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"On a Better Understanding of Land Use Regulation, it's Determinants, and it's Relationship With Households' Residential Tenure Condition"

2010-2011 PROJECT FINAL REPORT

FOR THE

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Cynthia Goytia and Ricardo A. Pasquini

UTDT

Abstract

This final report is aimed to briefly present the completed steps of our research agenda during the year 2010-2011, as well as and the forthcoming steps. Our research aims to deepen the understanding of the causes and consequences of land use regulation, using land regulation in Argentina as the case of study. Following the introductory research undertaken in 2009, the project is now deepening its focus on the economics of land regulation, and its causes and consequences. In order to improve our previous empirical research, new sources of data have already been added, including an improvement and extension of the Land Use Regulation and Practices Survey -directed to the planning directors of municipalities all over the country- and the collection of zoning uses maps and satellite images for the development of zoning-use and land cover related metrics. Our next steps comprise the improvement and development of new indicators of the stringency of regulation (e.g., degree of stringency in zoning changes, infrastructure provision, access-to-land policies) and the (spatial) econometric analysis of the characteristics of the jurisdictions that determine regulation as well as the effect of regulation on the development and fragmentation of urban footprints.

Contents

I. Introduction

Land use regulation has both direct and indirect economic effects that extend into many areas of economic life. For example, the interaction of land markets and their regulation should determine access to a wide range of publicly provided goods, the consumption of environmental goods, and even informal land development and the patterns and the incidence of residential segregation.

Empirical studies can shed light on many of those issues. However, comparable data on regulatory measures for land use across jurisdictions is not abundant. Therefore, one relevant issue concerning empirical studies is that with little data (for example, for developing countries), the few theories that have been advanced about its determinants and effects, have not been carefully tested. Even the specialist international research community has still only scratched the surface with respect to the extent and complexity on the generation of land use regulation and its main effects on land markets.

Our research agenda is aimed to improving the available data that will allow explore the mentioned questions, in particular regarding the causes and consequences of land regulations (for residential use), using as case study the municipalities of Argentina. The project also aims to shed light on the understanding of informal urban land markets.

Our current efforts to improve and expand research on land use were primarily focused on the deliberate development of better data. As far as we know these task -that we have already completed (see Goytia and Pasquini 2012 a, 2012 b)- is the most comprehensive effort done for assembling a complete database for the whole set of the main municipalities (either those that form part of the great urban agglomerates and others outside them) in a Latin American country. This database includes either detailed data on land use regulation, quantitative metrics about all land use zoned areas, as well as land cover metrics (i.e., built-up, open space areas, and fragmentation indicators) based on satellite images of jurisdictions in years circa 1990 and 2000. A preliminary descriptive analysis provides some suggestive insights that we mention below in this document. It is expected that, as better data is available, the existing community of scholars will help to develop methods providing more reliable tests of hypotheses about the links between land use regulation, land -and housing development and policies- and general welfare issues.

Our next steps comprise, first, the improvement and development of new regulation and practices indices to measure the stringency of regulation and its enforcement (e.g., degree of stringency in zoning changes, infrastructure provision, access-to-land policies) as well as a standardized regulatory index to facilitate the comparison at the municipal level (also allowing for aggregation to the metropolitan and state levels).

The results of our descriptive analysis show how the restrictiveness of land use regulations varies strongly across jurisdictions in Argentina Goytia and Pasquini (2010 and 2012a). Therefore, it makes it meaningful to look for determinants of the spatial variation of regulation stringency.

Second we will produce an (spatial) econometric analysis of the characteristics of the jurisdictions that determine regulation as well as the effect of regulation on the development and fragmentation of urban footprints. More broadly, the compiled database will support an agenda for future research

in the area of land use regulation, its effects (i.e., on prices, on informal land and housing development, or on sprawl, among others) or the determinants for land use regulatory patterns.

This final report is aimed to briefly discuss the completed steps of the tasks during the year 2010-2011, as well as and the forthcoming steps. In Section II presents the completed steps including the Regulation and Practices Survey to Planning Directors, and the zoning uses and land cover metrics analysis. The background papers (see Goytia and Pasquini 2012 a, 2012 b) can be consulted for further details. Section III discusses our next steps including a plan of the regulation indices development and an empirical framework for the econometric of the determinants of land regulation. In the first appendix we provide a revision of the academic literature on the causes and consequences of land use regulation, where information about theoretical and empirical approaches to the determinants for land use regulation is discussed. The second appendix presents the definition of a series of regulation stringency indicators, which are a methodological basis for the improvement of indicators that will be developed in our forthcoming research.

II. Completed Steps

i. Improving the Availability of Land Use Regulation Information: The New Survey on Regulation and Practices of Residential Land Use

Following an initial survey collected to Land Planning Directors throughout municipalities in Argentina in 2009, we considered the need of improving the research with a new survey based on an improved questionnaire and extending the sample of respondents. The new survey added questions related to issues such as enforcement, and information related to the time occurrence of key changes in land regulation.

The population under analysis was significantly extended, which allows new research possibilities. A first sample of jurisdictions –which was initially surveyed in 2009- was comprised of those municipalities located in the big urban agglomerates was surveyed1. The new survey was additionally targeted to smaller jurisdictions, which although not belonging to big urban agglomerates, are still classified as urban (although many of them incorporate a significant share of rural area).

The new coverage included two additional groups of municipalities: the first one with more than 50.000 inhabitants (a total population of 41 jurisdictions), and a group of jurisdictions between 20.000 to 50.000 inhabitants (of 290 municipalities) In this way, the new version of the Survey has covered almost the complete universe of municipalities with a significant level of land planning.

We distributed the survey across all the targeted municipalities, working in partnership for this purpose with the Secretaría de Asuntos Municipales (Municipal Affairs Secretariat – SAM), Ministerio del Interior de la Nación Argentina. The Secretariat helped us in the generation of the contacts' database including the information of key people in land regulation in each municipality. We contacted the Planning Director in each municipality. Where none existed, we contacted a planning officer, specially designated by the Mayor in each locality to answer the survey.

[1] According to the definition by the National Census and Statistics Institute of Argentina (INDEC). The big urban agglomerates are the usual object of analysis since for those agglomerates the information of the Encuesta Permanente de Hogares (EPH Indec) is available. A population of 120 municipalities is comprised in these urban agglomerates.

In order to minimize non-response, respondents were contacted and followed up mainly by telephone. In order to collect the answers we also built up a web page, which facilitated the task for respondents. In many cases, due to the technical limitations in some municipalities, we have been forced to use the postal service or to send questionnaires or receive answers. The survey was collected from May to September 2011. The survey included the collection of zoning maps, which has also been done according to the technological possibilities of each jurisdiction.

An additional objective of our sample – also in relation to minimizing non-response- was to count with information of all the municipalities that belong to a at least one or two selected urban agglomerates, since we are interested in studying the possible interactions between municipalities in the determination of its regulations. We devoted significant efforts to collect the answers in the biggest urban agglomerate of the country, the Great Buenos Aires region, also from Santa Fe and Cordoba. In the case of many non-respondents, this task has proven to be particularly difficult, since many jurisdictions decided not to answer or reported severe problems to do so.

There is a significant number of suggestive finding that have resulted from a first descriptive analysis of the regulation data that we do entirely discuss here for brevity reasons. Just to mention some of them, for example, in relation to infrastructure extension, municipalities with a relatively higher extent of vacant land (as percentage of total jurisdiction area)- as well as those with relatively less total urbanized area- are found to report a lower infrastructure extension financing from public sources (as percentage of total financing). The requirements of infrastructure provision are also found to be more present in regulation for gated than open urbanizations, and higher in those jurisdictions with their surface in process of urbanization, which might account for the greater incentives to zone for gated communities in these territories, as the bundle of services will be privately financed.

