GOVERNMENT REGULATIONS AND HOUSING MARKETS: AN INDEX TO CHARACTERIZE LOCAL LAND USE REGULATORY ENVIRONMENTS FOR RESIDENTIAL MARKETS IN THE HOUSTON – GALVESTON AREA

A Dissertation

by

LUIS ESTEVEZ JIMENEZ

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2012

Major Subject: Urban and Regional Sciences

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Approved by:

Chair of Committee,	Cecilia Giusti
Committee Members,	Elise M. Bright
	J. Russell Peterson
	Shannon Van Zandt
Head of Department,	Forster Ndubisi

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ABSTRACT

Government Regulations and Housing Markets: An Index to Characterize Local Land Use Regulatory Environments for Residential Markets in the Houston – Galveston Area.

(May 2012)

Luis Estevez Jimenez, B.A., National Autonomous University of Mexico;

M.U. National Autonomous University of Mexico;

M.U.P. Texas A&M University

Chair of Advisory Committee: Dr. Cecilia Giusti

Affordability continues to be a major challenge for housing in America. According to the Joint Center for Housing Studies of Harvard University (JCHS), in 2006, 57 million households were moderately and severely cost burdened in America.

Although high housing prices and the lack of real income growth are cited as the main factors behind the housing affordability problem, it has been proven that land use regulations have some responsibility in this matter as well. Data from the JCHS suggests that between 2002 and 2005, the average appreciation percentage in housing prices was greater in most stringent regulatory environments when compared to less restrictive environments.

Despite this fact, and compared to analyses performed in other states, the relationship between the stringency of local land use regulatory environments and housing has not

been fully addressed in Texas. The methodological approach used to characterize this relationship has been by means of the creation of a composite index measuring the stringency of local regulatory environments.

In response to this lack of evidence of the characteristics of local land use regulatory environments in Texas, this research created the first city-level index characterizing local regulatory environments for housing markets in the Houston-Galveston Area. The index was created taking into account both the different and the most recent practices for the creation of indices.

The index created proved to be a valid and reliable measure capable of taking into account the different aspects of the relationship between land use regulations and housing markets. Correlation procedures allowed the detection of a significant relationship between the stringency of local land use regulatory environments and local traits such as median family income, race distribution, poverty, and median housing values. After alternative indices were developed for a sensitivity and uncertainty analysis, the index proved to be a statistically robust measure against modifications on the different assumptions used for its creation.

Further research could use this new composite index in empirical analysis to look at the statistical effect of regulatory environments on variables such as housing values and rent prices.

NOMENCLATURE

CI	Composite Indicator/ Index
CLA	Cluster Analysis
FA	Factor Analysis
ETJ	Extra Territorial Jurisdiction
EW	Equal Weighting
GA	Geometric Aggregation
H-GA	Houston Galveston Area
H-GAC	Houston Galveston Area Council
KMO	Kaiser-Meyer-Olkin Measure
LURE	Land Use Regulatory Environment
LA	Linear Aggregation
MCMC	Markov Chain Monte Carlo Method
MI	Multiple Imputation
MMA	Multi-modeling Approach
MSA	Metropolitan Statistical Area
PCA	Principal Component Analysis

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1. INTRODUCTION

1.1. Statement of the problem

The number of households having to pay more than 30 percent of their income in housing and rental costs has increased alarmingly in the last few years. According to The State of the Nation's Housing report from the Joint Center for Housing Studies of Harvard University (JCHS2008), in 2006, 39 million households were moderately cost burdened in America (investing more than 30 percent of their income on housing costs) and nearly 18 million were severely cost burdened (investing more than 50 percent). Between 2001 and 2006, the number of burdened cases alone rose by almost four million.

Although high housing prices and the lack of real income growth are cited as the main factors behind the housing affordability problem, some studies suggest that stringent land use regulatory environments (here after referred to as LUREs) exacerbate the problem of affordable housing (Quigley and Rosenthal 2005).

Data from the JCHS (2008) suggest that between 2002 and 2005, the average appreciation percentage in housing prices was greater (45 percent) in most stringent regulatory environments when compared to less restrictive environments (24 percent).

This dissertation follows the style of *Urban Studies.*

The JCHS recognizes that despite having higher average incomes, Metropolitan Statistical Areas (MSAs) with more stringent regulatory environments have a greater incidence of severe housing cost burden.

Even though the problem of land use regulations and their effect on housing affordability is clearer in MSAs with stringent regulatory environments, this does not mean that it is not present in other less apparent regulatory stringent MSAs. Additionally, even if the effect is not clear in terms of affordable housing, other related problems such as exclusion and segregation could be strongly related to the type of land and development regulations in place (Quigley and Rosenthal 2005).

1.2. Previous studies and limitations

This high incidence of affordability problems in MSAs has caused extensive interest in evaluating the relationship between affordable housing and the role of LUREs (Knaap 1998). The literature and empirical studies about the effect of land use regulations on housing markets is abundant. However, most of these studies are limited to the analysis of the effect of one specific regulation (e.g. growth boundaries, impact fees) in place at the local or metropolitan level (Quigley and Rosenthal 2005). Few studies look at the totality of LUREs and their effect on housing markets.

