Land supply effects and drivers of town planning choices. Some empirical observations in a Metropolitan Modeling perspective

Laurence Delattre[1] and Claude Napoléone[2]

Summary:

When the price of housing is high or increasing rapidly, public regulation of land use becomes an important issue. Although considered as a way to address land and housing market imperfections, land use regulations are often criticized for their positive impact on land and housing price increases and consequently for their negative impact on access to housing, especially when seen as favoring certain social or interest groups. However, land and housing markets can hardly be considered perfectly competitive. Here, we question the assumption, based on theoretical analysis of a pure competition market, that developable land supply restriction (or indeed increase) will inevitably lead to developable land and housing price increases. With a view to improving recommendations to policy makers, this paper presents the results of two empirical analyses conducted on data from Southeastern France, where developable land and housing markets are very unbalanced in favor of demand. We show that: i) policies supporting increased developable land supply can lead to price increases and ii) the drivers of land use policies are mainly social and political, generating a framework within which market trajectories may differ. The implications of these findings are then discussed.

Keywords: Developable land supply, land use regulation, empirical analysis, local public decision modeling.

[1] AgroSup Dijon – UMR CESAER, Dijon, France.
[2] INRA Ecodéveloppement, Avignon, France.

Introduction

High or rapidly increasing prices for housing generally raise the question of the role and impact of public regulation of land use. Land use regulations can be considered as ways to address market imperfections and failures that characterize land and housing markets. In fact, land markets are far from perfectly competitive: land and housing owners can be considered as monopolist since they own goods that are unique in terms of location and thus neither homogeneous nor substitutable without cost (Scotchmer and Thisse, 1993; Fujita and Thisse 2003). Land markets also suffer from a high level of uncertainty, leading to under-efficient speculative behaviors (Mills, 1981) and densities (too dense in the center and not enough toward the periphery, Fujita and Kashiwadani, 1989). Brueckner (2000, 2001) identifies three kinds of failure: the failure to account for the amenity value of open space, these values being incompletely capitalized in natural or agricultural land prices; the failure to account for the social costs of freeway congestion (due to excessive commuting), leading to over-wide and insufficiently dense urbanization; and the failure to fully account for the infrastructure costs of new development (i.e. to make new development pay for the infrastructure costs it generates), leading to over-development and cities of excessive spatial size. Brueckner (2000, 2001) also found that these failures are difficult to address with public regulation tools. On public expenditure issues, Arnott and Stiglitz (1979) theoretically demonstrated how a system of optimal-size cities cannot be competitively maintained.

However, land use regulations are often criticized for their bullish effect on land and housing prices and consequently for their negative impact on access to housing (Jaeger and Platinga, 2007, Ihlanfeldt, 2007; Glaeser and Gyourko, 2006; Saiz, 2010; Malpezzi, 1996; Pollakowsky and Wachter, 1990; Cheshire and Sheppard, 1989). Thus, McMillen and McDonald (2002) in Chicago, Tse (2001) in Hong Kong or Lecat (2006) in France observed higher prices where a zoning regulation is implemented. The frequently implemented land use regulations, such as developable and non-developable land zoning or low-density policies, may well have a positive effect on price increases, through a number of mechanisms. First, due to the increased scarcity of developable land; then, through an amenity effect (restrictive land use regulations can lead to greater provision of desirable local amenities - and consequently to increased demand - that are capitalized into prices; see Ohls et al, 1974; Pogodzinski and Sass 1990); and finally through spillover effects, if regulations implemented in neighboring communities

or locations induce a shift of demand toward places where supply is less constrained (Pollakowski and Wachter 1990).

On the other hand, land use regulations are often considered to result from a desire to favor certain social or interest groups rather than from a desire to increase "total" welfare. One reason for excessive zoning restrictions is said to be the desire of existing residents to raise the value of their homes, what Fischel (1987, 2004) calls « monopoly zoning », directly attributing to it exclusionary and leapfrog development effects. Moreover, even given "benevolent" local authorities (i.e. whose objectives are to "maximize" and equally distribute urban development benefits), land and housing market failures and imperfections (as well as the issues of "fair" access to housing and open space) are difficult to address. Thus, even when regulations are used to limit market dysfunctioning, land and housing markets can still hardly be considered as pure competitive markets. Consequently, it is questionable to assume, based on theoretical analysis of a pure competitive market, that developable land supply restriction (or land supply increase) will inevitably lead to developable land and housing price increases, as is usually done (Erner et al., 2007), when advising policy makers.

To explore these complex relationships, we conducted the two empirical analyses presented in this paper, The first assesses how new developable land supply impacts price, revealing that the more a municipality extends new developable areas, the higher land prices become. The second examines the local determinants of developable land supply. We discuss the implications of these results in terms of urban policy modeling, after describing the French legal context as well as our study area.

Preliminary remarks: The French legal framework for land use regulation and our study area

In France, the municipality is the smallest jurisdiction. There are 36,680 municipalities (vs. only 330 in the United Kingdom, 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 the 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 compulsory only 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 – see Schone, 2010). The main types of zone are the "urban zone" (U), covering built-up and developable areas; the "future urbanization zone" (AU), developable in the middle or long term; the "agricultural zone" (A), non-developable except for agricultural-activity-related buildings; and the "natural zone" (N), generally non-developable (with some exceptions). In these plans, specific developable zones (NB) 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 favors urban renewal (Solidarity and Renewal law in 2000 and Urbanism and Housing law in 2003, see 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).

Our study area is the administrative region of Southeastern France (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 2), while other areas are plateaus and mountains. This area is part of Southern Europe, whose dense and compact cities with centers 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.