In the case of illegal occupations of land, these are reported to occur in nearly two thirds of the jurisdictions, more probably in those with largest percentage of their surface in process of urbanization. A wide array of measures is followed in those cases including legal, social and managerial procedures reported by half of the municipalities and the endorsement of judicial actions or the use of public force which is followed by a quarter of them.

We ask the reader to refer to Goytia, Pasquini, and Hagedorn (2012a) for further details.

ii. Construction of Zoning Uses Indicators using GIS

In order to understand the regulation of land use, our planned methodology analyses the degree of severity/softness of some regulations, such as for example when comparing the constraints on the intensity of land use, using measures such as for example F.O.T. or the Minimum Size of Lot. But also, the spatial dimension needs to be accounted for, this is, we need to incorporate the extent in which these measures constrain the total area of the jurisdiction.

In order to fulfill this second objective, we collected zoning maps of each of the target jurisdictions and developed a series of metrics that will allow weighting our regulation data. The collection of images was done by contacting the local authorities, and through the Ministry of Government of the Provincia de Buenos Aires. Having obtained the base map of each municipality and corresponding zoning map images (bitmap - BMP), we proceed to geographically refer the zones using GIS (Arc Map software 9.3).

So far, the analysis of zoning uses has provided some interesting insights:

- We find that zoning for residential use accounts for an average of approximately 62% of the non-rural zoned area. There is also great degree of dispersion in residential zoning uses across municipalities, with a standard deviation of between 25% and 27% in the low and medium zoning categories.

- The total residential zoning use is 10% higher in those jurisdictions with most of their territory in process of urbanization than in those jurisdictions with larger share of rural area.The increase in residential areas in jurisdictions is process of urbanization is driven by a significant increase in the medium and mixed zoning category, nearly duplicating the average percentage of those jurisditions with largest share of their territory still rural.

- The zoning for gated communities is on average only 3% of the total non-rural zoning area, although there are a few exceptions were the percentage might climb up to 80% . The highest zoning uses for gated communities are also found between those with their largest share of their territory in process of urbanization.

For more details and a series of descriptive results the reader is asked to consult Goytia and Pasquini (2012b).

iii. Generating Land Cover Metrics, and Measuring Urban Footprints Using Satellite Images

As it is has been mentioned before, the incorporation of land cover based metrics are fundamental pieces in our planned empirical analysis, since they, for example, allow us to proxy for the degree of developed and developable land in a certain jurisdiction, to properly assess for densities

We followed Angel, Civco and Parent (2010), in their methodology for the classification of satellite images pixels and in their construction of land cover metrics. Images for 30 agglomerates - comprising 140 municipal jurisdictions- circa 1990 and 2001 were collected and processed, allowing the analysis of developments occurring during that period.

The process allowed us to obtain metrics of, for example, the extent of built-up surfaces and its composition (distinguishing between urban, suburban and rural built-up), the extent of new developments and its composition (distinguishing between infill, extension and leapfrog developments) as well as a number of built-up fragmentation indicators (i.e., the fragmentation of built-up regions by open space under different scales of analysis). These measures allow rigorous quantitative assessment of urban spatial structure –and its changes over time.

The following results are worth mention

- The built-up surface of a jurisdiction is comprised of built-up in the urban core area of nearly 60%, 38.5% in the sub-urban area, and 10.5% in the rural area.
- The built-up surface in the urban core increases as jurisdictions gather more population, for example, climbing above 70% when the population is between 152,000 and 300,000 inhabitants, and above 85% when the population is above 300,000 inhabitants.
- The average Openness index suggests that close to one half of the one-square-kilometer area in the immediate vicinity of a randomly selected built-up place in a given city is likely to consist of open space. In other words, a typical urban neighborhood consists of approximately equal areas of built surfaces and open fields. A similar value is obtained for the Edge indicator which measures the fragmentation at an individual building (30 by 30 meters) scale. Nonetheless, a standard deviation of 0.2 in the Edge and Openness suggest a significant degree of fragmentation variability across jurisdictions.
- All fragmentation indicators are found to display maximum values (highest probability of adjacency with open space) in the jurisdiction with population between 11,500 and 50,000 inhabitants and then decrease monotonously in jurisdictions with larger population.
- When examining the composition of new developments for the period 1990-2001 we find that most of it is related to *extension*. The average extension percentage accounts for 61% of total new developments. Another 29% is computed as *infill* and the average leapfrog area is 10%.
- There is an homogeneous tendency towards less fragmentation across all the indicators considered and across all jurisdictions. In other words, fragmentation indicators for the year 2011 suggest less fragmentation than in 1990 across all the scales of analysis that were considered and in most jurisdictions.

For more details and a series of descriptive results the reader is asked to consult Goytia and Pasquini, (2012b)

I. Next Steps

i. Generation of Regulation (Stringency/Flexibility) Indices: Improving the Available Indices by Adding New Regulation and Practices data, and Zoning Weighting

Our next step will be focused on the improvement and development of new regulation and practices indices to measure the stringency of regulation and its enforcement (e.g., degree of stringency in zoning changes, infrastructure provision, and access-to-land policies). We will also develop a standardized regulatory index to facilitate the comparison at the municipal level (also allowing for aggregation to the metropolitan and state levels).

In order to examine land regulation our introductory research (Goytia and Pasquini, 2010) pursued the construction of indicators by following the approach of some studies available in the literature for developed markets (such as Gyourko, Saiz, and Summers, 2006). Their approach however, do not fit adequately to the reality of land use in developing countries such as Argentina, so therefore we needed to adapt and construct new indicators that took consideration on issues as relevant as the existence of informal markets and the level of regulation enforcement.[2] Our available information now adds several variables related to these issues. As an example, we focus on the process of infrastructure expansion, on the presence of redistributive and access to land elements in the regulation, and on fiscal policies.

The Appendix II of this document present the methodology for the creation of thematic indicators we employed in the past and will be the basis of the new indicators to be constructed, including: i) Land Use Plan and Regulation Existence Indicator (LPI), ii) Zoning and Residential Projects Approval Processes Indicator (ZRPI), iii) Building Restrictions Indicator (BRI), iv) Infrastructure Provision Indicator (IPI), iv) Access to land Regulation Indicator (ALRI), v) Municipality Fiscal Indicator, and vi) Projects Approval Costs Indicator (ACI).

In particular, in some of our indicators we are now able to incorporate the reported degree of application or enforcement of the specific mechanism that is set in the regulation. This differentiation between regulation and the degree of practice or enforcement is clear for the Planning Directors that answered our Survey.

Second, and in particular in relation to land use and building parameters –which are now available by zoning use category for each of the respondent municipalities-, the recently developed zoning uses GIS-based metrics now allows us to weight these parameters by zoning area, which will provide a more appropriate understanding of the overall degree of stringency of these parameters for the entire (zoned) jurisdiction.

We aim to devote a specific working paper to construct the improved indicators. We expect to use regression and principal components techniques for their construction, provide several robustness checks, a description of the resulting ranking of jurisdictions, and a set of geo-referenced illustrations.

[2] See more on this on the Literate Review Section.

ii. Land use regulation and the characteristics of jurisdictions. Analysis and Methodology

Once we have completed the regulation indices creation phase, we will approach the analysis of the determinants of causes and consequences of regulation. We present here a preliminary methodology to address the question of the determinants of regulation.

A significant issue in order to understand the relationship between land use regulation and tenure informality is an appropriate understanding on the factors that determine (the economics behind) the production of regulation. Using the results from our Regulation and Practices Survey, the available demographic and socioeconomic data, and the geographic and land cover data, we will explore the production of regulation by estimating a (spatial corrected) cross-section econometric model. In particular, the role of segregation, income inequality, and key variables such as the share of vacancy of land, is aimed to be incorporated in the analysis.

The key variables to be explained in the empirical approach are a selection of the regulation indicators that have been defined in the previous section. This means that we will focus on the study of proxies of the stringency of the regulation (such as our Zoning and Residential Projects Approval Indicator, ZRAI or the GIS corrected Building Parameters Indicator) across jurisdictions, and we will also exploit in our analysis specific regulation indicators such as the Infrastructure Provision (IPI).