The attempt to study the overall effect of LUREs on housing markets is complex. Most of the studies attempting to measure the effect of the stringency of LUREs on housing markets have relied on the creation of a composite index that could capture the different

dimensions explaining this effect. Nonetheless, any effort to create such an index requires as a preceding step taking into account all regulations that could be present in local jurisdictions. Nonetheless, any effort to create such an index first requires that all regulations that could be present in local jurisdictions be taken into account. Thus, the first challenge that these studies had to overcome was to obtain a complete inventory of land use regulations in each jurisdiction. The effort to create a composite index characterizing LUREs had to rely on either inventories created by the same studies or to rely on other studies that focused solely on the creation of such inventories.

Notable efforts in administering surveys to obtain data on local land use regulations have been conducted by authors and institutions such as Linneman and Summers (1990); Pendall, Puentes et al. (2006); Gyourko, Saiz et al. (2008); Glickfeld et al. (1992); Lewis and Neiman (2000); The Pioneer and Rappaport Institute (Dain 2006), and Ihlanfeldt (2007).

An significant drawback of these surveys is that they have been conducted in LUREs known to be stringent (e.g. California, Florida, Massachusetts) which raises questions about the possible generalization of such results (Malpezzi 2009). And when the surveys involved exercises which evaluated the MSAs on a national level (e.g. Gyourko, Saiz et al. 2008), they lacked a sufficient number of observations in certain areas making it impossible to make detailed analyses of these cases (some studies reported having information of only 8% of local jurisdictions defining a MSA). Another disadvantage of the lack of studies focusing on other not so known stringent LUREs is

that the characterization of other environments is denied or put aside, and as a result no possible comparison can be made (Green 2009).

Texas is among the states whose metropolitan areas have been considered as not so stringent in terms of its LUREs (Pendall, Puentes et al. 2006; Gyourko, Saiz et al. 2008). Empirical analysis looking at the overall role of local LUREs has not been fully addressed at the MSA level in Texas, thus, little is known about their impact on housing supply and, as a consequence, on housing affordability.

Few empirical studies have evaluated the effect of land use regulations in the Houston MSA. Peiser (1981) developed a comparative study of the effect of land development regulations on developments costs. In comparing the cities of Dallas and Houston, he found that development in Dallas is more costly than in Houston. Speyrer (1989) analyzed the effects of zoning and restrictive covenants on single-family housing prices in and around Houston. An important finding in her empirical analysis is that premiums paid for zoning and restrictive covenants do not differ significantly. Most recently, Groves and Helland's (2002) empirical analysis evaluated the transfer of wealth between owners resulting from the enactment of the municipal zoning ordinance in Baytown, the first city of Harris County to pass a zoning ordinance. They found that zoning increases the value of properties best suited for residential use.

The design of an index is complex, and methodological flaws in these types of analyses have raised questions regarding the procedures, validity and transparency in the creation and publication of such indices (Nardo, Saisana et al. 2005). Results of analyses of

indices which have been published in referred journals have proven that those reports frequently have important methodological flaws (Coste, Fermanian et al. 1995). The neglect of some properties such as measurement level, content and construct validity and reliability are some of these identified flaws. The creation of indices in the planning area is not exempt from the same h methodological issues. In an interesting research creating an index of regional containment, Bright (2005) also found some flaws in these called sprawl indices.

1.3. Hypothesis, goals and methodology

Based on previous studies and the limitations which have been observed, the main question driving this research is:

Can an index of land use regulatory stringency be a valid measure to characterize regulatory environments for housing markets in other geographies with different land use regulations and housing market conditions?

In an attempt to answer the research question, primary and secondary hypotheses were derived:

Main Hypothesis: The stringency of local LUREs for housing markets can be properly characterized by a composite index.

Secondary Hypothesis: The created index will be statistically robust so as provide flexibility in its assumptions as a result of the different procedures used for its creation.

Specific goals and methods were implemented in this research to test the hypotheses. The first three goals were aimed at testing the main hypothesis and the fourth at testing the secondary hypothesis. Below are the specific descriptions:

1. To design and implement an instrument to create an inventory of land use regulations across local jurisdictions in the Houston–Galveston Area (here after H-GA, see Figure 1 for study area)[1]. In order to validate the created index, the instrument (here after called the LURE Survey) was designed to be as similar as possible to the instruments implemented in other studies which also created inventories (especially the surveys of Gyourko, Saiz et al. (2008) and Pendall, Puentes et al. (2006)).
2. To create an index that reflects the different LUREs in the H-GA. A composite index (here after called the LURE Index) has been created following the latest methodological procedures used in psychometric and measurement theory as well as in other fields (Nardo, Saisana et al. 2005).
3. To validate the created index. The LURE Index was validated by statistical correlations with other indicators. Indicators of variables such as median housing values, race distribution, poverty, and median family income were correlated with the LURE Index.

[1] This H-GA is defined by the 13 counties being part of the Houston-Galveston Area Council (H-GAC). This area was chosen over the Houston-Sugar Land-Baytown MSA (conformed by 10 counties) defined by the Office of Management and Budget, December 2006. Source: U.S. Census Bureau (2009) http://www.census.gov/population/www/estimates/metrodef.html (obtained: 9/12/2009). The reason for this was that the H-GAC is defined for more counties.

4. To assess the statistical robustness of the LURE Index. The statistical soundness of the created index was assessed by means of performing an uncertainty and sensitivity analysis. Specifically, 51 alternative scenarios (indices) were created varying the assumptions of the LURE Index.