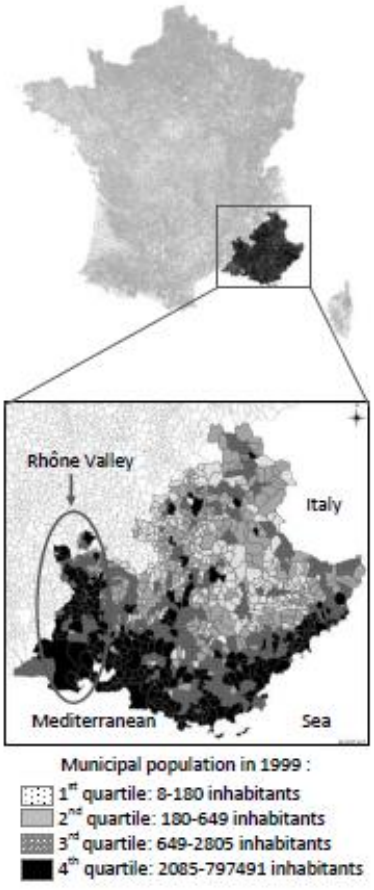

Figure 1: Population by municipality in study area (by quartile of number of inhabitants in 1999, INSEE).

I) How does land supply affect price?[3]

I.1 Methodology

Numerous authors have assessed the relationships between new developable land supply and price via indirect means of measuring supply:

- Ex-post measures of housing supply based on indicators reflecting efforts to control urban sprawl (Wu and Cho 2007).
- The presence/absence of certain zoning types (Lecat, 2006; McMillen and McDonald, 1993).
- Measures of developable land supply based on a strictly physical constraint definition (Rose, 1989) such as the absence of existing buildings, water bodies or slopes.

Here, however, our data allowed us to directly measure developable land supply as well as to assess its relationships with developable land prices (see Appendix 1). We performed measurements of developable land supply using both physical and legal constraints, through GIS analysis of all urban zoning. Specifically, to explore how supply affects land prices, we implemented a causal approach from Difference in Difference (*DiD*) experiments, applying spatial matching methods to assess the effects of land supply on prices in 358 municipalities of a French region (*Provence, Alpes, Côte d'Azur*). The causal framework enabled us to compare a counterfactual with a group of municipalities where land supply was high. The counterfactual is the average property price that would have been expected had the observed municipalities not benefited from this level of supply. We identified two groups:

- A treatment group: the municipalities that had created the greatest number of developable plots, generating a high land supply (75% and 90% more than the other municipalities).
- A control group: the municipalities with the same characteristics regarding the likelihood of having high land supply and land prices but that had not experienced great price changes (technical propensity score "Propensity Score Matching" or PSM; Rosenbaum and Rubin, 1984).

[3] From Geniaux, G., B. Leroux and C. Napoléone (forthcoming). "Les effets prix de l'offre foncière." Revue d'économie régionale et urbaine.

For each municipality with at least 10 sales during the period, we assess a land price index following the formula $I_c = \sum_{i \in c} \frac{\log(P_i)/\log(S_i)}{n_c}$ where *Ic* is the average percentage increase in price for a 1% increase in the sold area, S_i represents the sold area, P_i the price and n_c the number of sales in the municipality *c*. Sales with extreme price values per square meter, i.e. below the 2.5 or above the 97.5 percentiles, are deleted to build the municipal price index (this led to excluding one municipality from the sample). Land price indexes for the treated group are compared to their untreated counterfactuals.

Treated groups are defined from *GT1* to *GT4* groups. We note OFN_{99} the net land supply of the municipality (number of plots), $pOFN_{99}$ the share of net land supply in the municipality area and W_2OFN_{99} the sum of the net land supply in adjacent municipalities. We have:

- GT1 :

$OFN_{99} > percentile_{75}(OFN_{99}) \cap W_2OFN_{99} > percentile_{75}(W_2OFN_{99})$

- GT2 : $OFN_{99} > percentile_{75}(OFN_{99})$
- GT3 :

$pOFN_{99} > percentile_{75}(pOFN_{99}) \cap W_2OFN_{99} > percentile_{75}(W_2OFN_{99})$

- GT4 : $pOFN_{99} > percentile_{75}(pOFN_{99})$

Thus, GT1 is the group of municipalities belonging to both the 25% of cities with the highest developable land supply in 1999 and the 25% of neighboring municipalities with the highest developable land supply in 1999. These groups are used to build treated groups in the *DiD* method groups.

Control groups are taken from a selection of the first 25%. More specifically, the control groups are defined as follows:

- GNT1 : $OFN_{99} < percentile_{25}(OFN_{99}) \bigcup W_2OFN_{99} < percentile_{25}(W_2OFN_{99})$
- GNT2 : $OFN_{99} < percentile_{25}(OFN_{99})$
- GNT3 : $OFN_{99} < percentile_{25}(pOFN_{99}) \bigcup W_2OFN_{99} < percentile_{25}(W_2OFN_{99})$
- GNT4 : $OFN_{99} < percentile_{25}(pOFN_{99})$

Finally, we consider several indicators of supply growth named *M1*, *M2*, *M3* and *M4*:

- *M1*, the area of the municipality's new developable zones
- *M2*, the proportion of the municipality newly zoned as developable
- *M3*, the net land supply of the municipality (OFN_{99}) after 1999
- *M4*, the reduction in net land supply of the municipality (OFN_{99}) after 1999

The counterfactual is the developable land price that would have been expected in treated municipalities had they adopted a low net land supply policy.