For example, when incorporating informality into the framework, several issues should be taken into consideration. The existence of vacant land (pvacantland in the equations below) or -as it is measured in our land cover assessment- the existence of open space, for example, are necessary condition for the creation of a new *villa* or *asentamiento* (slum). So to incorporate a measure of the percentage of developable land that is vacant as a control variable is required.

Explanatory Variables and Econometric Specification

Following the theoretical model of Hilber and Robert-Nicoud (2009), we can motivate three variables that should be incorporated in the empirical approach. We now explain the hypothesis behind them, and their empirical implementation.

- *Political Power of Homeowners (proxy by the share of developed land, SDL)*: The hypothesis is that home owners will tend to avoid new developments, and their effect on the regulation that is set will be stronger as stronger is their political power. Using a similar approach to the one of Hilber and Robert Nicoud, we incorporate measures of developed land (as share of total developable land) as proxies of political power of homeowners. In our case, this variable is measured on the basis of satellite and topographic imagery.

$$\text{Political Power of Homeowners} \cong \frac{\text{Developed land}}{\text{Developable land}} = \frac{Footprint\ built-up\ area^{3}}{\text{Total Footprint Area}\ below\ 15\%\ slope^{4})}$$

Notice that by definition the share of land that is not built is vacant. As a second approach we use the estimations of planning professionals on the extent on vacant land.

[3] The City footprint is an area that is defined to capture the core urban and suburban spaces, but also including a smaller surrounding area that is affected by the urbanization (approximately of 100 meters in with). The definitions of urban and suburban areas as well as the other satellite imagery based measurements are available in the appendix.

[4] In our estimations we also use an alternative indicator considering a maximum 30% slope.

- *Ratio of homeownership (RHO):* Also necessary to measure the power of homeowners. It is proxy using Census information, the percentage of households that declare to be owners of the dwelling and land they occupy.

- Population density (PD) should also be incorporated as a control, since it controls for the regulation that is originated to correct externalities that arise from agglomeration.
  The traditional measures of density that are available for Argentina are generated as averages on the basis of ratio of the total population and total departmental (partidos) areas, which limits are well known, but which do not necessarily coincide with the effective limits of the jurisdictions that set out their regulations, This overall administrative area of a municipality is not a particularly good denominator for measuring urban density. First, in the case of municipal jurisdictions in Argentina, their limits are not clear since many provinces set "Ejido " for determining municipal jurisdictions, These limits are not clear, (i.e., it can change by fiat through the incorporation of new areas into its city limits, thus causing density to change overnight). Second, it can be much larger than the built-up area of the city. Using the administrative area will usually under-estimate density (Wolman et al, 2005)
  Hence, in this study, we did not use the administrative areas of municipalities for calculating average density. We are forced to create measures with criteria that are common to all jurisdictions. In this case we take the city footprint measure of area in defining and calculating average density.

$$Population\ Density = \frac{Population^{5}}{Total\ Footprint\ Area}$$

- *Additional Socioeconomic controls*:
  When considering the approach cited above in the context of developing countries, there are differences that should be accounted for. For example, it seems desirable to consider the role of informality into the theoretical and empirical approach –an inexistent phenomenon in developed countries' land markets-. For example, households with informal tenure might influence the political agenda of municipalities only in some cases (e.g., slums generally display an important participation of migrants –both national and international- which might not necessarily participate in the local electoral process). Therefore, additional variables might play a significant role in the definition of regulation. In order to control for the relative wealth of the jurisdiction, we will use some available proxies such as the average number of years of education; the percentage of population with material resources needs, according to a deprivation index (i.e., Índice de Privación Material). Particular attention is put into the incorporation on inequality and urban segregation measures, since they are theoretically linked to the generation of exclusionary regulation. The approach will need to address, in the case of these variables, a possible reverse causation.

Econometric Specification

Summing up, an equation similar to the following one is estimated:

[5] Since 2010 census population results are not available, we use 2001 Census population results. Results will be updated as soon as this data is available.

$$\mathrm{I_j(u)} = \beta_1(\mathrm{u}) * \mathrm{SDL_j} + \beta_2(\mathrm{u}) * \mathrm{RHO_j} + \beta_3(\mathrm{u}) * \mathrm{PD_j} + \sum_{\mathrm{h}} \beta_{\mathrm{h}}(\mathrm{u}) * socioec\_control_j^h$$

Where *I* stands for an indicator measuring the degree of stringency of regulation in jurisdiction *j*, and will be chosen among the indicators that were defined in the previous section. The notation $\beta_{\mathrm{k}}(\mathrm{u})$ indicates that the parameter k describes a relationship around location u and is specific to that location. The model is estimated using a Geographically Weighted Regression[6].

As it is standard for the case of the GWR, the estimator will take the form:

$$\hat{\beta}(\mathrm{u}) = (\mathrm{X}^T W(u) X)^{-1} \mathrm{X}^T W(u) I$$

Where W(u) is a square matrix of weights relative to the position of u in the study area. The W(u) matrix contains the geographical weights in its leading diagonal and 0 in its offdiagonal elements. Notice, in particular that for this case the weights themselves will need to be computed on the basis of a kernel with a flexible bandwidth. In the case of the Argentinean jurisdictions, the sample points are far to be regularly spaced but are somewhat clustered in the study area, so it is desirable to allow the kernel to accommodate this irregularity by increasing its size when the sample points are sparser and decreasing its size when the sample points are denser.

Regulation Externalities of Neighboring Municipalities Extension

Another factor that will be considered is the possible interaction of neighboring municipalities in the definition of regulation. For example, the generation of exclusionary policies towards lower income groups in a certain jurisdiction might externalize the neighbor jurisdictions. This dimension might be particularly important, for example in the case of the analysis of the Access to Land Elements Regulation Indicator (ALRI) or in the case of Infrastructure Provision (IPI)[7]. In particular, when analyzing IPI, coverage of infrastructure variables should also be incorporated as controls[8].

Summing up, a model similar to the following is expected to be estimated:

$$\mathrm{I_j(u)} = \beta_1(\mathrm{u}) * \mathrm{SDL_j} + \beta_2(\mathrm{u}) * \mathrm{RHO_j} + \beta_3(\mathrm{u}) * \mathrm{PD_j} + \sum_{\mathrm{h}} \beta_{\mathrm{h}}(\mathrm{u}) * socioec\_control_j^h + \sum_{\mathrm{h_2}} \beta_{\mathrm{h2}}(\mathrm{u}) * \mathrm{I_j^{h_1}} \qquad (2)$$

The components of the equation have been already explained above, with the exception of the forth term $(\sum_{\mathrm{h_2}} \beta_{\mathrm{h2}}(\mathrm{u}) * \mathrm{I_j^{h_1}}$ which represents the regulation indicators in the h_2 the neighboring jurisdictions and is expected a significant coefficient if there are externalities in place.

[6] Charlton M. and Fortheringham S. (2009)

[7] As mentioned in the Literature References Section, the provision of infrastructure has been considered in the literature as an indirect exclusionary (inclusionary) policy.

[8] These variables will be particularly important in when analyzing the regulation related to infrastructure provision as well as the mechanisms of financing the provision of infrastructure that each municipality has settled.

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Appendix I: Literature Review: Causes and Determinants of Land Use Regulations

What type of jurisdictions adopts particular kinds of land use regulations? This is the question addressed in this section of our study which reviews the academic literature on the determinants of land use regulations.

The rationale for land use regulation falls into three broad categories. The academic literature cites externalities and fiscal purposes as motives for regulating land use, in particular for zoning and development controls[9], as well as a third category exclusionary purpose, added to the fiscal motives. Taking into consideration a welfare economics perspective, the generation of regulation is seen as an optimal solution to market failures, correcting for externalities, especially in the case of densely populated places. Therefore, a powerful economic justification for local governments to regulate land uses lies under the idea that such regulations are designed largely to manage *externalities* which need some mechanism for dispute resolution. So, in countries such as Argentina, a diverse degree of powers are delegated to local governments to regulate land use, while some provinces still manage the overall guiding framework for land use.

