U_{dom.\ grp} = \phi\,(\Delta U_{du}(\Delta urb, \Delta D)\ ,\ \Delta U_{da}(\Delta urb, \Delta D)\ ) \qquad (Eq.\ 3)$$

where $\Delta U du$ *is the variation of utility of the pro-development interest group and* ΔU_{da} *is the variation of utility of the pro-agriculture group*

- *Hypotheses associated with equation 3:*

Hd1: A very concentrated land ownership and a high sub-regional urban pressure (low housing or developable land supply relatively to the demand) reinforce the pro-development interest group in favor of an increase of the amount of land devoted to urban development.

Hd2: High agricultural profitability[3], high rate of employment in the agricultural sector, young farmers or probability of take-over and good agricultural activity's image reinforce the pro-agriculture interest group

II.2.4. The role of the median voter

The field study also allows us to bring some complements to the Solé-Ollé and Viladecans-Marsal's considerations on the median voter. Indeed, the median voter can be simultaneously seen as resident, a taxpayer and local public service user, an amenity "consumer", a working or not working active or an inactive (see equation 4).

$$\Delta U_{med.vot} = \omega(\Delta U_{\rho}(\Delta urb, \Delta D),\ \Delta U_{f}(\Delta urb, \Delta D),\ \Delta U_{e}(\Delta urb, \Delta D),\ \Delta U_{\tau}(\Delta urb, \Delta D)) \qquad (Eq.\ 4)$$

where ΔU_{ρ} *is the resident's utility variation,* ΔU_{f} *is the tax payer's and public services user's utility variation (f as "fiscal"),* ΔU_{τ} *is the beneficiary of amenities' utility variation,* ΔU_{τ} *is the (non-)active's utility variation.*

As a resident he can be a homeowner potentially willing his adult children can afford housing on the municipality or a renter potentially willing to become a homeowner. According to his age and income, the housing preferences are different (size, price, distance to

[3] in particular, relatively to the average/median local agricultural profitability or relative to the average/median profitability of the particular type of agricultural activity

city-center…). Let's note $\boldsymbol{\rho}$ the set of characteristics describing the median voter as a "resident".

The median voter can also be considered **as a potential local-tax payer and a local public services user.** So, elements of the municipal budget like local taxes, central State's grants or elements describing potential local public services congestion or potential need to make them more profitable must be considered. The willingness to attract secondary or permanent residents can be explained by such fiscal and public services considerations. Indeed, an increase in the number of permanent residents can be desirable either if the municipality has a low (or a decreasing) number of resident inhabitants or a low or decreasing permanent/secondary residents ratio (R) This is especially the case when this decrease puts into question the continuation of local services such as schools or other public services but also local shops. An increase in the number of secondary residents can be wanted if the municipality has a high R ratio and needs more tax-benefits to provide services to the resident population without increasing to much the tax this population pays. Characteristics linked to fiscal and public services aspect gathered in a set of characteristics $\boldsymbol{f}$.

The median voter also beneficiates from **various rural and urban amenities** that partly explain his choice to reside in a particular municipality and whose quantity and quality can be affected by a variation in the area devoted to urban development or in authorized densities. According to the existing theoretical and empirical literature and to our field observations, some characteristics gathered in a set $\boldsymbol{e}$ can explain his sensitivity to amenity variations and his willingness to improve or maintain the amenities he enjoys in his municipality. Thus, the median voter, especially if homeowner, is all the more sensitive to rural amenities changes linked to urban development if the area he chosen to live is a preserved, not densely urbanized place, that his income and his socio-professional category are high and that his municipality has experienced rural amenities degradations linked to the extension or densification of urbanization The willingness of residents to preserve open-space can also be increased by the relative scarcity of this one.

The median voter can also be an **employed or unemployed person**. In both case, his utility can be improved if jobs implantation corresponding to his skill is favored by the land use plan since it could allow him to get a job or to get a closer or a better paid job. The impact of policy change on the median voter as a worker depends of a set of characteristics $\boldsymbol{\tau}$.

- *Hypotheses associated with equations 4:*

Hρ1 : A high proportion/increase of renters creates a high demand for (affordable) housing that can theoretically be satisfied by allowing small lot and house size and/or by increasing the amount of land devoted to urban development.

Hρ2: A high proportion/increase of ageing or small households creates a high demand for small, central and so denser housing.

Hf1: A weak municipal self-financing capacity / cash flow position as well as an important debt lead municipal government to increase the amount of land devoted to urban development when a high share of municipality receipts comes from property and housing taxes

Hf2: High expenditures in equipment (road works and services connections) lead municipal governments to limit urban development (and) to make the existing one denser and so more profitable.

Hf3: A rapid decrease in median household income (and so in perceived housing tax) leads municipalities to be willing to attract wealthy households namely by increasing minimum lot sizes.

Hf4: Depending on the municipal financial position and the ratio permanent residents/secondary residents (R), municipalities seek to attract permanent or secondary residents. The willingness to attract permanent residents results in an increase in the amount and/or developable land or authorized densities. The willingness to attract (wealthy) secondary residents results in landscape preservation, the increase of minimum lot sizes (except in crowded touristic urban places like the "Côte d'Azur") and the creation of leisure activities areas.

Hf5*:* A rapid population increase (especially if associated with an increase of the number of children in schools) leads municipalities to slow down population growth by limiting extension of developable land and/or increasing minimum lot sizes to avoid equipment expenditures and services congestion (i.e. to keep an "optimal size").

He1: Amenities preservation by stopping urban extension or by allowing it only in a low density way is favored by a high share of wealthy homeowners belonging to high socio-professional categories in amenities-rich municipalities (low density…) especially if they have recently experienced degradation linked to increases in the share of urbanized area or in densities.

He2: A high share of urbanized area can lead the residents to want to preserve the last non-built areas. This willing to preserve can also focused on agricultural lands when they are rare in comparison with natural lands

Hτ1: A high proportion of commuters (working outside the city) or a low ratio number of job/number of residents can lead municipalities to be willing to attract new economic activities by allowing non-residential development but to avoid new inhabitants arrival by limiting new residential development or densification.