We then compared municipality groups with their nearest neighbor,(matching municipalities with the most similar characteristics). We relied on a Mahalanobis distance[4] to reduce the problem to a single dimension (Rubin 1973, 1980; Imbens, Wooldridge, 2009). If N_0 is the number of municipalities in the control treated group (I_1), N_1 the number of municipalities in the treated group I_0, then:$\Delta^{TT} \frac{1}{N} \sum_{i \in I_1} \{Y - \bar{Y}_{j(i)}\}$. Treated and untreated groups have similar distribution characteristics in terms of population, distance from an employment center and size. Each treated observation is paired with the 1 or 5 closest observations for these three characteristics using the Mahalanobis distance with a draw without replacement. To ensure the quality of pairings, we removed from some treated groups the 2-3 observations with the highest municipal populations.

1.2) Results

We find a net increase effect on adjusted price of between 16.4 and 18.8% for each type of matching (table 1). The assumption of a perfectly competitive market at regional scale is therefore invalidated, since each new area opened for development generates a correlated price increase. This counterintuitive phenomenon can to some extent be explained by the behavior of external demand: the region studied here is experiencing high housing demand from other French and European regions, but this demand is not focused on a particular location. Regulations increase uncertainty and transaction costs, while zoning large new developable areas is a market signal for non-specific demand, which impacts price at a regional level regardless of municipal characteristics.

[4] Mahalanobis distance is a measure of similarity between data sets.

Options	N	n_1	n_0	ATT est.	Std. Dev.	T	p-val.	**Effect cor. %**	Balancing t-tests: dist. pole	population	area
GT1/NT1, M=1	53	12	12	0,24071	0,0665	3,6178	0,0003***	**17,17**	0,17	0,078	0,175
GT1/NT1, M=5	53	12	60	0,1943	0,0584	3,3265	0,0009***	**16,40**	0,21	0,003**	0,044*
GT2/NT, M=1	36	12	12	0,29136	0,0764	3,8125	0,0001***	**18,05**	0,66	0,051,	0,038*
GT2/NT2, M=5	36	12	60	0,22925	0,0615	3,7274	0,0002***	**16,98**	0,32	0,049*	0,031*
GT3/NT3, M=1	54	11	13	0,24172	0,0571	4,2302	2,3e-05***	**17,20**	0,79	0,113	
GT3/NT, M=5	54	11	55	0,22996	0,0383	5,997	2,0e-09 ***	**17,02**	0,94	0,070	
GT4/NT, M=1	29	9	9	0,33597	0,1009	3,3301	0,0009***	**18,84**	0,38	0,060	
GT4/NT, M=5	29	9	45	0,31122	0,0661	4,7094	2,5e-06***	**18,43**	0,76	0,048*	

Table 1. Results on treated group (M = 1) with matching pairs or on untreated group (M = 5) without replacement

Our results reveal a counterintuitive relationship between developable land supply and price. Now we turn to the drivers of this supply.

II) What drives local government policy?[5]

There is a large economic literature regarding the determinants of local land use policy choice, relying on micro-economics models (based e.g. on Fischel 1987, Tiebout 1956, Alonso 1964, Ellickson 1976, Brueckner, 1995 etc.) and on empirical analyses, namely quantitative (econometric) validation of such models (see e.g. Rolleston 1987, Howell-Moroney 2004, Glaeser et al, 2005 etc.). However, results are inconclusive, and studies rarely explicitly consider the spatial implications of land use regulations; moreover, they almost always deal with American cases. Yet there are obvious historical, geographical, and legal differences between Europe and the USA.

[5] This section refers to Chanel et al., 2014; Delattre et al, 2012 and Delattre et al., 2014 and Delattre L., O. Chanel, C. Livenais, C. Napoléone," Combining discourse analyses to enrich theory: the case of local land-use policies in South Eastern France", currently under revision for *Ecological Economics*

2.1) Methodology

Our multi-approach analysis combines the following:

- both qualitative and quantitative analyses of discourse collected through a field survey[6]. We used them (Alonso, 1964) to enrich a theoretical model based on an existing theoretical framework developed by Solé-Ollé and Viladecans-Marsal in 2012[7]. For the qualitative analysis we organized the main information derived from survey notes and recordings in a matrix, with municipalities listed by line and the following information by column: the land-use plan dates of adoption and changes, its main objectives, means used to reach these objectives and rationales for the selection of these means, reactions from inhabitants by category (homeowners, renters, landowners, (tenant) farmers), reactions from neighboring municipalities, government and local organizations, municipal council characteristics (number of terms, score at the last municipal election, political homogeneity, professional composition). This matrix enabled us to establish a "strategic profile" for each commune highlighting the main policy objectives, rationales, tools and the context factors influencing their choice. Based on these strategic profiles, a figure presenting all the municipalities along two axes (here densification and expansion) and showing similarities and differences between cases was constructed. "Quantitative" analysis refers to computer-assisted text-statistics methods that classify terms according to their proximity: the ALCESTE[8] and Similarity Analysis methods.

- econometric validation (≈300 municipalities) using both a Tobit and a Two-stage model. 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. We then relax this constraint by approaching the modeling of the political choice as a two-stage model and controlling for possible selection bias (if municipalities with increased developable land are not randomly drawn from the overall sample). The amount of land rendered developable by law between

[6] Semi-directive interviews with the elected official in charge of urban planning or, by default, with the technical officer in charge of urban planning of 38 municipalities.