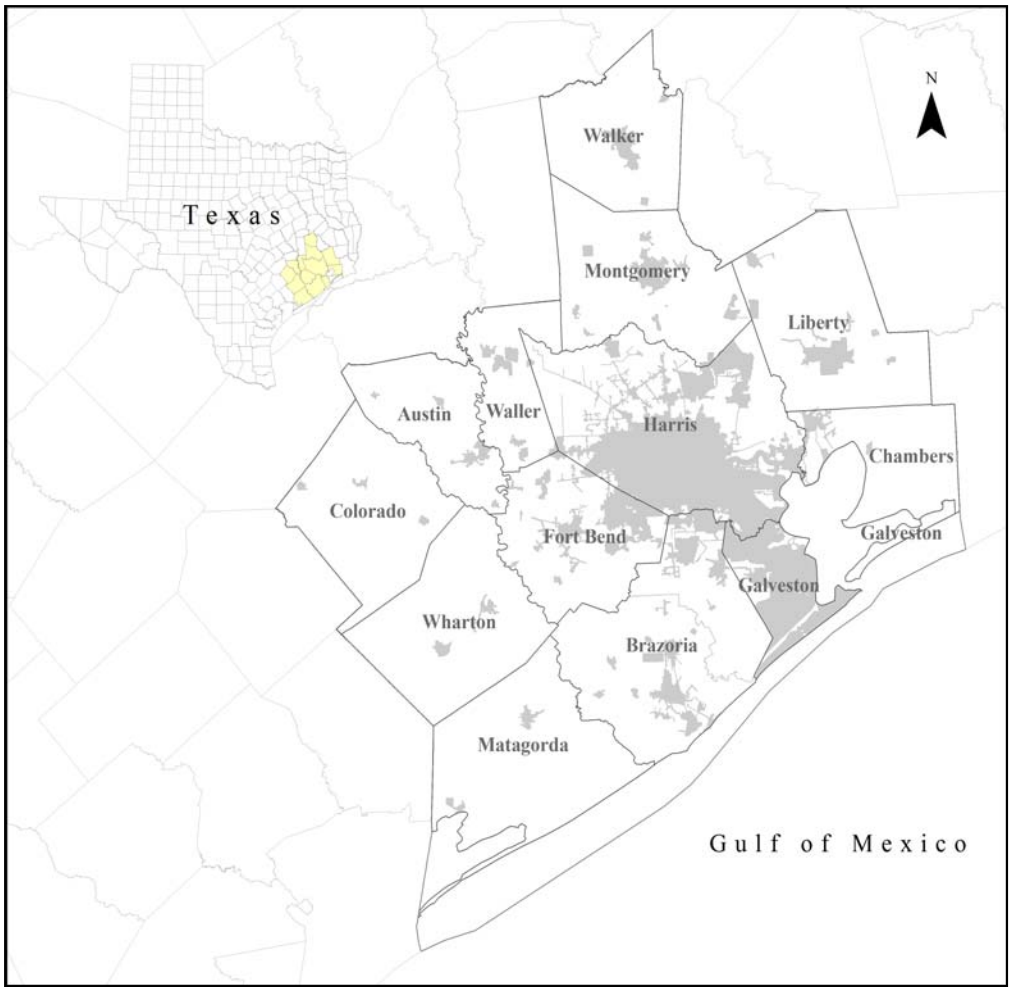

Figure 1 Houston—Galveston Area and its 13 Counties

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

In order to achieve the goals of validating an index as a measure capable of capturing the different dimensions relating land use regulations and housing markets, the review of literature for this research focused specifically on studies which designed and implemented instruments to register land use regulations in different housing markets and on studies which created composite indices based on data gathered by such instruments. The purpose of this approach was to design and implement an instrument which in turn provided the data needed to create an index with similar characteristics to indexes created in the past.

2.1. The role of land use regulations in the supply and demand model of housing

Land use planning, through the implementation of land use regulations, is based on the allocation of a scarce resource for different uses. Cheshire and Sheppard (2005) mention that although land use planning has historically operated in a specialized arena on its own, its role has fundamental implications for both price and economic competitiveness in terms of supply and demand.

Government regulations are aimed at intervening in markets in order to ensure a fair equilibrium between producers and consumers. From an economic perspective, when markets do not send the correct information to both producers and consumers, in order to maintain an equilibrium (clearance price), market failures are noted. It is in these situations that government interventions, through regulations, are necessary in order to assure a fair context for markets (Pindyck and Rubinfeld 2008). The problem with

regulations arises when these fail to provide that necessary equilibrium and either one of the two sides of the economic model (supply and demand) are affected.

Housing is considered a location-commodity, and as such, is subject to market conditions similar to any other commodity. Authors such as Glaeser and Gyourko (2006) have been able to show how the price and availability of housing operates in a supply and demand model. Figure 2 shows such a model explaining the effect of land use regulations on price and the production of housing. The following is a hypothetical description on how this classical model works when land use regulations are having an effect on the supply of housing.

In this model, land use regulations act by altering the price elasticity of supply. Land use regulations can have an effect in two ways (Henderson 2007). The first considers land use regulations affecting (constraining) the supply elasticity. This case may apply to regulations that directly affect the production costs of housing such as height restrictions, quality standards, processing times, among others. In this first model the initial demand situation is D_0. When demand shifts out to D_1, a no-regulation community has the "elastic supply" curve while a regulation community has the inelastic supply curve with a much higher price response and a much lower quantity response to the demand shock.

The second way of modeling the effect is to estimate the pure supply elasticity for the elastic supply curve and treat regulations as items that shift the supply curve up. This is shown by the dashed line. This second way of modeling would apply to development fixed fees that only shift prices up without affecting the input costs of production.