In this type of analysis of land use regulations, zoning is the regulatory measure that has been studied the most by the urban economic literature. It regulates the range of uses (commercial, industrial, residential) to be developed in each area as well as the intensity of each use (density or floor-area-ratio). In particular, the aim for zoning is to promote the general welfare by separating land uses in order to mitigate negative external effects (externalities). This means that zoning is aimed to correct for an inefficient market allocation of land when externalities are not internalized.

Associated with this aim, some recent academic studies points out to the confusion of externalities with the exercise of monopoly power by preexisting owners, an issue that need not be intentional or even conscious, where owners of preexisting dwellings will have financial incentives to search very carefully for external effects in urban land use patterns, so that restrictive regulation -reducing the land and housing supply- will appear to be welfare enhancing rather than welfare reducing.(White, 1975, Hamilton,1978, Fischel, 1980 and 1985, Quigley,2007)
Restrictive land use regulation and zoning, which reduces the supply of developable land -or available dwellings- may confer a particular benefit on preexisting owners- as the values of their dwellings increase- which suggests that owners of existing properties (homeowners) might have a monetary interest in restricting growth (Quigley,2007)
Considering that, a second motivation for zoning and growth control is usually identified as a fiscal one. It is generally argued that land use regulation not only has the aim to manage externalities – as a primary rationale for local authorities to regulate land use-, but also land use is considered of primary importance for fiscal motives. The rationale here is that decentralization confers an additional bundle of responsibilities for local economic development and to finance public goods and services which are significantly affected by the patterns of land use. For that reason, municipalities take into consideration the fiscal implications of alternative patterns of development at the same time that regulatory measures are used to influence the size of the local tax-base and the demand for local government services.
This type of development controls or zoning may thus act to exclude certain groups of potential residents such as the poor or minority ones. Therefore, a third motive that is now considered in the literature is the use of zoning and other land use regulations in an exclusionary aim, in order to maintain community homogeneity or eventually keeping out particular population groups. At this

[9] Comprehensive reviews of the literature on local land-use regulations are provided on growth controls (Fischel, 1990), land-use and zoning (Pogodzinski and Sass, 1991), among others

point, while the composition of the tax base is considered, it is the exclusionary aim which prevails. A recent review of the evidence on exclusionary land use regulation for suburban communities in US - has been provided by Inhanfeldt, 2004. In his review, whether a desire to exclude poor households or minorities for reasons unrelated to value preservation or the local fiscal issues, is considered without finding certain evidence. In general, homeowner preservation of value appears as of fundamental importance motivating exclusionary regulations (Inhanfeldt, 2004) The evidence gathered is usually consistent with a fiscal motivation, which reflects both a desire for value preservation (since net fiscal benefits are capitalized into property values) as well as a desire on the part of homeowners to maximize the net benefits they receive from their local government.

This topic is extensively considered from a political economy approach to government regulation, which was originated on several seminal works -such as the one by Downs (1957), later followed by Ellickson (1977), Madison or Fischel, among others. In particular, from the publication of Ellickson's article (1977), a theoretical literature in urban economics has developed in order to explain the underlying motivations of residents, which argued that the tightness of land use regulation is adopted for the benefit of the owners of existing real property in the jurisdiction.

Homeowners are the most sensitive players in local politics, an issue that is not true at the state or national level. Note that land use regulations are largely determined by local planning boards and legislative bodies, whose members are elected by local residents. In view of that, the dominant political economics view suggests that this regulation relates to the aspirations of a majority of voters (Fischel 2001, Ortalo- Magné and Prat 2007, Hilber and Nicaud,2010).

Political economy models provide different explanations for the interest on the local political influence of homeowners in establishing growth controls: such as creation of amenities, restriction of the supply of housing and capitalization or strategic interaction with other local governments. Because homeowners cannot diversify their assets adequately, they are motivated to be "home voters"—which means homeowners whose voting (and other local political activities) are guided by their concerns about home values (Fischel, 2001).

The "collective property rights approach" to zoning and development controls was initially formulated by Fischel (1985), in his book, *The Home-voter Hypothesis*. The prospect of capital gains and losses to home-owners is the most consistent motivator of local government activity, due to the fact that the great part of the residents' wealth is tied up in their homes (Fischel, 2001). Land-use regulation provides municipal voters with the opportunity to establish property-rights in their municipality's location advantages and amenities. Not only external effects are internalized but it also allows for residents to use land use regulation and zoning as devices to maximize the value of their homes. It is in this vain that the home-voter hypothesis has offered in recent years an explanation for local behaviors of land use, where residents risked about neighborhood change.[10] NIMBY's attitudes are not confined to potential environmental hazards, but also may be manifested in opposition to higher-density patterns or low-income housing, which may be occasions for homeowners to use their land-use powers by mobilization or voting.

Recall here that the group of "home-voters " may be homogenous –a prevalence of homeowners or absentee landowners- or can be very heterogeneous – including renters and a great share of informal owners, such as observed in most cities from developing countries.

Models of political influences, in which special interests may define the outcomes, are more likely to prevail as the electorate increases in size and issues become more numerous. For example, Ellickson

[10] In Fischel's view, adopting the home-voter view strengthens the case for viewing the local property tax as a benefit tax.

and Tarlock (1981) reached the conclusion that the land-use agenda is more likely to be 'captured' by development interests in the larger, more heterogeneous jurisdiction, or in large and complex places where many renters live. There is less interest in development controls among low income homeowners located in poorer suburbs (Ellickson ,1977) , or those located in older and declining suburbs (McDonald and McMillen ,2004) The studies from developed countries found that the degree of restrictiveness might be the greatest for small, homogeneous suburban jurisdictions and least for large, heterogeneous cities and very rural areas.

One key issue in this type of analysis is that it assumes municipal voters as being conscious participants in governance, not merely passive receptors of decisions by government officials, an issue that can surely be discussed when taking into consideration issues of asymmetric information. In particular, this view assumes local voters and their elected officials understanding the relationships among zoning, spending, taxation, and property values. (Lenon et. al., 1996).

Finally, when we come to the empirical studies, available evidence is strongly suggestive that 'homevoters' are influential in regulating land use *locally* (e.g. Dehring *et al.* 2008), but less explanatory power in explaining *across metro area* differences in planning restrictiveness.

Review of Empirical studies for the Determinants of Land Use Regulations

One relevant issue concerning empirical studies is how land use regulation (and its restrictiveness) is measured, due to the fact that comparable data on regulatory measures for land use across jurisdictions is not abundant. The empirical studies that evaluate the causes and determinants of land use regulation can be separate into different groups when taking into consideration the type of regulation that is explained, or considering the scope of the analysis (e.g., within metropolitan areas or across metropolitan ones).
Most of these empirical models regress land use indicators on a set of explanatory variables, using isolated regulatory measures or aggregated in overall land use stringency indicators. As a result, there are studies assessing the determinants for a bundle of regulatory measures in the form of a land use tightness index, while other group is focused on explaining the determinants for single regulatory measures, such as minimum lot size (MLS), zoning or development controls.
Land use restrictiveness across MSA in US is usually measured by regulatory indicators, such as *WRLURI,* the Wharton Residential Urban Land Regulation Index created by Gyourko, Saiz, and Summers (2008), constructed to capture the stringency of residential growth controls, or the *SAKS* measure -created by Saks (2008) –which uses the simple average of six independent surveys conducted during the 1970s and the 1980s