[7] According to SOMV's model, to choose the amount of new developable land, the local incumbent weighs both the amount of political rents he will obtain in the present term-of-office and the effect of his decision on the probability of re-election. On the one hand, the more new developable land there is, the higher Political Rents are because the developer's profits i.e. the pro-development interest groups profits, increase with developable land. This increase also depends on the current demand and supply for developable land. On the other hand, the probability of re-election decreases with the amount of new developable land because development entails costs and dIsamenities for the representative voter. The model is formalized in such a way that the weight of voter's welfare rises with the degree of political competition.

8 Analysis of co-occurring lexemes in simplified text statements (ALCESTE : Analyse des Lexèmes Cooccurrents dans les Enoncés Simplifiés d'un Texte).

1999 and 2006 (according to the digital land use plan maps) as a percentage of the 1999 built-up area (*ΔUrbanland*) is used as dependent variable, in line with SOVM (2012)[9]. Unfortunately, the densities authorized in the different zones are not available[10]. The explanatory variables all describe either the municipal situation in 1999[11] or the evolution of a characteristic during years before 1999 or 2000 (mainly between 1990 and 1999–2000)[12]. To take into account neighbor effects, we compute two variables for each municipality: the population in neighboring municipalities (*PopNeighb*) and how it changes (*ΔPopNeighb*). In accordance with the field observations, only neighboring municipalities larger than the municipality considered are included in the computations[13].

2.2) Results

2.2.1) Qualitative and quantitative discourse analysis results

Qualitative analysis enabled us to broadly classify the 38 municipalities into 8 groups of land-use strategy, along two axes: their change in developable area and their change in authorized density (Figure 2).

9 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

10 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.

11 (or if not available, in 2000, 2001, or 2002, except for one variable, Disputes, for any land-use-policy-related disputes between 2004 and 2007)

12 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.

13 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

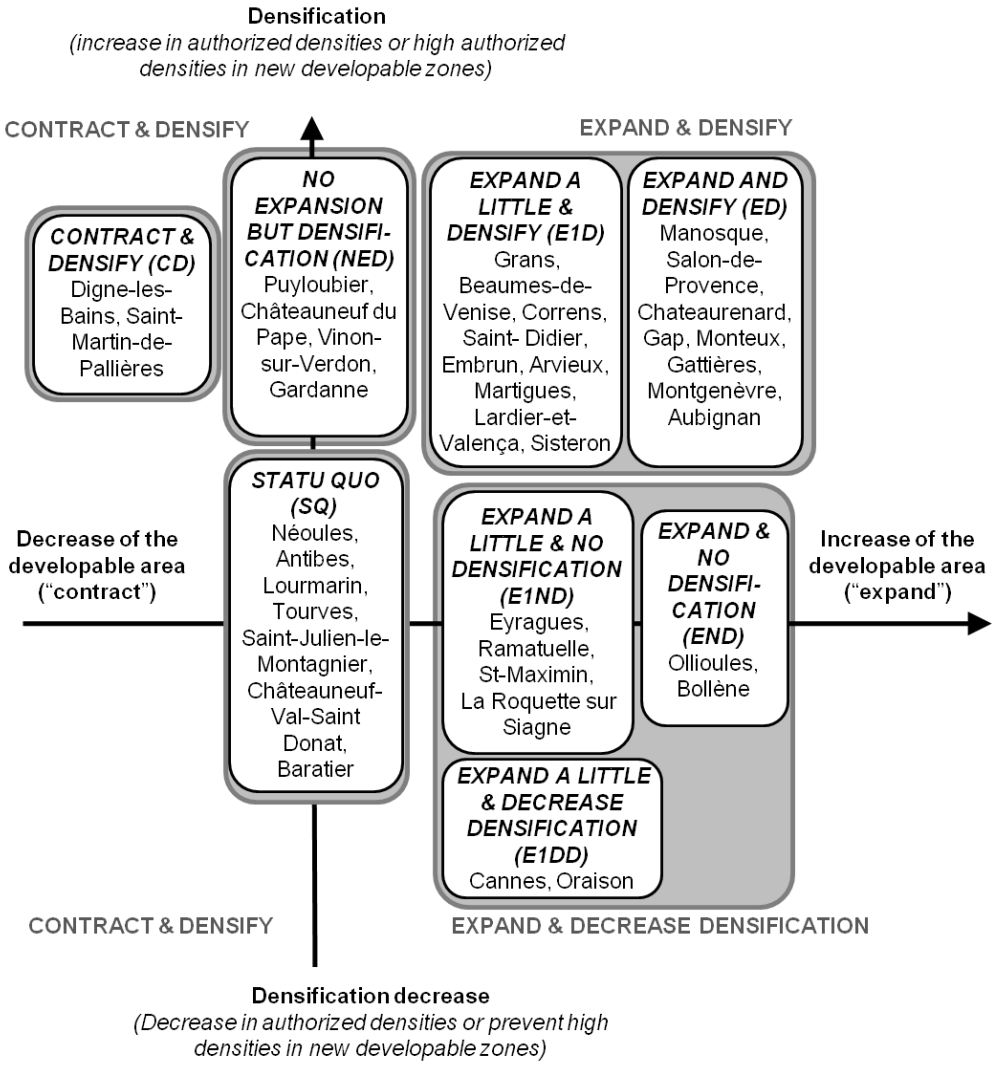

Figure 2: typology of municipalities according to their strategies in terms of densification and expansion of their developable areas. (« Ramat. » = Ramatuelle) (Delattre et al. 2012)

- Municipalities in the status quo group could be viewed as having achieved their optimal "size", if not in terms of public services, at least in terms of residents' preferences. However, this "no change" strategy is also considered by elected officials as the "safest one" in municipalities where land use issues are strongly felt. Most of the municipalities belonging to the Status Quo group had relatively low populations, low "urban" density and a low proportion of urbanized area in 2006. However they experienced high population and urban density growth from 1999 to 2006 and are now in a "stabilization" phase.