Hτ2: the proportion of unemployed people can lead municipalities to allow business urban development but is also a poverty indicator that could be correlated with the willingness of the municipalities to attract wealthy households (see above).

II.2.4. The role of surrounding municipalities' policies and characteristics

The median voter as well as the interest groups in presence and the elected officials will not have the same perception of policy changes according to what happens in **neighboring municipalities**. Thus, if the surrounding municipalities have experienced changes that would have been beneficial to them if they would occur in their own municipality, this leads the municipality to adopt the same behavior as its neighbors (mimetism). If the neighboring municipalities have experienced changes that would have been to their detriment if they would happen in their own municipality, this lead the municipality to adopt a behavior that differs from its neighbors 'one. Last, if these neighboring municipalities

have experienced changes that have actual or potential spillover effects on the median voter's municipality then the municipal government will adjust the policy in order to beneficiate of or to protect the municipality from these effects. According to the field study, a policy change in a municipality A is more likely to induce changes in a neighboring municipality B's characteristics or policy if A is close but also equivalent or bigger in population than B. The set of characteristics taken into account about neighboring municipalities is denoted by ***v***.

$$(\Delta SADU, \Delta D) = max\ [f(\Delta U_{grp.dom}, \Delta U_{el\cdot med}, m, v)] \qquad (Eq.\ 5)$$

- *Hypotheses associated with equations 5:*

Hv1: A municipality considers the situation in neighboring municipalities especially when they are close and larger than itself.

Hv2 (strategic interaction): Restrictive neighboring municipalities' policies (in terms of number of new houses) will be seen as an opportunity for pro-development voters, group interest and councils (respectively seeking for tax revenues, public service maintenance, land rent maximization and political weight) who will react by increasing the amount of developable land and/or the authorized densities but as a threat for anti-development voters, interest groups and councils who will react by restrictive land use policy too.

Hv3 (mimetism or rejection): The impacts of policies in neighboring municipalities on their own characteristics (related to land rent, residential, fiscal, amenities, employment, and electorate change aspects) will lead the considered municipality to adopt either a similar or an opposed political behavior.

II.2.5. Other complements and theoretical model global formalization

Last, some elements should also be taken into account like political ones: for instance, the number of years since the last land use policy change or the traditionally contentious aspect of land use decision in that municipality. By the way, avoiding new pressures is often a rationale for the absence of major changes in land use policy especially in municipalities where stakes are high and/or where the issues are traditionally very tense. So it's important to take into account the "climate" in which elected officials evolve beyond their vote margin. We can also include local specificities as the diffuse aspect of the existing urban fabric (which can make coherent land use projects very complicated to implement beside the low density amenities conservation aspects) or the presence of supra-municipal regulations that make some areas permanently non-developable. These characteristics are described by a set of characteristics ***p***, which leads us to equation 6.

$$(\Delta SADU, \Delta D) = max\ [f(\Delta U_{grp.dom}, \Delta U_{el\cdot med}, m, v, p)] \qquad (Eq.\ 6)$$

- *Hypotheses associated with equations 4:*

Hp1: Municipalities traditionally facing a lot of disputes about land use policy changes or municipality with a large share of diffuse urban fabric are reluctant to undertake changes in their land use plan.

***Hp2*:** Municipalities having recently reviewed their plan are less likely to do it again.

Hp3: Some specific regulations such as state environmental or risk zoning or law related to mountainous or coastal locations can impact in a sense or another the changes in authorized densities and developable land area.

III. Empirical model

In this section, two models are estimated: the Solé-Ollé and Viladecans-Marsal's model and our model. The former is used as a benchmark to estimate how the latter evolves when applied to our area of study. To do that, we first described the available data for the two empirical models (section III.1). Second, we recall the Solé-Ollé and Viladecans-Marsal's empirical model specification and apply it to our area of study using the most similar variables the data availability allows us to do (section III.2). Third, we present our alternative empirical model specification, perform the model and discuss the results (Section III.3 and III.4).

III.1. Data and variables

To perform empirical tests, several types of data are available at the municipal level for a majority of municipalities of the area of study.

Data on land use and urban fabric are available from Occupsol 1999 (an improved version of Corine Land Cover available for our area of study) and from the land register 2010 and 2005 (from which we made estimations to access the building exiting in 1999).

Land use policy data (zoning) are available for 1999 and 2006 over around 400 municipalities (Land Use Database= LUP DB).

Socio-demographic data from the National Institute of Statistical and Economic Studies (INSEE) are available for 1990 and 1999.

Data on agricultural holdings and types of agricultural activities are available for 2000 from the Social Agricultural Mutuality's database and from the bureau for statistics of the French Ministry of Agriculture and Fisheries (AGRESTE).

Municipal budgetary data for 2000 come from the French Ministry of Finances.

We also used the National Topographic and Equipment Data Base (BDTopo) and we gathered the state environmental and risk zonings from Regional Department of Environment, Planning and Housing (DREAL) and the National Museum of natural History (MNHN).

Last, we used the Quetelet Network's database on 2001's municipal elections results and the National Department of Urbanism, Housing and Building (DGHUC)'s database for disputes on land use policy changes between 2004 and 2007.

Table 1 presents the different variables built for the following empirical tests as well as their sources, the model(s) in which they are used and/or the hypotheses they should contribute to verify. For some hypotheses, data were not available (e.g. hypotheses related to neighboring municipalities) or only partly available (e.g. for hypothesis *Hf5*, we can assess the population growth but not the evolution of the percentage of children; for hypothesis *Hρ2* we have the 1999's share or people over 75 but not its evolution over the previous years…). We also considered variables that were neither directly related to any of the previously

mentioned hypotheses nor used in the Solé-Ollé and Viladecans-Marsal's model but whose influence seems interesting to study (e.g. "*Farmland*", "*Local_tax*", "*State_grant*") at least in a first trial.