Empirical research -roughly categorized for the scale of its analysis – comprises those studies that measure the stringency of regulation across metropolitan areas –and sometimes across states, while others focused on a single state or city. This first group takes advantage of the substantial variation in regulatory regimes across metropolitan areas to provide evidence of the diversity of local housing markets [11]. . Among others, Glaeser and Ward 2009[12],and Hilber and Nicaud, 2010, are two of the

[11] See for example, Glaeser, Gyourko, and Saks, 2006; Green, Malpezzi, and Mayo, 2005; Gyourko, Saiz, and Summers, 2008; Hwang and Quigley, 2006; Linneman et al., 1990; Mayer and Somerville, 2000; Quigley and Raphael, 2005; Quigley, Raphael, and Rosenthal, 2004; and others reviewed in Quigley and Rosenthal, 2005

[12] Using land use regulation data from the Pioneer Institute's Housing Regulation Database for Massachusetts Municipalities in Greater Boston, which was supplemented with data from the Mass GIS system detailing the minimum lot size requirements throughout the state? Permitting and demographic data come from the Census.

most recent studies using the *aggregate* indices – rather than various measures of different types of land use to capture the overall regulatory environment, to run estimations at MSA level. [13]

However, such group of studies neglect within- metropolitan variation in regulatory regimes; and a good example of such a critique is provided by Ihlanfeldt (2007). The other group of studies that inquired on the determinants of land use regulation is focused on data for communities or towns from one state. Studies that examine one or a few jurisdictions, such as early studies by Pollakowski and Wachter (1990) and Green (1999), McDonald and McMillan (2004). not only address but actually take advantage of the richness of within- market variation, but corresponding questions can be raised about their generalizability.

Determinants for land use regulation: externalities, fiscal and exclusionary motives

Most of the studies that provide evidence on the intended purposes of exclusionary regulations are focused on the political economy of regulations, and can be categorized into two broad types. A first group of studies is focused on the motivations behind local jurisdictions' adoption of restrictive land use regulation (Rolleston, 1987; Bates and Santerre, 1994; Pogodzinski and Sass, 1994), reviewed by Inhanfeldt,2004. A second group of studies assessed the characteristics of the jurisdictions or cities that are associated to the adoption of local land use regulations , which provide evidence on the types of cities that are likely to use a particular regulation or that are likely to have more restrictive land-use policies overall, (such as the ones by Lenon *et al*., 1996 for zonning; Baldassare and Wilson,1996 and Brueckner, 1998 for growth controls; Feiock, 2004 and McDonald and McMillan,2004).

For the goal of identifying the specific motivations behind the adoption of regulations, all these studies adopt the same empirical methodology, where a measure of *land use regulation is* regressed on variables that attempt to proxy for each of the different motivations. We have already explained in the previous section the three different potential motivations: the 'externality'aim (desire to mitigate negative externality effects that rise from incompatible land uses), 'fiscal' (the desire of existing residents to maximize the net benefit they receive from the public services/taxes package provided by their local government) and 'exclusionary' motivations (a deliberate desire to exclude lower income and/or minority households from the jurisdiction).

There is certain consensus across the studies based on cities and communities in US, that *fiscal* considerations frequently motivate the more restrictive land use regulations. While the fiscal motive may exclude lower-income and minority households, this would be a byproduct and not the primary objective. The evidence on the *exclusionary* motivations is mixed across the group of studies that are focused on exclusion by income or by race (Inhanfelt,2004).
Some interesting evidence providing support in favor of the exclusionary hypothesis is provided by Bates and Santerre (1994) , finding that higher central- city poverty relative to that of the (suburban) jurisdiction, reduces the percentage of land zoned residential, and by Rolleston (1987) finding that lower percentage minority relative to surrounding communities increases the restrictiveness of residential zoning

One particularity of Rolleston (1987) is that data on communities in New Jersey, US, is used to analyze the determinants of residential zoning restrictiveness on vacant land.). A weighted index of the restrictiveness of residential zoning, is used, which combines Cho and Linneman's separate indexes of residential use and minimum lot size,[14] to measure zoning restrictiveness in residential

[13] See also Gyourko *et al.* (2008) and Saiz (2010) on the merits of using MSA aggregates.

[14] in a way that is analogous to that used by Pollakowski and Wachter (1990) and Cho and Linneman (1993)

use. The index assigns specific weights to the proportion of vacant residential land zoned for particular lot sizes . The restrictiveness index is regressed on externality, fiscal and exclusionary variables.
The externality variable is the population density within residentially developed land areas. The fiscal variables are the proportion of total tax-base derived from non-residential property, local fiscal capacity relative to that in surrounding communities and the percentage change in local fiscal capacity, from 1967–70. Two exclusionary variables are used: the percentage of minorities relative to that of surrounding communities and a measure of local income homogeneity.

Rolleston (1987) concludes that there is enough evidence in these results for both the fiscal zoning and the exclusionary zoning hypotheses. The externality motive is not supported by the results. However, the variable selected -population density- is assumed to be the most rudimentary proxy for the externality motivation, which might be affecting the results.
Fiscal variables are generally statistically significant with the expected signs, which supports the fiscal motivation for zoning. Finally, both variables measuring the exclusionary motivation yield contrasting results. The percentage minority relative to that of surrounding communities is negative and statistically significant, which is consistent with the exclusionary hypothesis. The expectation is that income- homogeneous communities will adopt more restrictive zoning in order to maintain income uniformity. By construction, higher values of the income homogeneity variable represent greater income dispersion within the jurisdiction. However, the estimated significant coefficient has an unexpected positive sign.

Bates and Santerre (1994) estimate two simultaneous equations using 1970 data on 132 towns in Connecticut. The first one of these equations explains the minimum lot size requirement (MLSR) placed on vacant residential land, while the second equation explains the fraction of vacant land zoned for residential purposes (FRL). Bates and Santerre conclude that exclusionary zoning shows up in residential land-use rather than lot size zoning. [15]
In their empirical analysis, the externality motive is supported by the results. It is measured by the share of developed acres in the community currently used for non-residential purposes (used in the FRL equation) and the average size of residential lots in use (entering the MLSR equation).

The results obtained support the existence of a fiscal motivation, as well. Here, the *fiscal motive* is measured by including two variables: the percentage change in the town's population over the prior decade (considering that greater growth imposes increasing public service costs on residents) and non-residential property taxes per capita (considering that residents in a community are likely to zone less land for residential use given relatively high-tax revenue from non-residential areas).

Lastly, the *exclusionary motive* is measured by the ratio of poverty in the nearest central city relative to poverty in the community. The main rationale here is that , for a desire to exclude lower income households to exist, greater relative central-city poverty should be associated with less vacant land allocated to residential use and a larger minimum lot size requirement.

Another study, by Pogodzinski and Sass ,1994, use panel data 1960–90 on communities in California, US to estimate a system of equations that treat local fiscal variables, zoning and the demographic dynamics of these communities as endogenously determined. The relevance of this study is that regulation is treated as an endogenous decision rather than exogenously determined.
The equations have minimum lot size and percentage of land zoned for single-family residential housing as dependent variables. The externality aim is measured by the percentage of dwelling

[15] They found that there was a trade-off between the fraction of vacant land zoned for residential use and the average lot size and that either device can be used to control population.

units that are owner-occupied, which is based on the idea that higher quality housing will be built in larger plots, an issue that should provide spillover benefits to existing homeowners. Finally, fiscal and exclusionary drives are measured using community median household income, while the percentage of the community's population that is non-Hispanic White is used to measure only the exclusionary intention.
In the first model that has minimum lot size as dependent variable, an increase in the percentage owner-occupied decrease -rather than increase- minimum plot size, an issue that is which is antagonistic to the externality aim. Reflecting either the fiscal or exclusionary motive, increases in median household income are found to rise lot size while an increase in percentage non-Hispanic White is not statistically significant, giving less confidence to the exclusionary aim. In the land-use allocation model, higher income is found to reduce the percentage zoned single family residential, while percentage non-Hispanic White has the opposite effect. Hence, the results from both equations provide mixed evidence on the exclusionary motive.