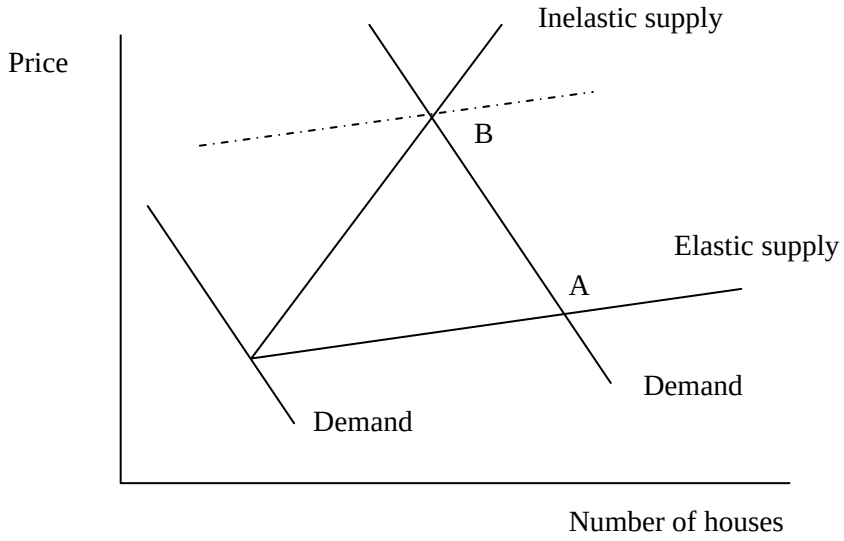

Figure 2 Modeling the Effect of Land Use Regulations on Price and Supply
Source: (Henderson 2007).

After analyzing this model a natural question was: what has been proven about the impact of land use regulations on the supply of housing by using these models? Some argue that land use regulations have a direct effect in the price and availability of housing (Quigley and Rosenthal 2005). Others point out the possibility that sometimes price increases could just reflect natural scarcity of land, scarcity which in turn could be also created by regulations (Henderson 2007). The possibility that land use regulations could also be behind this scarcity has encouraged a body of literature testing this hypothesis and proving that stringent land use regulations do indeed have an impact on housing supply and that it is not just a matter of scarcity (Ellickson 1977; Brueckner 1990; Glaeser, Gyourko et al. 2005; Glaeser and Ward 2009).

2.2. Operational relationship between land use regulations and housing supply

Figure 3 shows an analytical model developed to depict the overall possible interactions between land use regulations and urban aspects such as housing supply, housing affordability, land, etc. Specifically related to the purpose of this research, the model shows how land use regulations can have an impact on the availability of affordable housing in two ways: 1) by having an indirect effect on the cost of housing and rent; and b) by directly inhibiting the production of affordable housing (e.g. exclusionary housing in this case). Based on this analytical model, this research assumes that housing supply could act as a mediator variable and housing affordability as the criterion variable.

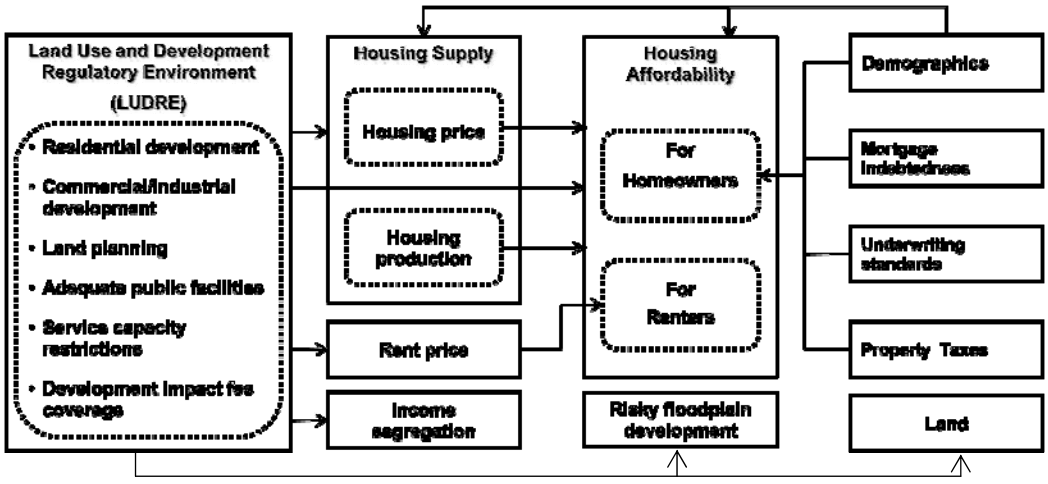

Figure 3 Analytical Model of Land Use and Regulations and Housing Supply

Source: Elaborated by author.

2.3. Index definition

Composite indicator, composite indices, index, performance indicator, performance index, composite measure, and rating scale are a few of the different terms frequently used to describe a measure that expresses the final rating based on a measure created by either using a single (e.g. Under Five Mortality Rank: U5MR[2]) or multiple items or attributes (e.g. Environmental Sustainability Index[3] or Human Development Index[4]).

For the purposes of this research, and because of similar approaches and methodologies used in comparable exercises and fields, the terms Composite Indicator (CI) and Index (I) are alternatively used to describe the measurement used to characterize multi-dimensional phenomena.