As the quantitative endogenous variable we in used in the two empirical models is equivalent to the one used by Solé-Ollé and Viladecans-Marsal (2012), we also denoted it as ΔUrbanLand.[4] It is the amount of land that became developable by law between 1999 and 2006 (according to the digitalized land-use plan maps) in percentage of the 1999 build-up area (according to Occupsol).

Although our theoretical model mentions the density restriction variations as possible endogenous variable, it has not been included in the quantitative validation of our model because of limited data availability.

The explanatory variables all describe either the municipal situation in 1999 (or if not available for 1999, in 2000 or 2001, except for the variable "dispute" that refers to the existence of 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 the decision to increase the amount of developable land and the extent of this increase. So this decreases the probability of endogeneity issues.

As we found a strong negative relationship between the vote margin and the population, we propose a population effect corrected version of the vote margin variable (C_VoteMargin)[5].

[TABLE 1]

III.2. Applying the Solé-Ollé and Viladecans-Marsal's empirical model to our area of study as a benchmark

III.2.1. The empirical model as initially formulated

Solé-Ollé and Viladecans-Marsal (2012) formulated their empirical model this way :

$$\Delta UrbanLand_{i;t4-t0} = \alpha_1 * VoteMargin_{i;t4} + \alpha_2 * VacantLand_{i;t0} + \alpha_3 * OpenLand_{i;t0} + \alpha 3 * Z_{i;t0} + \Sigma_k \alpha_{4;k} * f_k + \alpha_5 * W_{i;t0} + \varepsilon_{i;t}$$

In this model, "$\Delta urbanLand_{i;t4-t0}$" is the amount of land that became developable during the studied term-of-office (2003-2007) expressed as a percentage of the 2003's built-up land area.

[4] Although our theoretical model mentions the density restriction variations as possible endogenous variable, it has not been included in the quantitative validation of our model because of limited data availability.

[5] The score (in percentage of vote casts) of the winning list was multiplied by the participation rate (and reduced to 50 % if the product was higher than 50% for a list elected a the second round so that a list elected at the second round can't have a score higher than the one of a list elected at the first one). Then the obtained score was corrected thanks to the estimated values of the coefficient a and error term e of the linear regression : Score~a*Log_pop+e where Exp_pop is the Neperian logarithm l of the 1999's municipal population.

"***VoteMargin****"* is the incumbent's margin of vote in 2007. "***VacantLand****"* is the amount of land assigned for development which remains vacant in 2003 as a ratio of the 2003's built-up land area and "***OpenLand***" is the amount of land neither built up nor assigned for development as a ratio of the 2003's built-up land area. ***Z*** is a set of control variables including "belong to an urban area"("*Urban*"), "belongs to a suburb"("*Suburbs*") and "*Beach*" dummies. ***f*** is a full set of local area dummies including a dummy indicating if the mayor belong to a left party ("*Left*"). ***W*** is a set of variables measuring the demand increase, the disamenity effects of growth, the residents preferences and the 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 government dummy, % graduate, % unemployed, population size and per capita income) as well as the amenity and productivity factors (an "amenity index", and a measure of road accessibility).

With this model and taking into account endogeneity issues (namely because the vote margin was measured for 2007 and not for 2003), Solé-Ollé and Viladecans-Marsal (2012) observe a significant and positive effect of "***VoteMargin****"*, "***OpenLand***", of belonging to an urban area ("Urban"), of being part of the suburbs rather than being a central city ("Suburbs") and of being coastal("Beach") on ***"ΔUrbanLand"***. They observe a significant and negative effect of "***VacantLand****"*. The positive effect of the vote margin is all the more important that the municipality is suburban or coastal, have a high percentage of commuters or homeowners and have a left mayor.

III.2.2. Implementation to the PACA Region

We applied the most similar test the data avaibility allow us to do to the PACA Region for the 1999-2006 period. To do that, we performed a both-directions stepwise procedure while controlling for outliers, leverage effects and colinearity. By the way, we directly included the equivalent of the variables that Solé-Ollé and Viladecans-Marsal used as subsamples determination variables (here equivalent to our variables "*ZONE*", "*POLE*", "*Homeowners*", "*Left*" and "*Non_commuters*") into the step-wise procedure. Indeed, considering the number of observations (263), it wasn't relevant to divide the sample into such subsamples. We estimate the OLS model for the total sample in a first time (Data= "*all*") and only for the municipalities with *ΔUrbanLand*>0 in a second time (Data= "*only changing*"). As there was colinearity between the geographical dummies "*ZONE*" and "POLE", we performed 2 regressions per sample, one with "*ZONE*" and one with "*POLE*", which gives us 4 estimations in total (see table 2).

[TABLE 2]

Although it is, of course, only a first, rapid transposition of the Solé-Ollé and Viladecans-Marsal's model to our area of study, we can however make some comments on the observed effects. Thus, significant and positive effects are observed for the variables "***Unemployed***" and "***Income***". Significant and negative effects are associated with the fact of being "urban" (relative to suburban) and of being an urban or a rural pole (variables "***ZONE***" and "***POLE***"). The variables "***% Mig***." and "***Manufacturing***" also have significant and

negative effects. Thus, the observed effects somehow validate hypotheses ***He1*** and ***He2*** (effects of variables "*Income*", "*ZONE*" and "*POLE*"), ***Hf3*** or ***Hτ2*** (effect of variable *"Unemployed"*) and ***Hf5*** (effect of variable "*% Mig.*"). The positive effect of being an urban pole is contrary to the effect showed by Solé-Ollé and Viladecans-Marsal (2012) as well as the insignificance of the variable "***VoteMargin***" and "***Left***". The insignificance of the two latter variables consequently doesn't allow to validate hypotheses ***Hm1*** and ***Hm2***.