Using a wide group of development controls measures -other than zoning- MacDonald and McMillen,2004, present a factor analysis that describes how the use of particular policy instruments tends to be correlated for the 198 suburban jurisdictions of greater Chicago, in US. These data counts the number of development controls utilized by each city. Factor analysis is used to generate three different factors which reflect: quality development regulations; regulation of lower-class development and growth control. Factor scores for each factor are regressed on characteristics describing each city. [16]

The econometric results show the characteristics of communities that are associated with the different types of regulatory measures. The dependent variables are the three factor scores for the 198 suburbs already explained as well as separate probit analyses computed for each individual regulatory measure. Among the explanatory variables, the location of the community (measured by the distance from the central business district), the population from 1990, median household income and racial composition, the age of the community(indicated by the proportion of housing built before 1940 and from 1980 to 1990) are included in the model. The data-set also includes the overall crime rate in the suburb, proportion of families in poverty in 1990 and the 1990 unemployment rate.

One of the main conclusions from McDonald and McMillan study is that their findings strongly confirm Fischel's hypothesis that suburban development controls are used to benefit homeowners. Another conclusion drawn from their regressions results is that larger suburbs tend to make greater use of nearly all forms of development controls, which suggests that there are economies of scale in the formulation and implementation of regulations. Regression results for each individual regulatory measure show one consistent result in the positive effect of population size on the use of any policy or combination of policies.

The determinants for the propensity to use growth controls is greater, the greater is distance to the CBD and if the suburb is located in the highest-growing county in the metropolitan area in the 1970s and 1980s. This propensity to have growth controls is lower in suburbs with larger minority populations (both Black and Hispanic) and in suburbs with higher crime rates. The size of the community is not a determinant of the propensity to use growth controls.

[16]Factor analysis is a standard technique for reducing the dimensionality of a data-set, by producing composite variables , which we called "factors", that represent patterns of covariance that exist in the original data-set (Harmon, 1976; Kim and Mueller, 1978). It expresses each variable *x* as a linear combination of the *K* common factors plus a unique component *ui*. Here, the K factors define a three-dimensional vector space that is a subset of the original 12-dimensional vector space.

The determinants of the propensity to have regulation of lower-class development are population size , that again enters with a positive coefficient and suburbs with higher crime and lower income.

The propensity to use quality development regulations is positively related to the population size and median household income. The effect of the size of the suburb suggests that larger communities have the greater resources to devote to this type of regulation.

Another set of econometric results presented by the authors analyze the determinants of zoning complexity, using as dependent variable the number of zoning categories - single-family, multifamily, commercial and other land uses. Here, the presumption is that the number of zoning categories that relate to a particular use is an indicator of the level of complexity and detail used to regulate that sector, as small suburbs often have very simple zoning ordinances while zoning complexity is increased with the size of the community.

The first approach to examine the complexity of zoning taking in isolation each of the five types of uses, estimates Poisson models of land-use zoning category counts for each of the five uses. The complexity of zoning in all five categories is strongly a positive function of the population size of the suburb while higher-income communities have more complex zoning for single-family housing units.

The factor analysis of the zoning count data shows that there are associations across uses and that this complexity of the zoning employed is associated with the population size. The results for this exercise lead the authors to suggest that communities decisions on particular combinations of zoning complexity is usually contingent upon the nature of the perceived needs. Jurisdictions with higher incomes and newer housing tend to have a more complex combination of zoning for residential and commercial uses. Communities with more poverty tend to have more elaborate zoning for multifamily apartment and commercial use, probably due to lowering housing costs by multifamily buildings as well as rapid access to commercial establishments.

The whole econometric results also tend to confirm the proposition that suburban development controls are used to benefit home-owners. However, the results are consistent with a broader set of homeowner interests than perhaps has previously been recognized, related to economies of scale in development control policy, which means that smaller suburbs may simply not be able to afford the whole panoply of policies, but also those jurisdictions with lower incomes, larger minority populations and greater poverty rates have an interest in promoting growth rather than reducing growth.

The results points to several interesting issues in the academic literature in the association among regulatory restrictions among municipalities inside and outside a metropolitan area. According to Fischel (2004), land use regulations originate within larger cities and then zoning spreads quickly to the suburbs and surrounding towns as the city grows. Rudel (1989) provides evidence about the timing and restrictiveness of zoning being tied to the distance from the central city while Gyourko *et al.* (2008) find that municipalities within MSAs tend to be more highly regulated than their counterparts outside of MSAs. Another relevant conclusion in this direction comes from a group of studies (reviewed by Baldassare and Wilson ,1996) showing that growth controls are favored when residents feel that their community is being overwhelmed by rapid urban growth in surrounding jurisdictions.

Another empirical contribution, by Hilber and Nicaud,2010 , identify the origins of cross-sectional variation on land use regulation across metropolitan areas in US, rather than in a single MSA area. Following a political economy approach, the *causal* effect of residential development on the overall regulatory restrictiveness at the MSA-level is assessed. Like Glaeser and Ward 2009, the authors use

the *aggregate* indices – rather than various measures of different types of land use to capture the overall regulatory environment. Estimations are run at MSA level. [17]Both *WRLURI* and *SAKS* indexes scaled to have a mean of 0 and a standard deviation of 1 is used.

Land use data from 1992 is used to explore the causal effect of the share developed residential land on regulatory restrictiveness around 2005. The prediction tested is that places that are more developed are more regulated. The study takes into consideration the endogenety of residential development to the regulatory environment, using an exogenous source of variation of urban development to identify its effect on regulation. Two sets of instruments are used: natural amenities and topography. The motivation for using these instruments is based on the notion that desirable locations and those that contain a lot of plains -so average conversion cost are lower- are generally the ones more developed.

The methodological strategy for identification of the effects is based on three complementary explanations of the measure of land use restrictiveness, similar to those that we have already analyzed in the previous section, which are regressed on a nested model of variables that proxy for i) the welfare economics hypothesis , ii) Fischel's 'homevoter' hypothesis iii) the 'influential landowner' hypothesis, running OLS and instrumental variables regressions.

Based on the theoretical underpinnings we have already discussed, the welfare economics explanation for land use suggests that regulation corrects externalities (market failures). So, in this study, population densities in the developed residential area are used as a proxy for the intensity of these market failures. The motivation for doing so is based on urban economic theories predicting that externalities conductive to agglomeration economies -and urban costs- are sensitive to distance and therefore, denser places generate more non-market interactions and pecuniary externalities, which are both conductive to urban growth (e.g. knowledge spillovers, labor market matching) as well as to urban costs (e.g. noise or congestion).

Secondly, the *homevoter hypothesis, which* argues that places with a higher homeownership rate should be more regulated, is also tested while the 'influential landowner' hypothesis (the political influence of owners of developed land relative to the influence of owners of undeveloped land) is captured in the model by the share of developed residential land in an MSA (*SDL)*. This 'developable residential land area' is the total land area minus the surface area that is covered by 'non-developable' land uses.

Additional controls are included to contemplate for other alternative explanations. The share *of Democratic party votes in the State* presidential elections, allows for the fact that regulatory restrictiveness may be driven by political ideology, while average *household wage* controls for the possibility that the findings are driven by income sorting. Finally, *regional dummies* are included to capture for all other region-specific unobservable characteristics.

The preliminary finding is encouraging for the influential landowner hypothesis as only the influential landowner variable has the expected sign and is statistically significant. Turning attention to the controls, MSAs in Democrat-voting states are more regulated, which may reflect that liberal voters is US are ideologically more sympathetic to regulation than conservative voters. This result is robust to the addition of an interaction term -between *share democratic votes* and *average income*-, suggesting that lower and upper income Democrats do not hold significantly different views on regulations. *Region dummies* reveal that broad geographic patterns emerge, with the West being the most regulated region and the Midwest (the omitted category) the least regulated.