- Municipalities belonging to the three groups that want to expand without densifying are reluctant to increase density, seeking to preserve a living environment seen as "rural" and, sometimes, to select any incoming population. However they intend to expand, either because of a specific project or in response to landowner pressure to target a wealthy incoming

population, thus increasing fiscal revenue. All but one of the municipalities adopting strategies of urban expansion without increased densification are found to have a right-wing mayor at the time interviews were conducted. This strategy, which can be viewed as a way to select (the wealthiest) population, appears thus to be more openly expressed (and preferred?) by right-wing local governments[14]. Some municipalities want to densify without expanding, in order to preserve non-urbanized land while ensuring population renewal and social diversity as well as to maintain local public services and to make facilities profitable. These municipalities have in common relatively high urban density in 2006, with a substantial increase from 1999 to 2006, and their proportion of urbanized area is low. Thus, the strategies they described in 2010 correspond to a continuation of an existing trend (densification and non-urbanized area preservation) and/or to a "waiting to fill in" strategy (of still vacant developable areas).

- Others - villages as well as medium-sized cities (up to 45,000 inhabitants) - want both to densify and to expand. They also want to meet local demand for affordable and centrally located housing, as well as to maintain public services and make facilities profitable by increasing their population. However, pro-development interest groups and the political ambitions of elected officials (such as competing for influence with neighboring cities) seem to play a role in the strategies of the cities with the greatest ambitions for expansion. In fact, the elected officials, and especially the mayor, of the latter are sometimes viewed (including by other elected officials) as "entrepreneur-mayors" (Le Duff and Orange, 1996). In addition to differences in terms of population (ED municipalities are on average more populated than E1D municipalities), ED and E1D differ in terms of urban density and proportion of urbanized area (high for ED, intermediate for E1D) and in terms of urban density growth (high for ED, low to intermediate for E1D). ED is also characterized by municipalities with high "gross" density and total area.

- Lastly, some municipalities (a city and a village) choose to cope with housing provision, non-urbanized land preservation, equipment profitability and expenditure limitations by densifying and reducing developable areas that, according to them, were over-generously allocated by former elected officials or by central government (before the

[14] However, these 3 groups show differing characteristics. The END group includes two medium-sized cities with an intermediate to high proportion of urbanized area but with low-to-intermediate urban densities that experienced a low positive or negative evolution from 1999 to 2006. EIND, the intermediary group between groups SQ and END on the "extension" axis, is characterized by urban density levels and growth and proportion of urbanized area that fall between those of the SQ and END groups. Lastly, the E1DD group includes two municipalities with very different characteristics, apart from their right-wing mayor and their low growth of urbanized area.

decentralization laws that transferred authority over land-use regulation to municipalities in the 1980's).

Based on the Similarity analysis over the whole corpus, Figure 5 shows the strongest relationships between terms (font size is proportional to the term's frequency of occurrence, while line thickness reflects the strength of the relationship). As expected, "zone" plays a central role but this representation also shows how agricultural-land- and commune-related terms are strongly linked to zone, while institutional and procedural aspects are present but less central (less linked to "zone", "municipality" or "parcel").

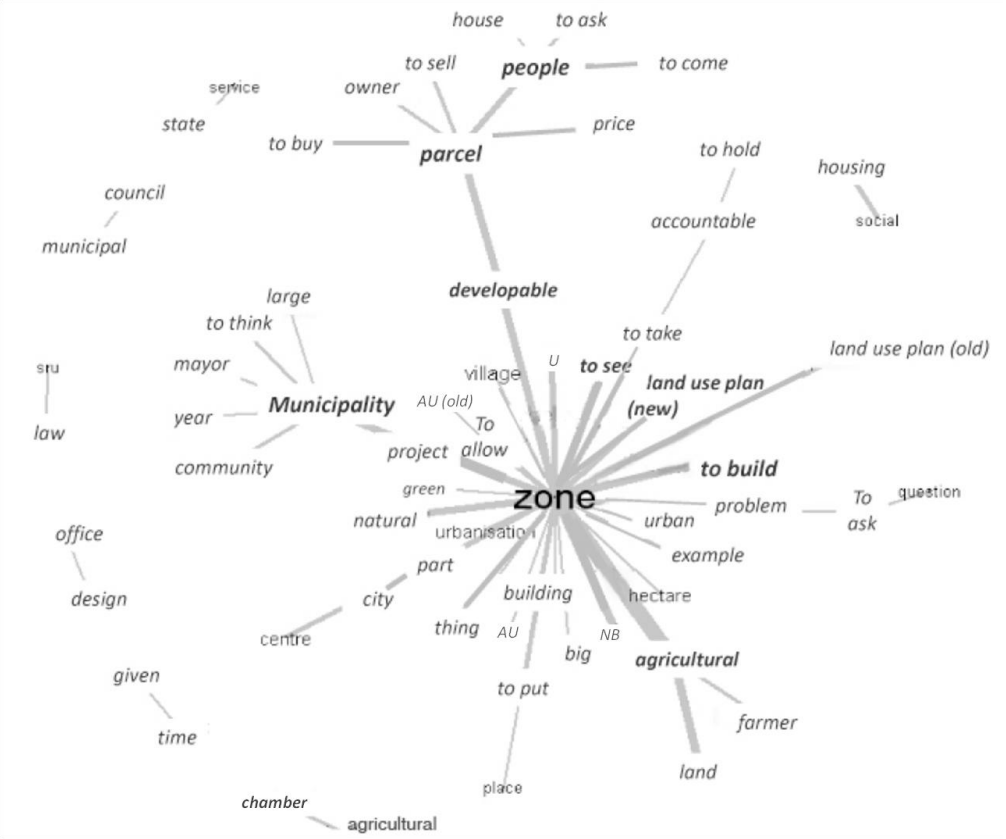

Figure 3: Graph of similarities (translated from French) applied to the whole corpus. For readability, only the strongest relationships are included.