III.3 Testing our model

III. 3. 1. Empirical model specification :A selection model rather than a linear one

A significant fraction of the municipalities in our sample didn't make any increase in their amount of developable land between 1999 and 2006 and we cannot exclude that the municipalities with an increase in the amount of developable land are not randomly drawn from the overall sample. In other words, we have to account for the probability that an increase appears when computing the extent of this increase, and we choose a selection model. Since the Heckman (1979)'s pioneering paper, models with selection effect are commonly used in various fields such as health, labor market and more generally when the objective is to study the effects on a population of phenomenon's that are only observed in a non-independent sample drawn from this population. The central idea of these models is based on the correlation between variables involved in the selection mechanism and unobserved individuals heterogeneity. Ignoring this selection would lead to biased estimators (Chanel and M'Chirgui, 2009).

Formally, equation (1) models the latent variable describing the decision to make an increase in developable land amount:

$$\textbf{(1)} \qquad Z_i^* = \alpha' W_i + u_i \qquad \text{with } u_i \sim N[0, \sigma^2_u]$$

where Z_i^* is an unobserved latent variable, W_i is the set of variables explaining the decision to make an increase in the amount of developable land and u_i is the error term. We observe the Z_i variable such as:

$$Z_i = 1 \text{ (the municipality i proceeded to an increase) if } Z_i^* > 0$$

$$Z_i = 0 \text{ (the municipality i didn't proceed to an increase) if } Z_i^* \leq 0$$

Equation (2) models the extent of the increase in the amount of developable land*:*

$$\textit{(2)} \qquad Y_i = \beta' X_i + \varepsilon_i \qquad \text{with } \varepsilon_i \sim N[0, \sigma_\varepsilon^2]$$

where Y_i is the increase in the amount of developable land, X_i is the set of variables explaining this amount of increase and ε_i is the error term.

The (Y_i, X_i) couple is only observed if $Z_i = 1$ and the auto-selection problem is that if u_i, the unobserved effect involved in the decision to proceed to 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 $E[Y_i|X_i, \varepsilon_i, Z_i=1] \neq E[Y_i|X_i,\varepsilon_i] = \beta' X_i + \varepsilon_i$. This possible

correlation should be explicitly taken into account by assuming a joint distribution between the decision-to-increase process and the decision of the amount of increase process:

$$[\varepsilon_i, u_i] \sim N_2[(0,0),(\sigma^2_\varepsilon, \rho\sigma_\varepsilon, 1)]$$

where σ^2_ε is the variance of ε_i ; $\rho\sigma_\varepsilon$ is the covariance between ε_i and $\mathbf{u_i}$; ρ is their linear correlation coefficient and σ^2_u, the variance of u_i, is normalized to 1 to allow identification. The obtained model is the most basic selection model, with a qualitative selection equation and a quantitative outcome equation.

Two estimation methods exist: the original one, proposed by Heckman (1976) in two steps and a one-step (full information) estimation by maximum likelihood. Although the second method is more efficient if the errors terms joint distribution indeed follows a bivariate normal distribution, we choose to use the first one, more robust in case of wrong specification and showing less convergence difficulties.

The two-step method consists in estimating equation (1) on the total sample with a binomial Probit model and then calculating the inverse Mill's ratio (***IMR***) thanks to the estimated coefficients:

$$(3) \qquad \hat{IMR}_i = \varphi(\hat{\alpha}'W_i)/\Phi(\hat{\alpha}'W_i)$$

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

In a second step, equation (4) is estimated only for municipalities showing a non-null positive increase in their amount of developable land:

$$(4) \quad Y_i = \beta' X_i + \rho\sigma_\varepsilon \hat{IMR}_i + v_i \quad \text{with} \quad v_i = \varepsilon_i - \rho\sigma_\varepsilon \hat{IMR}_i \sim N[0, \sigma^2_\varepsilon(1-\rho^2(\hat{IMR}(\hat{IMR}+\alpha'W)))]$$

To estimate the marginal effect of a change in an explanatory variable on the explained variable, 3 cases should be distinguished:

- <u>*Equation (1)*</u> : the Probit model is not linear so the marginal effect of a W_k variable on the probability to proceed to an increase in the amount of developable land is

$$\frac{\partial E[Z]}{\partial W_k} = \hat{\alpha}_k \phi\, \hat{\alpha}'W$$

- <u>*Equation (2) and (4)*</u> : the marginal effect of a variable X_k not belonging to the W_k variables is simply

$$\frac{\partial E[Y]}{\partial X_k} = \hat{\beta}_k$$

- <u>*Equation (4)*</u> : the marginal effect of a X_k variable *belonging* to the W_k variables is

$$(5) \quad \frac{\partial E[Y/Z=1,W]}{\partial X_k} = \hat{\beta}_k - \hat{\alpha}_k \hat{\rho}\hat{\sigma}_\varepsilon \left(\hat{IMR}^2 + (\hat{\alpha}'W)\hat{IMR}\right)$$

This effect is compounded of two parts: β_k, a direct linear effect of the X_k variables on the amount of increase, and a more complex and non-linear indirect effect resulting from the impact of X_k in the selection equation. If the correlation ρ between the errors terms of equations (1) and (2) is not null, this indirect effect alters the direct linear effect in a sense that depends on the sign of ρ and on the sign the coefficient associated to the X_k variable in

equation (1). So the total effect can be very different of the direct effect and even can have the opposite sign (Chanel and M'Chirgui, 2009).

III. 3. 2. Empirical results and interpretations

While controlling for outliers, leverage effects and colinearity, we looked for the best model, namely with a both-direction stepwise procedure and we obtained the estimation showed in table 3 (only the marginal effects are shown, computed on Eq (1) and (4).

[TABLE 3] As ***rho***, the linear correlation coefficient between the residuals of the two equations is significantly different from zero, we reject the hypothesis of non-correlation and consequently a selection model is justified. Concerning the performance of the model, we observe an adjusted-R^2 of 0.2503 which is low but acceptable considering the predominance of percentages among endogenous and explanatory variables.

- *Location and urbanization variables*

The probability to make the decision to increase the percentage of developable land decreases with the "***Distance***". These results suggest that demand for developable land indeed affects the decision to increase the amount of developable land, remote municipalities certainly facing less "demand" (in accordance with ***Hd1***).