[17] See also Gyourko *et al.* (2008) and Saiz (2010) on the merits of using MSA aggregates.

Endogenety issues and IV specifications in empirical models of land use regulation

As we have already explained, the relevance of this study embraces in how endogenety concerns are tackled in the effects identification strategy. In particular, the study considers one important limitation with the OLS estimates for some key explanatory variables if been endogenously determined such as *SDL,* which implies that the estimation of the coefficient for the landowner hypothesis will be downwards biased (in case regulation works as an impediment to development) The issue is addressed by instrumenting for *SDL* by a set of sources of exogenous variations in *SDL* that are not directly correlated with the regulatory measure *WRLURI*. The identification assumption is that places endowed with *desirable amenities and located on plains* are developed earlier, attract more residents over time and, as a result, are more developed.[18] According with Glaeser et al. (2005), who find that the regulatory tax is highest in Manhattan and in the Bay area (exceeding 50% of house values), but no evidence for a regulatory tax in places such as Pittsburgh or Detroit. Hilber and Nicaud (2010), suggest in their model that the most desirable places should indirectly be the most regulated.

The share *of plains, i*s a supply factor, used as an instrument for *SDL, taking* into consideration that it is simpler and cheaper to convert open land into developed land in plains. Finally, one last instrument H*istorical population density in* 1880 captures all the unobserved and time-invariant amenity and cost factors which are not included in the previous set of instruments, It also captures historic amenity and cost factors that were important a long time ago and which started a dynamic development process of cities.
Instrumenting for these variables TSLS estimator, the Limited Information Maximum Likelihood (LIML) estimator or the Jackknife (JIVE) estimator are alternatively used. Their results endorse the presence of a downward bias in the OLS specification and reinforce the influential landowner hypothesis by finding a positive, statistically significant and larger than the OLS coefficient for *SDL.*

Another caveat leads to endogenizing the population density variable. Land use regulation – e.g., minimum lot size restrictions – differentially affect the population density, suggesting reversed causation and biased estimates. Therefore, the *share of plains* in an MSA and historical MSA-level population density from 1880 are used as instruments for density, while regression results are analogous to the previous ones.

Finally, total amount of open land (independent of whether the land is developable or not) in an MSA or the amount of open land in an MSA per capita are used as additional tests for the effect of *SDL* on regulation not to be driven by preferences for open space or conservationist motives. Again, the results provide strong support for the influential landowner hypothesis.
Spatial Data in empirical studies

It is important to remark that available information from satellite images and GIS data are now providing additional sources of information to complement this type of analysis of the determinants of land use regulation. For example, the amount of developable land has been introduced in recent studies in different ways. Saiz (2010), builds a measure of developable land for each MSA and regresses WRLURI on this measure. His findings suggest that cities with a relatively small fraction of

[18] For example, amenity characteristics - *average temperatures in January and a major border with a coastline are used* as instruments for *SDL*- which are related to demand factors (e.g. ceteris paribus, people prefer to live in nice places) and not directly related to regulatory restrictiveness. However, while *January temperatures* should not have a direct and systematic influence on a broad index of residential land use regulations, *valuable ocean coasts* might require some kind of state or federal protection in the form of regulation.

developable land are more regulated. Emphasizing political economy mechanisms, Hilber and Nicaud, 2010, complement this study, by creating a measure of developed land (SDL) that has developable land at the denominator in order to understand how the fraction of land *actually developed* influences regulation.

Sprawl studies have benefited as well for the availability of new data. The issue of amenities is associated to sprawl. Burchfield et al. (2006 find that cities with better natural amenities sprawl more than others – likely because of minimum lot size restrictions that reduce the capital-to-land ratio. Hilber attribute this phenomenon to endogenous land use constraints as locations with more desirable amenities are more developed and more regulated.

The literature reviewed here provides a strong motivation for our study since, given the scarcity of evidence on the issue in developing countries, this type of analysis that focus on the determinants of zoning and other types of land-use regulations are certainly warranted.

Flexibilization of rules and Enforcement

Municipalities adopt rules that also impact new construction. While the bulk of these rules make new development more difficult, some regulation rules—like those that are flexibilized to accommodate more density or FOT—can make it easier to build. Flexibilization of residential development, for example, allow reductions in minimum lot sizes or increasing in Floor to Area Ratio (FAR or FOT, in Spanish) , among others. Because changes in zonings and other increments to land-use restrictions are not much constrained in municipalities where no formal law or plan exists, jurisdictions that have loose normative principles can quickly adopt more flexible or stringent regulations if a desirable or an unwanted project is proposed. Like Glaeser and Ward, 2009, Hilber and Nicoud, 2010 empirical work, use a simple categorical variable that takes on a value of one if the town has passed a rule that goes beyond the current development standards. Later, those categorical variables are summed together for an overall regulatory barriers index (similar to Quigley and Raphael, 2005). In particular, this metric attempts to capture the overall flexibility of the regulatory environment in each jurisdiction, while avoiding the loss of statistical clarity associated with trying to look at the effects of all three regulations simultaneously.

One relevant issue that ought to be considered about regulation is whether what is actually done may vary from what appears to be allowed on the regulatory framework. There are several reasons that motivate this type of concern. First, variances can be granted that waive certain regulations for specific projects, an issue that we are trying to capture in part in our "flexibilization section" of the survey. In this way, lack of a comprehensive plan or code for urban land use, especially in jurisdictions where land use is managed only by the enactment of municipal ordinances, could confer the greatest flexibility for the managing of land use.

Second, what is planned as "allowed" may be made infeasible by the details of the regulations or impracticable, as appeared to be the case for some types of multi-family housing in some jurisdictions from Bs As province. Third, some municipalities enforce "policies" that have not been formally promulgated, and thus are hard to track by researchers, such as the mechanisms for addressing land invasions in each jurisdiction, besides the land regularization programs from the national and provincial level. For example, several jurisdictions work on relocalization or intercede for the acquisition of private land, while others left private disputes to be resolved in the judicial power by private negotiations between those affected. All these processes are not codified in the local law/ordinance and we try to capture them by our survey section focused on norms and practices. Fourth, outdated regulations that are still on the books may not be enforced. Finally, regulations may be ambiguous or vague, so interpretation of the same written language can vary

across municipalities. While most databases on land use regulation are coded according to the official or "on the books" regulations, our survey is intended to capture these type of issues.

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Appendix II: Regulation (Stringency/Flexibility) Indicators: Definition as in the paper Goytia and Pasquini, (2010).

Our indicators are classified according to their main topics:

i. Land Use Plan and Regulation Indicator (LPI)
ii. Zoning and Residential Projects Approval Processes Indicator (ZRPI)
iii. Building Restrictions Indicator (BRI)
iv. Infrastructure Provision Indicator (IPI)
v. Access to land Regulation Indicator (ALRI)
vi. Municipality Fiscal Indicator (MFI)
vii. Projects Approval Costs Indicator (ACI)

Land Use Plan and Regulation Indicator (LPI)

The aim here is to capture the extent in which a plan for the use of land exists and whether it has been formally established in the legal and regulatory framework. At both the provincial and the municipal level, two indicators (provincial and municipal) reflect the existence of land use plans and whether these has been promulgated as laws or decrees (at the provincial level) or as regulations at the municipality level (e.g. *ordenanzas*, urban planning codes). These indicators take the value of one in the case a plan for the use of land exists and it has already been incorporated in the respective legal or regulatory framework; one-half in the case the plan exists but it hasn't been promulgated, and zero otherwise.

$$provincial, municipal = \begin{cases} 1 & \begin{matrix} if \text{ exists and it has already been incorporated} \\ \text{in the respective legal or regulatory framework} \end{matrix} \\ \frac{1}{2} & \text{exists but it hasn't been promulgated} \\ & 0 \; otherwise \end{cases}$$

$$LPI = STD[provincial + municipal]$$

Zoning and Residential Projects Approval Processes Indicator (ZRPI)

This indicator is aimed to capture the involvement of different governmental authorities, and the community organizations in the approval of residential projects. The indicator considers the approval of projects that require zoning changes and those regular projects that do not require zoning separately.