Complex phenomena such as health status, quality of life, educational achievement, climate for foreign investment are just some of those multi-dimensional concepts in which the role of indexes are very useful. Clinicians (Spitzer, Dobson et al. 1981) and psychosocial scientists (Bergner, Bobbitt et al. 1981) have probably been the pioneers in creating indexes to express complex phenomena (Hulka, Zyzanski et al. 1970; Meenan, Gertman et al. 1982).

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[2] UNICEF. Various years. *State of the World's Children.* New York: UNICEF. http://www.unicef.org/sowc/

[3] Yale Center for Environmental Law and Policy and Center for International Earth Science Information Network. 2005. "2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship" http://www.yale.edu/esi/

[4] UNDP. Various years. *Human Development Report*. New York: Oxford University Press. http://hdr.undp.org/en/

CIs or Indexes are commonly found in the economic, social, health and policy fields (Freudenberg 2003). The uniqueness of having a measure to characterize multidimensional phenomena makes them a useful tool. Some of the ways in which these fields make use of indexes is to create a ranking using this measure and then to measure performance or to rank countries or institutions. For instance, up until 2008 there were 178 CIs ranking country performances based on an economic, political, social or environmental measure (Bandura 2008).

2.3.1. Some basic definitions

For the sake of clarity, the basic definitions provided have been adapted to the context of composite indicators by borrowing concepts from multi-criteria decision theory and complex system theory. These definitions are taken entirely from the work of Munda and Nardo (Munda and Nardo 2009).

> **Dimension**: is the highest hierarchical level of analysis and indicates the scope of objectives, individual indicators and variables. For example, a sustainability composite indicator can include economic, social, environmental and institutional dimensions.
>
> **Individual indicator**: is the basis for evaluation in relation to a given objective (any objective may imply a number of different individual indicators). It is a function that associates each single jurisdiction with a variable indicating its desirability according to expected consequences related to the same objective.

Variable: is a constructed measure stemming from a process that represents, at a given point in space and time, a shared perception of a real-world state of affairs consistent with a given individual indicator. For example, an objective connected with the social dimension might be “maximization of residential attractiveness”. A possible individual indicator could then be “residential density”. The variable providing the individual indicator score might be the ratio of persons per hectare.

A **composite indicator** or synthetic index is an aggregate of all dimensions, objectives, individual indicators and variables used. This implies that what formally defines a composite indicator is the set of properties underlying its aggregation convention

2.3.2. Pros and cons of indices

Indexes are popular because of their capacity to characterize complex phenomena. The multidimensional aspects of some constructs make them difficult to grasp at first glance, so indexes are useful in providing a single measure to capture the totality of such phenomena (Nunnally 1978).

In the economic and policy fields, indexes are regarded as useful in providing experts, stakeholders and decision-makers with (Saisana and Tarantola 2002):

- The direction of developments
- Comparison across places, situations and countries
- Assessment of state and trends in relation to goals and targets

- Early warning
- Identification of areas for action
- Anticipation of future conditions and trends
- A communication channel for general public and decision-makers

Probably (Saisana and Tarantola 2002) best summarize the pros of composite indices as:

- Composite indicators can be used to **s**ummarize complex or multi-dimensional issues, in view of supporting decision-makers.
- Composite indicators provide the big picture. They can be easier to interpret than trying to find a trend in many separate indicators. They facilitate the task of ranking countries on complex issues.
- Composite indicators can help in attracting public interest by providing a summary figure with which to compare the performance across countries and their progress over time.
- Composite indicators could help to reduce the size of a list of indicators or to include more information within the existing size limit

Despite the increasing use of indexes in different fields and the increasing number of created indexes, they are surrounded by controversy. The implications of their use and methodological flaws when created are the main aspects of controversy. Among the cons cited are:

- Composite indicators may send misleading, non-robust policy messages if they are poorly constructed or misinterpreted. Sensitivity analysis can be used to test composite indicators for robustness.
- The simple *big picture* results which composite indicators show may invite politicians to draw simplistic policy conclusions. Composite indicators should be used in combination with the sub-indicators to draw sophisticated policy conclusions.
- The construction of composite indicators involves stages where judgments have to be made: the selection of sub-indicators, choice of model, weighting indicators and treatment of missing values, etc. These judgments should be transparent and based on sound statistical principles.

- The composite indicators increase the quantity of data needed because data are required for all the sub-indicators and for a statistically significant analysis.

2.4. Literature on related LUREs indices and inventories

A fundamental part of the construction of a statistically sound and consistent index is the appropriate definitions of dimensions that the index is intended to measure. Literature review and the opinion of experts and stakeholders are essential in order to select the appropriate framework with variables that could fulfill the required dimensions.

The review of the literature pursued the specific objectives of generating the appropriate framework in order to: 1) design and implement an instrument to create an inventory of land use regulations in the H-GA; and 2) use the inventory in the creation of the LURE index.

The literature review provided: 1) a general array and classification of different variables related to land use regulations; 2) a detailed review of the studies creating inventories of land use regulations and studies creating LURE indices; and 3) a preliminary list of candidate variables that was used in the design of the LURE Survey and the creation of the LURE Index.

Regulations could be broadly divided according to the existing literature: 1) building codes, 2) environmental laws, 3) land use regulations, 4) impact fees and 5) government procedures (Schill 2005). After reviewing the specific literature of the effect of land use regulations on housing prices, Quigley and Rosenthal (2005) developed a classification of land use regulations (see Table 1) based on a study done by Levine (1999).