Surprisingly, the availability of developable land (***VacantLand***), equivalent to the "supply", at the beginning of the period affects this decision in the opposite sense (in opposition to ***Hd1***). We suggest a **trend prolongation**: municipalities allowing an excessive share of their land to development in comparison with their urbanization rhythm keep on doing so. We also suggest the influence of **land retention and land prices**: the still available land can be considered as land that is not really available because of the owner' absence of willingness to sell and/or the low supply that put land prices so high that nobody wants to buy this land. Consequently, the municipalities can decide to increase the amount of developable land to supply developable at demand price. Yet, "***VacantLand***" didn't bring any improvement to the outcome equation and so wasn't upheld for it.

The percentage of disperse land use fabric (***Disperse_urban***) and the percentage of evolution of urbanized area (***Evol_build_up***) both have a significant and negative effect on the decision to increase developable area. One reason for the effect of the percentage of disperse land use fabric can be that once people have chosen to live in a place with disperse urban fabric they want to keep the place as such (as supposed in ***He1***). Another reason is that implementing a "coherent" land use policy (to fill in the empty space...) is more complex with disperse land use fabric configurations (as mentioned in ***Hp1***). An increase of the urbanized area can be seen as a loss of rural amenities that decreases the probability of the studied decision to be made but an increase in the urbanized area can also mean that the municipality reached the size from which it is no longer financially interesting to grow (equipment spending, congestion…). So, the negative effect of "***Evol_build_up***" on "***Increase***" tends to confirm ***He1*** and to some extent ***Hf5***. However, the only building-related variables that has been upheld in the outcome equation is the percentage of urbanized land in 1999 (***Build_up***)

and has a negative effect. This effect confirms hypothesis ***He2*** but can also suggest that municipalities would indeed want to reach an optimal size and then stop growing (***Hf5***).

- *Agriculture-related variables*

The ratio farmland on natural land (***R_farml_natld***) has a positive effect in the selection equation. This could suggest that the decision is less likely because the municipality wants to protect its last farmland (as put in ***He2***) or because urban development on natural areas is technically more difficult. Yet, in the case the decision to increase the percentage of developable land is made, the percentage of land newly devoted to development decrease as the municipal percentage of farmland (***Farmland)*** increases. As the Occupsol classification doesn't consider shrubs as farmland, a high share of farmland can mean an active agricultural sector (in accordance with ***Hd2***).

The number of heads of holding in percentage of the number of households (***farmers***) has a positive effect in the selection equation like in the outcome equation. This suggests that "***Farmers***" should be considered as a proxy for the importance of the interest group of non-built land owners (***Hd1***) rather than a proxy for the strength of the agricultural activity. Contrary to our expectations (and to ***Hd2***), the percentage of heads of holdings over 55 (***Farmers55***) has, a negative effect in the selection equation and was not selected (because not significant and not improving the model) for the outcome equation. "***Farmers55***" certainly reflects the rural and remote characteristics of the municipality and so the low demand for developable land (***Hd1***) that would not be entirely captured by "***Distance***". An increase in the number of people belonging to the socio-professional category "Agriculture" between 1990 and 1999 (***Evol_farmers***) has, as expected (see ***Hd2***), a negative effect on the decision to increase developable area. Nevertheless, and contrary to expected (***Hd2)***, this variable wasn't selected for the outcome equation.

The median agricultural turnover (***Agri_turnover***) has a negative effect in the selection (***Hd2***) but wasn't a relevant variable for the outcome equation suggesting that the profitability of agriculture plays a role but is not sufficient to explain farmland conservation.

Contrary to expectations, the share of permanent crop among farmland and the share of vineyards among permanent crops have a positive effect in the selection equation. However, if the decision to increase the amount of developable land is made, then the amount of land in question decreases as the share of vineyards among permanent crops increases (***Hd2***). This can mean that the permanent character of crops doesn't protect them from urban pressure but vineyards better resists. Note also that permanents crops and especially vineyards are located in areas already highly urbanized experiencing high urban pressure where changes in land use plans are certainly more frequent than elsewhere (which explain the effect in the selection equation) but result in lower extension of the developable area because of this already urbanized context and because of the vineyards profitability and reputation.

- *Socio-demographic variables*

The percentage of evolution of the population (***Evol_pop***) was upheld for the selection equation only whereas the population (***Pop***) was selected for the outcome equation only. However only the variable "**Pop**" has a significant, and negative, effect. This negative effect

reinforces the argument of an "optimal size" in relation with public services financing and amenities preferences (***Hf5, He2***).

Still related to public services provision and although just above the significance threshold, the percentage of population under 14 ("***under_14***") has a negative effect in the selection equation which is somehow in accordance with ***Hf5***.

The probability to make a decision in favor of an increase in the developable area increases with the ratio number of jobs / population. It seems therefore that *ceteris paribus* municipalities with a high number of jobs relatively to their population are likely to grow, maybe to accommodate this active population which is a variation of hypothesis ***Hτ1***. On the contrary, the probability to make such a decision decreases with the growth of the percentage of "executive, intellectual professions" (***Upper_class***) and the percentage of land newly devoted to development is lower where the percentage of "executive, intellectual professions" in the active resident population is high. The rural amenities (***He1***) and maybe some segregation towards poorer households effects are possible explanations for these results.

By the way, it is interesting to notice that if the median household income (***Income***) has only a significant effect in the outcome equation, its presence in the selection equation contributes to improve the model performance. Moreover, its impact on the outcome equation is opposite to the one of percentage of "executive, intellectual professions". An explanation can be that high income household and high share of executive, intellectual professions can have preferences for low densities of slow growth, the second characteristics may also be associated with a willingness to preserve non-build area associated with an environmental awareness (***He1***).