The ALCESTE classification procedure yields four classes that include around 80% of the analyzed text. The largest class in terms of classified terms (around 40%) includes terms describing agriculture, land ownership and housing (see Figure 7). This can be interpreted as an illustration of an important issue facing local elected officials: dealing with the sometimes conflicting individual interests in the land market. In this regard, Figure 7 confirms the relevance of the electoral market theoretical frameworks (as described by Fischel, 1987, 2001; and Solé-Ollé and Viladecans-Marsal, 2012) by representing three groups - potentially pro-

development (land) owners, farmers and others (inhabitants, electors) - only connected through parcel-related terms, in particular dealing with price (to sell, to buy, sale, price, euro), which depends on authorized construction. This even suggests the need to enrich the theoretical framework by considering farmers, or at least "agriculture", as a full-fledged interest group (distinct from the pro-development group representing landowners' interests) because these two groups appear independently on the Figure and are only connected through a regulated land market.

Figure 4: Graph of similarities (translated from French) of the most representative class. For readability, only the strongest relationships are included.

2.2.2) Enriched theoretical framework:

We consider that changes to the land use plan, for instance the amount of new developable land (or even changes in authorized densities), result from a trade-off by the local government

between meeting the dominant interest groups' preferences and meeting those of the median voter given local conditions, namely the vote margin.

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's (2012) study 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 favor 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 groups 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 southeastern 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, and 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 modeling. Formally, we assume that the dominant groups' utility is composed of the pro-agriculture group and the pro-development group.
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; a taxpayer and local public service user; an amenity "consumer"; and an adult of working age, working in the municipality or not.

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 (pro-development) interest groups more consideration. Our field study brought to light more

"audacious" political behavior (in favor either of urban expansion or of densification) where electoral competition was weak. We assume that the incumbent assesses the level of electoral competition through the expected vote margin at the next municipal election.

Third, what happens in neighboring municipalities will affect the median voter's, the interest groups', and the elected officials' perceptions of policy changes. A change in a neighboring 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 neighboring population is the same or larger.

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, and 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.

2.2.3) Econometric validation

As the Tobit model performance was low, we will only present the two-stage model results (we observed no selection bias; we also checked for absence of spatial dependence). We present below the results of the Probit and linear equations:

Variable	Definition
Azur	Municipality is located on the *Côte d'Azur*(=1)
BuiltUp	Municipal area urbanized in 1999 (%)
CashFlow	Municipal cash flow as fraction of operating revenues in 2000 (%)
DebtOutstand	Municipal debt outstanding as fraction of operating revenues in 2000 (%)
ΔPop	Change in population between 1990 and 1999 (%)
ΔPopNeighb	Kernel distance weighted mean of population change in bigger municipalities (%)
ΔUnder14	Difference in number of under-14s between 1999 and 1990 as fraction of 1990 population (%)
ΔUrbanland	Area rendered developable from 1999 to 2006 as fraction of 1999 built-up area (%)
ΔVacantH	Difference in number of vacant housing units between 1999 and 1990 as fraction of 1990 housing units (%)
Disputes	At least one dispute about land use plan changes between 2004 and 2007 (=1)
Farmers	Fraction of farmers in the 2000 population (%)
Homeowner	Fraction of principal residence homeowner occupancy in 1999 (%)
Income	Median annual income per unit of consumption in 2000 (€)
Left	Left-wing party (extreme left, left or green) received the highest number of votes in the municipality in 2002 legislative election (=1)
Organic	At least one organic farmer in municipality (=1)
Over75	Fraction of population over 75 in 1999 (%)
PopNeighb	Kernel distance weighted mean of population of bigger municipalities
Population	Population in 1999
UpperClass	Fraction of managers and professionals in 1999 (%)
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 (%)
VoteMargin	For municipalities over 3500 inhabitants: score in 2001 municipal election winning list * participation rate (%). 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 (%)

Probit	
Variable	**dy/dx**
Azur (=1)	-0.26***
CashFlow	-3.2E-3*
ΔUnder14	-0.013**
ΔPop	2.0E-3
ΔPopNeighb	0.02**
Farmers	0.024**
Income	-2.4E-5**
Left (=1)	-0.15*
Turnover	-3.4E-4*
PopNeighb	1.1E-5**
Population	2.9E-6
VoteMargin	-2.6E-3**
Intercept	
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	

Linear equation	
Variable	**Coef.**
BuiltUp	-4.21E-02***
DebtOutstand	7.35E-03***
ΔPop	-2.46E-02*
ΔPopNeighb	9.00E-02*
ΔVacantH	-7.02E-02***
Disputes	6.91E-01*
Homeowner	1.72E-02
Left	-8.46E-01*
Organic	7.69E-01***
Over75	-1.63E-01***
PopNeighb	-4.24E-07
Population	-9.69E-08
UpperClass	-1.46E-01***
Intercept	3.23E+00***
Dependent variable = ((ΔUrbanland^0.17)-1)/0.17)	
Note. P-values: *** if < 0.01, ** if <0.05 and * if<0.1	
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	

Table 2: Variables and results of the econometric validation (2-stage model)

- Population size has no significant effect, but population and especially population growth in neighboring bigger municipalities have a positive effect in both equations, while population in the municipality itself has a negative effect on the amount of new developable land. This suggests that municipalities with neighbors that are bigger and growing tend to adapt to this neighboring growth by increasing their amount of developable land, rather than protecting themselves from this growth. However, the increase is lower if the municipality itself experienced population growth over the preceding years, and if its urbanized area has reached a certain proportion. All this also suggests that the urban area's periphery will also be affected by the same spatial, social and economic factors.