Table 1 Land Use Regulatory Categories

Residential development	Building permit cap
	Population cap
	Floor area ratio limit
	Downzoning to open space/agricultural use
	Reduction in permitted residential density Referendum for Density increase
	Supermajority in legislative body for density increase
Commercial/industrial development	Square footage cap (commercial)
	Square footage cap (industrial)
	Rezoning to lower intensity height reduction
Land planning	Growth management element
	Moratoria Urban growth boundary
	Tiered development
	Subdivision cap
	Other growth control
Adequate public facilities (APF)	Roads
	Highways
	Mass transit
	Parking
	Water supply
	Water distribution
	Water purification
	Sewer collection
	Sewer treatment
	Flood control
	Other APF measures
Service capacity restrictions	Roads
	Water supply
	Water distribution
	Wastewater collection/treatment capacity
	Wastewater treatment quality
	Flood control
Development impact fee coverage	Administration
	Traffic mitigation
	Mass transit
	Parking
	Water:
	Service
	Treatment
	Sewer
	Flood control
	Parks/open space
	Natural resources
	Schools Libraries and arts
	Other development fees

Source: Quigley and Rosenthal (2005)

The creation of LURE Indices has relied on inventories of land use regulations from which candidate variables have been selected. Table 2 summarizes the main characteristics of selected studies reviewed in this research. Most of the indices were either created based on already existing databases of land use regulations (Malpezzi 1996; Somerville 1999; Quigley and Raphael 2005; Glaeser and Ward 2009) or from creating an inventory of land use regulations first and then crafting an index. (Black and Hoben 1985; Segal and Srinivasan 1985; Pendall, Puentes et al. 2006; Ihlanfeldt 2007; Gyourko, Saiz et al. 2008).

Of all the inventories which were reviewed, the ones of the Wharton Urban Decentralization Project (Linneman, Summers et al. 1990) and Glickfeld and Levine (1992) probably have been applied the most frequently by other studies in the creation of indices. Other inventories used were those from institutions such as the American Institute of Planners (AIP 1976), the National Multi Housing Council (NMHC 1982), the Urban Land Institute 1980-81 (Black and Hoben 1985), the US Department of Housing and Urban Development (HUD 1991), Lewis and Neiman (2000) and the Pioneer Institute for Public Policy Research and Harvard's Rappaport Institute for Greater Boston (Glaeser and Ward 2009).

The geographical coverage of each of these studies was different. Some were defined on a national level and the surveys were sent to either all municipalities in the U.S. (Linneman, Summers et al. 1990; Gyourko, Saiz et al. 2008) or were limited to local governments in specific MSAs (Black and Hoben 1985; Segal and Srinivasan 1985;

Pendall, Puentes et al. 2006). Others surveyed jurisdictions at the state level (Glickfeld and Levine 1992; Lewis and Neiman 2000; Ihlanfeldt 2007).

The goals for creating an index were different in every study. Some were investigating the effect of regulations on: a) land prices, housing, and rent costs (Black and Hoben 1985; Segal and Srinivasan 1985; Malpezzi 1996; Ihlanfeldt 2007); b) concentration of homebuilders (Somerville 1999); and c) supply and price (and rent) of housing (Quigley and Raphael 2005). In other cases, the goal was to create an index in order to characterize regulatory environments based on their stringency (Pendall, Puentes et al. 2006; Gyourko, Saiz et al. 2008).

Some studies were particularly interested in creating an index which took into account a certain amount of specific regulations such as growth control measures, minimum lot sizes, etc. (e.g. Malpezzi 1996; Glaeser and Ward 2009), while others were interested in creating an index that would reflect the overall LURE (Pendall, Puentes et al. 2006; Gyourko, Saiz et al. 2008).

Studies creating an inventory of land use regulations have relied on the implementation of a survey directed (in a majority of the cases) towards the jurisdiction's planning staff. (Black and Hoben 1985; Linneman, Summers et al. 1990; Glickfeld and Levine 1992; Lewis and Neiman 2000; Dain 2006; Pendall, Puentes et al. 2006; Ihlanfeldt 2007; Gyourko, Saiz et al. 2008).

2.4.1. Methodological aspects

In terms of the specific methodology in the creation of indices, studies have relied on the simple addition method (linear arithmetic addition) for aggregation and either equal or factor analysis approaches for weighting. In relation to the latter two options, some studies claimed not to find significant differences in their results when using either one of these methods (e.g. Gyourko, Saiz et al. 2008).

Among all these studies, the one done by Gyourko and Saiz (2008) deserves special mention. This study offered very detailed information regarding the methodological process used in creating their index. Details such as normalization, aggregation, weighting and imputation procedures were explained.

In all these studies, special attention was given to the length of the surveys implemented for the creation of inventories of regulation, units of analysis, specific regulatory measures surveyed, data sources, and methodologies used for the creation of their indices. Table 2 provides a detailed depiction of each one of these aspects reviewed in these studies.

Table 2 Selected Studies Measuring Land Use and Development Regulations

Author(s) year/ goals/ comments	**Unit of analysis/ Regulatory measure**	**Data source**	**Methodology for index creation and variables used**
Black and Hoben (1985) Goal: The effect of regulations on land prices Comments: The respondents were not randomly selected	30 MSAs Rating of regulatory restriction	Survey to 11 national experts	Simple rating +5 to -5 (most open to limited growth) - Most open (pro-growth areas): Having few restrictions on development Policies supportive of public or private expansion of infrastructure - Limited growth: Long development approval procedures Limited public provision of infrastructure High development fees Active programs to protect open space and agricultural lands
Segal and Srinivasan (1985) Goal: to use the variable as a supply factor to estimate a simultaneous equation models of housing price inflation. Comments: No details about calculations, neither raw data from the interviews.	51 MSAs Suburban restriction growth variable	Interviews with Regional Councils of Governments' staff, regional and local planning agencies	Use of average percentage of developable suburban land removed from growth by regulations. The values ranged from 0 (about a third of the areas) to 43.5 (Sacramento) Considering growth controls the use of: water, sewer and gas moratoria, public acquisition of open-space, building permit restriction and zoning.