- *Budgetary and fiscal variables*

"***Cash flow***", "***Debt outstand****."* and "***Local tax***" have a negative effect in the selection equation but a positive effect in the outcome equation (***Hf1***). This can be interpreted as follows: if the municipality beneficiates from a good situation in terms of cash flow or on the contrary if the municipality has a high debt outstanding or else if the local taxes represent a high share of the operating revenues then the municipality is not likely to make the "increase decision" because the municipality doesn't need more revenues from urban development or can't afford it .However, if the municipality makes this decision, then the amount of land devoted to new development will increase with "cash flow" and "*Debt_outstand*." And, in a lower extent, with "local tax", either because the municipality can afford the spending it implies or because considering the share that local taxes represents in operating revenues, the municipality, in a short-term view, relies on the urban development revenues to improve its situation as also noticed by Solé-Ollé and Viladecans-Marsal (21012) in case of debt.

The percentage of land that becomes developable decreases as the share of State grant in the operating revenues increases.

Thus, if fiscal aspects are generally considered as playing no direct role in French households decision location, they seem to play a quite important role in municipal land-use policies decisions.

- *Political variables*

"***Disputes***" is relevant in both equations while the corrected vote margin is only selected in the outcome equation and "***Left***" wasn't significant and didn't improve the model performance (***Hm2*** not verified).

On the one hand, the existence of disputes does not favor undertaking about increase in developable area (in accordance with ***Hp1***), but once the municipalities made this decision, the existence of disputes increases the percentage of land that become developable either to satisfy pressuring non-build land owner or to satisfy Not In My Backyard (NIMBY)'s and taxpayers' interests (at least in short-term). Indeed, expanding the developable area allows pushing new urbanization and its nuisance without giving up its fiscal receipts as a complete prohibition would have done.

On the other hand, the corrected vote margin (***C_VoteMargin***) has a negative effect in the outcome equation: the larger the vote margin is, the lower the percentage of land devoted to new development is. This result is also in opposition to Solé-Ollé and Viladecans-Marsal (2012)'s hypothesis and result according to which the larger the vote margin is, the less the mayor has to take into account the median voter preference (typically an anti-growth homeowner) and can consequently satisfy landowners interest groups by designing large share of developable land. Introducing the homeownership rate doesn't bring anything to the model but this one is relatively high (around 62% on average with a median value around 57% for both selection and outcome equation samples if not considering secondary residences) and so we can assume that in case of low vote margin, elected officials indeed devote more attention to the "homevoter's" preferences (in accordance with ***Hm1***) but these preferences would rather consist in the maintain of a low density even at the price of urban expansion. In case of high vote margin, elected officials can take the risk to undertake densification possibly not so popular both for residents and for landowners.

- *Conclusion and discussion about empirical results*

The econometric model allowed us to test ten hypotheses among the twenty-one formulated. Among the eleven others, four hypotheses wasn't tested because of data unavailability (hypothesis related to neighboring municipalities characteristics, ***Hv1***, ***Hv2***, ***Hv3***, and to the number of years since the last change in the amount of developable land, ***Hp2***), one wasn't tested because it only concerns minimum lot size (***Hf3***) while the five others had their associated variables excluded from the regression for colinearity reasons or lack of significance (***Hρ1***, ***Hρ2***, ***Hf2***, ***Hf4***, ***Hτ2***, ***Hm2***).

Among the ten tested hypotheses, we can say that nine (***Hm1***, ***Hd1***, ***Hd2***, ***He1***, ***He2***, ***Hf1***, ***Hf5***, ***Hτ1***, ***Hp1***) were globally verified while ***Hp2*** had its associated variable (***Risk***) improving the model but without showing a significant effect. However, some unexpected effects of the variables that contributed to test the nine verified hypotheses outline the need for hypotheses refinements (e.g. in ***Hd1***, ***Hd2***, ***He1***, ***Hp1***) or alternative formulations (e.g. in ***Hτ1***).

Discussion and conclusion

As the global urban sprawl trend linked to environmental and agricultural issues doesn't seem to be slowed down by Governmental recommendations as the French Government's ones, we tried to understand the determinants of local policies in favor of agricultural and natural land preservation in the French context.

Considering that most of these issue-related theoretical and empirical works are either North-American based or not formalized/quantified, we tried to enrich the existing theoretical and quantitative empirical models by a field-based approach on South-East France and using a existing theoretical model developed for a European Mediterranean context (Solé-Ollé and Viladecans-Marsal, 2012) as a starting point.

This led us to develop a new theoretical model compatible with the French historical, legal and jurisdictional context as well as a set of associated hypotheses to test.

We then proceeded to an econometric validation of our model. The empirical model specification, a selection model, allowed us to take into account both municipalities that made changes in their land use plan (in terms of increase in their developable area) and municipalities that didn't, which was not possible with a linear model as usually employed like in the Solé-Ollé and Viladecans's empirical that we used as a benchmark.

Our econometric model showed that nine of the proposed hypotheses are fulfilled, allowing a first validation of our theoretical model and an appraisal of its "added-value". The procedures also confirmed the interest of combining a qualitative field-based approach with a quantitative one. Namely, the role of agricultural activity characteristics other than agricultural land rent has been outlined although it is generally not explicitly mentioned in existing theoretical and empirical formalized models.

This empirical test also introduced possible alternative interpretations and themes for considerations. Thus, further researches should be oriented toward empirical model specification improvements in terms of considered variables and hypotheses refinement. In particular, variables related to the effect of surrounding municipalities'characteristics and policies should be included. Such improvements will allow feedbacks toward the theoretical model and even possibly recommendations at the local level for policy makers.