- The proportion of farmers has a positive effect on the probability of increasing the amount of developable land, which suggests that this percentage is more of a proxy for landowner's power. Farmers in this area own a large share of the land they use. Conversely, relative agricultural profit, here expressed as the median agricultural turnover in the municipality as a % of the median turnover in municipalities with the same kind of production, has a negative effect on the probability of an increase in developable land. This confirms our hypothesis about the role of relative profit[15].

- Municipalities experiencing financial difficulties (low cash-flow, high outstanding debt, low income) are more likely to increase the amount of developable land. Urban expansion can be seen, rightly or wrongly, as a way to obtain more tax revenue, namely through new rich inhabitants on large lots. However, the financial difficulties may be the result of previous expenditure aimed at ensuring this growth, and data covering longer periods would be useful here.

- Lastly, a high electoral score has a negative effect on the probability of an increase in developable land. While all the municipalities altered their plans, some did not make an increase: strong political legitimacy seems to promote this type of decision. This is also contrary to Solé-Ollé and Viladecans-Marsal (2012)s' findings. And while disputes have a positive effect, it is not clear whether disputes about land use policies are a cause or a consequence of the increased amount of developable land: increasing the amount of developable land can be either a source of disputes or a means of solving them.

[15] The presence of organic farming has a positive effect on the amount of new developable land, contradicting our hypothesis on the role of agriculture's image. This variable is not very accurate; it is a dummy based on available data that could be improved, but it suggests particular spatial relationships between this kind of agriculture and urbanization which merit closer analysis.

Discussion and conclusion

Our findings indicate, ceteris paribus, that a greater developable land supply does not necessarily lead to lower prices. Theoretically, the greater the supply, the lower the price; however, when demand is far higher than supply (the study region is highly attractive), a really high increase in supply is needed to make prices drop, and there may not be enough land available for this to happen. Such demand could be termed infinitely elastic. Moreover, under such scarcity economic agents may over-react to market signals like a developable land supply increase through land use regulation changes. For instance, a large amount of the demand may focus on (or "rush to") a community known to have significantly increased its developable land supply, thus causing a developable land price increase in this community. Conversely, a community known to implement restrictive zoning could see demand for its developable land decrease because potential buyers fear increasingly restrictive regulations in the future that would prevent them developing their land as intensively as they would like. If this negative effect on demand is stronger than the positive effect of environmental amenities, it will lead to price decreases. These mechanisms may have a social cost when they extend across a whole region, for example limiting labor supply.

Our contribution highlights the determinants of local land use policy in a region characterized by a very unbalanced market and strong development pressure. By combining different methods, we bring to light the crucial role of rarely studied policy drivers such as relative agricultural profit, political legitimacy and asymmetric relationships between municipalities. Exploring the drivers of local land use policies, we find that choices are explained by the social structure (proportion of landowners and farmers; agricultural relative profitability; income; lobbies) or the financial situation of the municipality (debt, cash-flow), by political considerations (vote margin for mayor at last election) and by an asymmetric effect from surrounding cities (only the largest cities having an effect). These characteristics generate the framework within which the market is expressed: a supply constraint favoring (tenant) farmers in a municipality in which the density is high may not be attractive for an external demand focused on individual houses.

We therefore conclude that modeling metropolitan dynamics on the basis of purely theoretical approaches to land market conditions can generate a degree of bias. For instance, during the housing boom Spanish law allowed building wherever it was not "permanently" forbidden (in national parks, for example). Thus, the developable area was extended enormously while prices constantly increased (Naredo, 2010). A better way to capture the effect of developable land and building opportunities is to better take into account the particular local features of land and housing markets and regulation. This would also ensure easier access to the determinants of local regulations concerning developable area and authorized densities, for analytical purposes.

References

Alonso, W. (1964). *Location and Land Use; Toward a General Theory of Land Rent*. Cambridge,

Ma, Harvard University Press.

Alterman, R. (1997). The challenge of farmland preservation. *J. Am. Planning Assn.* **63**, 220, 221-35.

Arnott, R. J., and Stiglitz, J. E. (1979). Aggregate land rents, expenditure on public goods, and optimal city size. *The Quarterly Journal of Economics* **93**, 471-500.

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

Brueckner, J. K. (2000). Urban sprawl: diagnosis and remedies. *International regional science review* **23**, 160-171.

BRUECKNER, J. K. (2001). Urban Sprawl: Lessons from Urban Economics. *Brookings-Wharton Papers on Urban Affairs 2001*, 65.

Brueckner, J. K., and Fansler, D. A. (1983). The economics of urban sprawl: Theory and evidence on the spatial sizes of cities. *The Review of Economics and Statistics* **65**, 479-482.

Chanel, O., Delattre, L. and Napoleone, C. (2014). Determinants of local public policies for farmland preservation and urban expansion: a French illustration. *Land Economics.* 90 (3) 411-433.