Table 2 Continued

Author(s) year/ goals/ comments	**Unit of analysis/ Regulatory measure**	**Data source**	**Methodology for index creation and variables used**
Malpezzi (1996) Goal: Analyze the effect of regulations in land and housing price and rent costs. Comments: Does not mention other important studies like the one done by Glickfeld and Levine (1992)	56 MSAs City-specific regulatory index State regulatory index Rent control dummy	Wharton Urban Decentralization Project (WUDP) (Linneman 1990)	Three regulatory variables: Simple additive index (although PCA[a] was also performed) For city-index seven variables collected by WUDP State-level index based in a survey implemented by the American Institute of Planners (AIP 1976) Rent control dummy based on National Multi Housing Council (1982) and HUD (1991) reports.
Somerville (1999) Goal: Effect of regulations on the size and concentration of homebuilder establishments Comments: Clear specification of how regulation variables were used.	33 MSAs (concentration analysis) 57 MSAs (construction data)	WUDP	Time (months) to obtain rezoning approvals and building permits (conversion of categorical variable from WUDP) A count of the number of ways growth management techniques (five) are introduced; (sum of dummy variables)

Table 2 Continued

Author(s) year/ goals/ comments	**Unit of analysis/ Regulatory measure**	**Data source**	**Methodology for index creation and variables used**
Quigley and Raphael (2005) Goal: Effect of regulations on the supply and price (and rent) of housing Comment: Detailed specifications.	407 California cities Index of regulatory stringency	Survey of California land use officials (Glickfeld and Levine 1992)	Index created by simple addition Regulatory stringency was established by the number of growth control measures adopted by each city. 15 growth control measures: - Restricting residential building permits in a given time frame - Limiting population growth in a given time frame - Requiring adequate service levels for residential development - Rezoning residential land to agriculture or open space - Reducing permitted density by general plan or rezoning - Requiring voter approval for residential up-zoning - Requiring super majority council vote for residential up-zoning - Requiring adequate service level for approval of commercial /industrial development - Restricting commercial square footage that can be build within a given time frame - Restricting industrial square footage that can be built within given time frame - Rezoning commercial/industrial land to less intense use - Reducing permitted height of commercial/office buildings - Adopted growth management element in general plan - Establishing urban limit line - Other measures to control development.

Table 2 Continued

Author(s) year/ goals/ comments	**Unit of analysis/ Regulatory measure**	**Data source**	**Methodology for index creation and variables used**
Ihlanfeldt (2007) Goal: Effect of regulation restrictiveness on house and vacant land prices. Comments: Similar index to that of Quigley and Raphael (2005)	327 Florida jurisdictions (cities and unincorporated areas) Index of restrictiveness	Survey administered by the DeVoe Moore Center at Florida State University	Index created by summing up the number of individual restrictiveness measures used by the jurisdiction (simple addition) Use of two jurisdictional variables: 1) chief planner's perception of school crowding (rating 5-point scale); and 2) jurisdiction's form of government (council-manager or mayor-council). Index of restrictiveness based in 13 land use management techniques: - Farm preservation policies - Development impact fees - Large lot zoning - Open space zoning - Population/Building caps - Environmental preservation zoning - Provision of public facilities by developers - Urban service boundary - Annual limit on building permits - Moratorium on growth - Time required to review residential projects - Environment impact assessment required for small projects - Zero lot line housing prohibited

Table 2 Continued

Author(s) year/ goals/ comments	**Unit of analysis/ Regulatory measure**	**Data source**	**Methodology for index creation and variables used**
Gyourko, Saiz and Summers (2008) Comments: Well detailed methodology. Few observations when evaluating some cities.	Over 2000 jurisdictions Wharton Residential Land Use Regulation Index (WRLURI).	A nationwide survey	Index created by factor analysis and simple addition The index is comprised of 11 sub-indexes: - Nine pertain to local characteristics - Two reflect state court and state legislative/ executive branch behavior Low values indicate a less restrictive approach to regulating the local housing market. The survey was supplemented by two other sources of data: - A state-level analysis of the legal, legislative and executive actions regarding land use policies, with each state rated on a common scale in terms of its activity (Foster and Summers, 2005) - The development of measures of community pressure using information on environmental and open space-related ballot initiatives.
Pendall, Puentes and Martin (2006) Comments: The study classifies regulatory regimes in four broad typologies.	50 US metropolitan areas.	A nation-wide survey	Index created by factor analysis The survey covers six areas of land use regulation: 1) zoning, 2) comprehensive planning, 3) containment, 4) infrastructure regulation, 5) growth control, and 6) affordable housing programs and funding. Once the factor analysis was completed, the authors used hierarchical cluster analysis which resulted in 12 clusters.
Glaeser and Ward (2009) Goal: Analysis of the relationship between land use controls and housing prices and construction.	187 cities and towns within Greater Boston	Pioneer Institute for Public Policy Research [b]	A Simple addition index. The use of a simple categorical variable that takes on a value of one if the community has passed a rule that goes beyond the state standards regarding septic systems, wetlands and subdivisions. The authors sum those three categorical variables together for create an index. Index similar to the one of Quigley and Raphael (2005)

[a] PCA= principal component analysis

[b] The database and a detailed discussion about how it was obtained is available at http://www.masshousingregulations.com/.