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Figure and tables

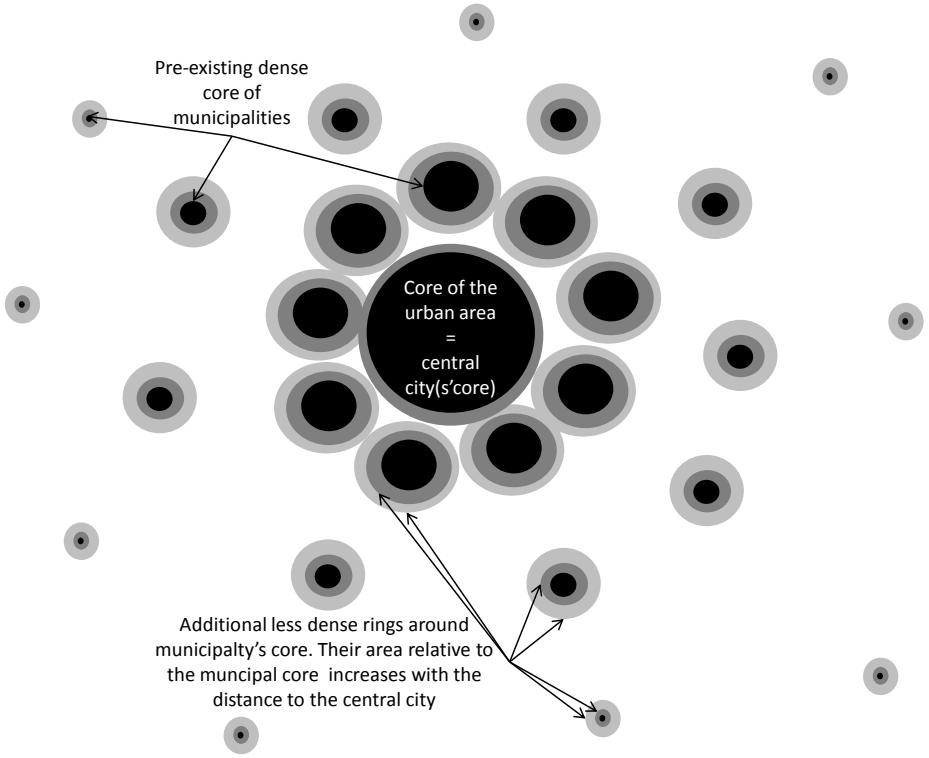

Figure 1: Representation of the « émiettement urbain » (≈ leapfrog development) (Castel, 2007) observed within urban areas of influence. *The grey gradient both represents urban fabric's density and age (darker = denser and older). Thus there is both center-periphery gradient at the urban area level (cores of municipalities more and more remote from each other) and at the municipal level.*

Next page ***: Table 1: Variables available for empirical modeling.*** *SV= Solé-Ollé and Viladecans-Marsal's model. Rel. hyp= related hypotheses.*

Variable	Meaning	Source	SV	Rel.hyp.
ΔUrbanland	Area become developable between 1999 and 2006 in %of 1999's build-up area	LUP DB/ Land register BDTopo/ DREAL/ MNHN/ Occupsol	X	Endog.
Increase	1 ift municipality increased its developable area between 1999-2006, 0 elsewise			Endog.
VacantLand	Vacant developable-zoned area in 1999 in % of 1999's build-up area		X	Hd1
OpenLand	1999's non-built area zoned as non developable in % of 1999's build-up area		X	
Risk	% of area strictly undevelopable for risk or environmental state zoning			Hp3
Farmland	1999'sFarmland in % of the municipal area			
R_farmld_natld	1999's ratio farmland area/natural land area			He2
Build_up	% of the municipal area urbanized in 1999			He2
Evol_build_up	1990-99's % of evolution of urbanized area			He1
Disperse_urban	1999's area of disperse urban fabric in % of 1999's urbanized area	Occupsol		He1,Hp1
Resid_density	Population in 1999*100/ Urbanized area in 1999	INSEE/ Occupsol		He1
Evolresid_densi	1990-99's evolution of population *100/ Urbanized area in 1999			He1
Zone	"urban_pole"(if urban area's center city or close peripherical municipality),"periurban"(if in an urban area periphery),"rural"(if not under the under the influence of an urban area)	INSEE (ZAUER 1999)	X	Hd1
Pole	"pole" if the municipality is an urban (if urban area's city center city) or an rural pole, "non_pole" elsewise		X	Hd1
Distance	Distance to the closest over-10000- inhabitants municipality, equal to 0 for	INSEE		Hd1
Perm_crops	1999's permanent crops area in % of 1999's farmland area	Occupsol		Hd2
Vineyard	1999's vineyard area in % of 1999's permanent crops area	Occupsol		Hd2
Agri_region	sub-areas along main agricultural production and geographical context	Agreste		Hd2
Agri_turnover	Municipality's median turnover of farms in 2000	MSA		Hd2
Farmers	2000's % of households including a head of agricultural holdings	MSA		Hd2
Farmers55	2000's heads of agri. holdings over 55 in % of the number of heads of agricultural.	MSA		Hd2
Evol_farmers	1990-99's % of evol. of people of the socio-prof.category "Agriculture"	INSEE		Hd2
Pop	Population in 1999	INSEE	X	
Evol_pop	% evolution of population 1990-99	INSEE		Hf5
Under14	1999's % of the population under 14	INSEE		Hf5
% Aged 30–45	1999's % of population between 30-45 years old	INSEE	X	
Over_75	1999's % of population over 75	INSEE		Hρ2
% Mig.	Net migration rate beetwen1990 an 1999	INSEE	X	Hf5
Homeowners	Percentage of homeowner occupancy in 1999	INSEE	X	Hρ1,He1
Second_resid	Secondary residences in % of the total number of housing	INSEE		Hf4, He1
Vacant_houses	Percentage of vacant housing	INSEE		Hd1
Graduate	1999 % of population with a Diploma of Higher Education	INSEE	X	He1
Income	Median household income in 2001	INSEE	X	He1
Upper_class	1999's % of "executive, intellectual profession" in the active pop.	INSEE		He1
Evol_up_class	% evol. of "executive, intellectual professions" 1990-99	INSEE		He1
Unemployed	% of unemployment in 1999	INSEE	X	Hτ2
Manufacturing	1999's % of jobs in manufacturing	INSEE	X	
Non_commuter	% of people both living and working in the municipality in 1999	INSEE	X	Hτ1
R_emp_pop	Ratio number of Jobs/population in 1999	INSEE		Hτ1
Net_cash_flow	Municipal cash flow in % of operating revenues in 2000	Ministry of Finance		Hf1
Debt_outstand.	2000's municipal debt outstanding in% of operat. revenues			
Equip_expend	2000's municipal equipment expenditures in % of total expenditures			Hf2
House_tax	2000's housing- and property-tax revenues in % of the operat. revenues			Hf1
Local_tax	Local taxes revenues in % of the operat. revenues in 2000			
State_grant	State grant in % of operating revenues in 2000			
VoteMargin	Winning voting list 's score (%) at the 2001 municipal elections	Quetelet Network Data	X	Hm1
C_VoteMargin	Score of the winning voting list (%) at the 2001 municipal elections corrected by round participation rate and population effect.			Hm1
Left	"left" if the winning voting list is a left party, "non_left" elsewise		X	Hm2
Disputes	Existence (=1) of disputes about land use plan changes between 2004 - 2007; =0 elsewise	DGUHC		Hp1