Cheshire P and Sheppard S (1989). British planning policy and access to housing: some empirical estimates. *Urban Studies*. 26(5):469.

Comby, J., and Renard, V. (1996). "Les politiques foncières," Presses universitaires de France.

Delattre, L., Chanel, O., and Napoléone, C. (2012). Comment modéliser les déterminants locaux de préservation des espaces non-artificialisés en France? L'apport d'une confrontation littérature-terrain. *Revue d'Economie Régionale et Urbaine* **5**, 805-829.

DGUHC (2003). "Loi Urbanisme & Habitat, Volet urbanism. Service après vote.."

Dura-Guimera, A. (2003). Population deconcentration and social restructuring in Barcelona, a European Mediterranean city. *Cities* **20**, 387-394.

Ellickson, R. C. (1976). Suburban growth controls: An economic and legal analysis. *Yale Lj* **86**, 385.

Fischel, W. (1987). "The economics of zoning laws: A property rights approach to American land use controls," Johns Hopkins Univ Pr.

Fischel, W. A. (2001). The Homevoter Hypothesis: How Home Values Influence Local Government Taxation. *School Finance, and Land-Use Policies* **4**, 81-82.

Fischel, W. A. (2004). An economic history of zoning and a cure for its exclusionary effects. *Urban Studies* **41**, 317-340.

Fujita, M., and Kashiwadani, M. (1989). Testing the efficiency of urban spatial growth: A case study of Tokyo. *Journal of Urban Economics*, 25(2), 156-192.

Fujita, M., and Thisse, J. F. (2003). "Economie des villes et de la localisation," De Boeck Supérieur.

Geniaux G and C. Napoléone (2011). Évaluation des effets des zonages environnementaux sur la croissance urbaine et l'activité agricole. *Economie et Statistique*. (444-445):181–199.

Geniaux G., Ay J.-S. and C. Napoléone (2011). A spatial hedonic approach on land use change anticipations. *Journal of Regional Science*. 51(5):967–986.

Geniaux, G., B. Leroux and C. Napoléone (forthcoming) Les effets prix de l'offre foncière. *Revue d'économie régionale et urbaine*

Glaeser E., Gyourko J. and R. Saks (2006). Urban growth and housing supply. *Journal of Economic Geography*. 6(1):71–89.

Glaeser, E. L., Gyourko, J., and Molloy, R. (2005). Why have housing prices gone up? *American Economis Review* **95**, 329-333.

Howell-Moroney, M. (2004). What Are the Determinants of Open-Space Ballot Measures? An Extension of the Research*. *Social science quarterly* **85**, 169-179.

Ihlanfeldt, K. (2007). The effect of land use regulation on housing and land prices. *Journal of Urban Economics*. 61(3):420–435.

Imbens G, Wooldridge J (2009). Recent developments in the econometrics of program evaluation. *Journal of Economic Literature*. 47(1):5–86.

INSEE (2009). La population légale des communes , 63 235 568 habitants au 1er janvier 2006 *Insee Première* **1217**, 4 p.

Lecat, G (2006). *Analyse économique de la planification urbaine*. PhD thesis, Unciversité de Bourgogne.Dijon, France

Malpezzi S (1996)/ Housing prices, externalities, and regulation in us metropolitan areas. *Journal of Housing Research*. 7:209–242.

McMillen D. and J. McDonald (2002). Land values in a newly zoned city. *Review of Economics and Statistics*. 84(1):62–72.

Mills, D. E. (1981). Growth, speculation and sprawl in a monocentric city. *Journal of Urban Economics* **10**, 201-226.

Naredo ; J.M. (2010). Presión inmobiliaria y destrucción de sistemas agrarios y suelos de calidad. El ejemplo de la Comunidad de Madrid. *Sociedad Española de Historia Agraria* - Documentos de Trabajo, 10(04)

Ohls, J., R. Weisberg, M. White (1974). The effect of zoning on land value. Journal of Urban Economics, 1(4):428-444

Pollakowski, H. and S. Wachter (1990). The effects of land-use constraints on housing prices. *Land Economics*. 66(3):315–324.

Rolleston, B. S. (1987). DETERMINANTS OF RESTRICTIVE SUBURBAN ZONING - AN EMPIRICAL-ANALYSIS. *Journal of Urban Economics* **21**, 1-21.

Rubin D (1973) Matching to remove bias in observational studies. *Biometrics* 159–183.

Saiz, A. (2010) On local housing supply elasticity. *Quarterly Journal of Economics*. 125(3):1253–1296.

Schone, K. (2010). *Strategies d'influences et politiques de maîtrise de la croissance locale*.Ph.D. thesis, Unciversité de Bourgogne.Dijon, France

Scotchmer, S. and J.-F. Thisse (1992). Space and competition. A puzzle. *The of Annals Regional Science*. 26:269-286

Solé-Ollé, A., and Viladecans-Marsal, E. (2012). Lobbying, political competition, and local land supply: Recent evidence from Spain. *Journal of Public Economics* **96**, 10-19.

Tiebout, C. M. (1956). A pure theory of local expenditures. *The journal of political economy* **64**, 416-424.

Tse, R. (2001). Impact of comprehensive development zoning on real estate development in Hong Kong. *Land Use Policy*. 18(4):321–328.

Uhel, R. (2006). Urban Sprawl in Europe: The Ignored Challenge. *EAA Report* **10**, 2006.

Wu, J., and Cho, S.-H. (2007). The effect of local land use regulations on urban development in the Western United States. *Regional Science and Urban Economics* **37**, 69-86.