The *Zoning Change Approval Indicator (ZAI)* was adapted from Gyourko, Saiz, and Summers (2006) and reflects the degree of difficulty of a certain project to obtain a zoning change approval. Our survey asked which authorities are involved in zoning change approvals. The listed organizations are: i) The executive power at the municipal or communal level, ii) The Planning Commission, iii) The Zoning Board or Council, iv) The Local (Municipal) Council, v) Provincial level governmental officials, and vi) The Environmental Evaluation Committee. The index adds the value of 1 for each organization involved. Finally, the indicator also adds a value of 1 if residential projects requiring changes in current zoning must be presented, debated or approved in local assemblies (public hearings) or meetings with the community, and equals zero otherwise.

$$ZAI = STD(executive + planningcom + zoningcouncil + localcouncil + provgovofficials + envcomittee + Localassembly)$$

The Regular Project Approval Indicator (RPAI) is analogous to the previous indicator. It considers the authorities involved in the approval of projects which do not require changes in zoning. The authorities considered are: i) Planning Commission, ii) Local Council/ local officials, iii) Environmental Revision, iv) Design Revision Office (e.g. cadastre office) and iv) Other authority reported. The index adds one for each authority involved.

$$RPI = STD(planningcomm + loccouncil + envrevision + designrevision + other)$$

The Zoning Change Approval Indicator (ZAI), and the Regular Project Approval Indicator (RPAI) are combined in a single indicator by averaging the value of both indicators. That is, we give equal weight to the two dimensions of the indicator when we build the Zoning and Residential Projects Approval Processes Indicator (ZRPI):

$$ZRPI = (ZAI + RPI)/2$$

Building Restrictions Indicator (BRI)

The following concepts are related with restrictions in the supply of residential buildings, and then summarized in an aggregate indicator. These are: i) Lot size restriction; ii) Maximum Land Use and iii) Maximum Total Building.

First, our survey asked whether there is a minimum residential lot size restriction, and the size of the requirement in case it exists. The indicator will take a higher value for a larger minimum lot size, indicating a higher restriction to the access to land. The indicator considers minimum size lot restrictions in low and high densities areas separately, and adds both dimensions in the aggregate indicator.

Second, the indicator also incorporates the existence of Maximum Land Use and Maximum Total Building Restrictions, and the perception reported by specialists of these as actually being active restrictions for new residential developments in the jurisdiction.
These restrictions are combined in the Building Restrictions Indicator (BRI) as follows:

$$BRI = STD(STD(lotsize_{high} * dlotsize_{high}) + STD(lotsize_{low} * dlotsize_{low}) + STD(landuseopinion * dmaxlanduse) + STD(totbuildopinion * dmaxtotbuild))$$

Where $dlotsize_{high}$ is a dummy variable that takes the value of one if a minimum lot restriction is incorporated in the municipality regulation, $lotsize_{high}$ is the size of the minimum lot size restriction in high density areas. $dlotsize_{low}$ and $lotsize_{low}$ are the analogous variables for low densities areas. *dmaxlanduse* and *dmaxtotbuild* are dummy variables taking the value of one if a maximum land use restriction or maximum building restrictions are in place. *landuseopinion* and *totbuildopinion* are subjective variables that range from 1 to 5, and take a higher value reflecting the degree in which the respondent believes that these are active restrictions for the supply of residential buildings.

Infrastructure Provision (IPI)

In this indicator we consider how basic infrastructure and public services are provided in sub-urban areas or in areas where these services lack.

We consider two major issues. First, we ask if the municipality has defined an urban perimeter where it guarantees the provision of basic services to new residential developments. We define a sub-indicator that, for those municipalities that have defined a perimeter, adds one for each service that is guaranteed. The "Urban Perimeter Infrastructure Provision (UPIP)" sub-indicator is defined as:

$$UPIP = STD\big(up_{electricity} + up_{sewerage} + up_{water} + up_{gas} + up_{pavement} + up_{sidewalk} + up_{streetlightingposts}\big)$$

Where up_x is a dummy variable that stands for the provision of service *x* within the urban perimeter.

The second issue is how infrastructure is financed in those regions that lack complete access to basic services. We consider here if the municipality and the public services related firms finance the service extension to these areas. If neither the municipality nor the respective public service firm provides finance, then the cost is completely born by the developers or new users. Two sub-indicators (IPMUN and IPPUBSERV) are constructed in other to capture the role of the municipality and the public services firms respectively:

$$IPPUBSERV = STD(pubservfirm_{electricity} + pubservfirm_{sewerage} + pubservfirm_{water} + pubservfirm_{gas} + pubservfirm_{pavement} + pubservfirm_{streetlightingposts})$$

Where $munfin_x$ is a dummy variable that stands for the municipality financing the extension of the service x and $pubservfirm_x$ the analogous for the respective public service firm.

Finally the three sub-indicators are added in the Infrastructure Provision Indicator (IPI). A higher value for this indicator is expected to reflect a more active role of the municipality in the provision of infrastructure.

$$IPI = STD(UPIP + IPMUN + IPPUBSERV)$$

Access to land Regulation Indicator (ALRI)

This is a measure of the presence of redistributive and access to land related elements in the regulation of the use of land. The index adds one for each of the following elements incorporated in the regulation: i) Recovery of the added value (appreciation) of land, ii) Obligatory use of the urban land, iii) Regularization of occupied land (e.g., establishing that occupied land, after a certain period of time, and if there is no opposition, might be regularized in favor of the occupant), iv) Building permits reserve for social projects., v) Obligatory donation of land for social projects, vi) Obligatory donation of land for public equipment (e.g., schools, green areas), vii) Possibility for the municipality to acquire land for social purposes, viii) Fiscal Incentives for zones that are desired to be developed.

$$ALRI = STD(AddedValueRecovery + ObligatoryuseUrbanLand + Regularizationoccupiedland + Socialprojectsreserve + LandDonation + LandDonatioPubEquipment + LandMunicipality + FiscalIncentives)$$

Municipality Fiscal Indicator (MFI)

This indicator is aimed to reflect the power of the municipality in obtaining local resources. The following issues are incorporated: i) The total tax collection per capita, which is aimed to reflect the available economic resources for the municipality, ii) In relation to the effectiveness in tax collection, we will analyze the effective tax revenue as a measure of total tax billing. This measure should reflect the efficiency of the municipality in its taxes collecting function. iii) We incorporate two other measures related to the building registry for fiscal purposes. First, we analyze a subjective dummy variable taking the value of one if respondents consider that the building registry or cadastre (i.e., *catastro*) has been recently updated. Second, an objective measure accounts if updating has been made in the last two years. The mentioned aspects are collected in the Municipality Fiscal Indicator (MFI):

$$MFI = STD(taxcollectioncapability) + STD(taxperhhcapita) + STD(dudpdatedregistry) + STD(drecentudpdated)$$

Projects Approval Costs Indicator (ACI)

This indicator is aimed to reflect costs related to residential projects registration procedures. It considers time and monetary costs.

Approval time (AT) is a measure of the average time the revision of a project takes between presentation and approval. This is a subjective indicator, since there are low chances of respondents having a precise estimation of the average delay. We asked separately the average time for single-unit and multiple-units residential building projects. The AT variable is then defined as the average time for the two procedures.

$$AT = (\frac{ATsingleunits + ATmultipleunits}{2})$$

The survey also asked the monetary value that is charged for a property registration. In practice, many buyers of land or properties do not have formal land tenure because they avoid the costs related with this registration. We will incorporate this cost as a relevant cost in our comparative analysis. A dummy variable will take the value of one in the case the municipality displays a cost of property above a threshold to be determined in the sample (e.g., the 66th percentile in the sample).

$$ACI = STD(AT) + STD(AMC)$$