Geographical dummy	+ZONE)		+POLE)		+ZONE)		+POLE)	
Data	all		all		only changing		only changing	
Intercept	-1.088E+1		-3.732E+		-1.454E+1		7.598E+	
ZONE[urban_pole]	-1.043E+1	***	--		-8.720	*	--	
ZONE[rural]	3.145		--		7.410	.	--	
POLE[pole]	--		-1.212E+1	***	--		-1.193E+1	***
% Mig.	-2.658E-1	*	-2.950E-1	*	--		-2.587E-1	
Manufacturing	-2.914E-1	*	-2.872E-1	*	-3.065E-1	.	-2.872E-1	.
Left	-3.843		-3.715		--		--	
Unemployed	1.745	.	1.558	.	1.634		--	
Income	1.076E-3	***	9.203E-4	***	1.115E-3	**	8.469E-4	**
Residual std. Error	22.26		22.13		23.72		23.68	
Multiple-R^2	0.09335,		0.1005		0.08816		0.0874	
Adjusted R^2	0.07339		0.08355		0.07042		0.07325	
F-statistic:	4.677		5.938		4.97		6.177	
Df,	7 and 318		6 and 319		5 and 257		4 and 258	
p-value:	5.231E-5		6.775E-6		0.0002314		9.23E-5	
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1								

Table 2 :Results of the Solé-Ollé and Viladecans-Marsal-like empirical model applied to the PACA Region for the 1999-2006 period. *Significant effects are outlined by grey cells.*

263 observations (39 censored and 224 observed) 3 free parameters (df = 221) Wald chi2(16)=44,35					
Log pseudolikelihood = -1068,751 Prob>chi2= 0,0002					
Wald test of indep. eqns. (rho = 0): chi2(1) = 7.29					
	estimate	Std,error	Z	P>|z|	
/athrho	-401,5E-3	148,7E-3	-2,7	7,0E-3	
/lnsigma	3,1E	91,0E-3	34,5	0	
Rho	-381,2E-3	127,1E-3			
Sigma	23,1	2,1			
Lambda	-8,8	3,3			
Probit selection eq.:	marginal effect	Std,error	Z	P>|z|	
Distance	**-9,30E-2**	3,40E-2	-2,69	0,007	**
Risk	-6,60E-3	8,10E-3	-0,81	0,416	
Vacantland	**5,30E-3**	2,80E-3	1,87	0,062	.
Disperse_urban	**-1,50E-2**	7,70E-3	-2,01	0,044	*
Evol_build_up	**-2,70E-1**	1,40E-1	-1,96	0,05	.
Vacant_house	1,80E-2	6,10E-2	0,29	0,769	
R_farmld_natld	**6,50E-1**	1,70E-1	3,76	0	***
Farmers	**1,80E-1**	5,00E-2	3,62	0	***
Farmers55	**-3,30E-2**	1,20E-2	-2,88	0,004	**
Evol_farmers	**-6,50E-3**	1,50E-3	-4,26	0	***
Agri_turnover	**-1,90E-5**	1,00E-5	-2,4	0,016	*
Perm_crops	**8,90E-3**	4,30E-3	2,06	0,039	*
Vineyard	**2,80E-2**	5,30E-3	5,28	0	***
Evol_pop	-2,30E-2	1,60E-2	-1,4	0,162	
Aged_under14	1,20E-1	7,80E-2	1,56	0,119	
Ratio_emp_pop	**2,10E+0**	1,30	1,68	0,093	.
Evol_up_class	**-2,40E-3**	3,60E-3	-0,67	0,501	.
Income	-4,00E-5	4,00E-5	-1,13	0,257	
Local_tax	**-2,60E-2**	1,30E-2	-2,07	0,039	*
Net_cash_flow	**-5,50E-2**	1,60E-2	-3,45	0,001	**
Debt_outstand.	**-9,20E-3**	3,40E-3	-2,74	0,006	**
Disputes	**-7,70E-1**	3,70E-1	-2,09	0,036	*
Outcome equation:					
Build_up	**-7,20E-1**	1,70E-1	-4,19	0	***
Farmland	**-2,30E-1**	8,10E-2	-2,86	0,004	**
Vineyard	-7,30E-2	4,80E-2	-1,52	0,129	
Perm_crops	-6,50E-2	6,90E-2	-0,94	0,346	
Farmers	**1,20**	4,20E-1	2,8	0,005	**
Pop	**-8,50E-1**	3,90E-1	-2,17	0,03	*
Upper_class	**-1,4E+**	4,00E-1	-3,57	0	***
Evol_up_class	3,90E-2	5,80E-2	0,68	0,497	
Income	**2,40E-3**	7,30E-4	3,27	0,001	**
State_grant	**-3,50E-1**	1,60E-1	-2,21	0,027	*
Local_tax	3,10E-4	1,50E-4	2,13	0,033	*
House_tax	2,40E-1	2,60E-1	0,92	0,359	
Net_cash_flow	**4,70E-1**	2,00E-1	2,29	0,022	*
Debt_outstand.	**1,30E-1**	3,90E-2	3,32	0,001	**
C_votemargin	**-3,20E-1**	1,50E-1	-2,14	0,032	*
Disputes	**9,70**	4,90	1,98	0,047	*

Table 3: Results of the Heckman 2-steps procedure estimation. Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1