The creation of the LURE Index had to take these methodological aspects into account to allow for the possibility of comparison and replication with these other reviewed exercises. This information was also helpful in establishing a sound framework as the first step in creating the LURE Index, in addition to the design and implementation of the LURE Survey.

This review provided the information needed to define the appropriate list of candidate variables to be included in the design of the instrument and the creation of the LURE index. This list of variables was further refined by focus interviews conducted with different stakeholders (see section 4.1.1. on LURE survey design for specifics of the methodology used for reduction of items and final list of variables).

3. AREA OF STUDY

The case study area chosen for this research was the Houston-Galveston Area as defined by the 13 counties being part of the Houston – Galveston Area Council (H-GAC).[5] This region includes the counties of Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Montgomery, Walker, Waller, and Wharton (see Figure 1).

The selection of the H-GA not only allowed the analysis of a regulatory environment recognized as less stringent in its relation to housing markets but also the opportunity of validating the use of an index to characterize LUREs in other contexts.

133 jurisdictions are part of the H-GA, in which approximately two-thirds of the total population of this area lives in these municipalities according to 2008 US Census estimates (3,652,069) and one-third in unincorporated county areas (2,214,194). The H-GA's built environment is the least dense among the 10 largest U.S. MSAs (3.25 persons per urbanized acre in 1997), and yet could be considered dense when compared to another area such as the Atlanta MSA (2.84) ((Fulton, Pendall et al. 2001). In addition, the City of Houston is the largest city in the U.S. without zoning (Pendall, Puentes et al. 2006) and Pasadena (the second-largest city in the region) does not have zoning as well.

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[5] This area has been selected over the area defined by the U.S. Census Metropolitan Statistical Area of the City of Houston (Houston-Sugar Land-Baytown MSA) because: 1) sponsorship from the H-GAC for the implementation of the LURE Survey and 2) availability of a greater number of units of analysis (local jurisdictions).

Houston's lack of zoning ordinance is the basis for the unique characteristics of the H-GA. However, the lack of zoning in Houston does not mean that there are not other types of land use regulations in place. Deed restrictions (covenants) are the most common type of land use regulations in the City.

Both the MSA and the City of Houston are unique case studies in themselves. Shown below are some facts of this area in terms of a) the stringency of its land use regulatory regime as seen by other studies, and b) additional significant affordable housing aspects.

Gyourko et al (2008) created an index of the local regulatory environment in 47 MSAs around the nation. Table 3 shows some selected MSAs and their rankings in terms of this index (see table in appendix A for a complete list of rankings). The index was designed so that a low value indicates a less restrictive or more *laissez faire* approach to regulating the local housing market.

According to these rankings, Houston MSA is one of the most unregulated land use cities among 47 MSAs ranked by these authors. It is also notable that the other MSAs of Texas (San Antonio, Fort Worth-Arlington and Dallas) fall even lower.

In a similar study which was based on a different classification and ranking, Pendall (2006) found similar conclusions regarding the stringency of Houston's regulatory environment. The author classified 50 U.S. MSAs in four families based on their regulatory stringency (Traditional, Exclusion, Wild-wild Texas and Reform). Pendall

identified the MSAs of Dallas, San Antonio and Houston as the less regulated environments.

Table 3 Average WRLURI Values in Selected Metropolitan Areas (7 out of 47)

Rank	Metropolitan Area	WRLURI
1	Providence- Fall River-Warwick, RI-MA	1.79
2	Boston, MA-NH	1.54
38	Houston, TX	-0.19
39	San Antonio, TX	-0.24
40	Fort Worth-Arlington, TX	-0.27
41	Dallas, TX	-0.35
47	Kansas City, MO-KS	-0.80

Source: Elaborated based on data from Gyourko et al. 2008

Table 4 shows that among the 105 MSAs ranked according to a measure of affordability[6], Houston MSA is located in the 74th place with a ratio of 2.4, which is lower than the national ratio of 3.1 (JCHS2008).

[6] Based on the simple ratio: median house price/median household income (a common measure of affordability)

Table 4 Rankings of MSAs by Ratio: House Price/ Household Income, 2000

Rank	Median House Price/Median Household Income Ratio	2000
1	San Francisco-Oakland-Fremont, CA MSA	5.3
2	San Diego-Carlsbad-San Marcos CA MSA	5.2
49	Austin-Round Rock TX MSA	2.8
63	San Antonio TX MSA	2.5
73	Dallas-Fort Worth-Arlington, TX MSA	2.4
74	Houston-Sugar Land-Baytown TX MSA	2.4
	National	3.1

Source: Elaborated based on data from State of the Nation's Housing 2007 from the Joint Center for Housing Studies of Harvard University

According to historical trends in the Houston MSA, Figure 4 shows how this ratio (3.3) has been falling since 1983 and in 2000 was near some of the lowest historical values at 2.4. Although this review analyzes data from the 2000 census, it is recognized that according to data from 2001 through 2006, Houston MSA is experiencing a rise in this ratio, having a value of 3.0 in 2006 (JCHS2008).

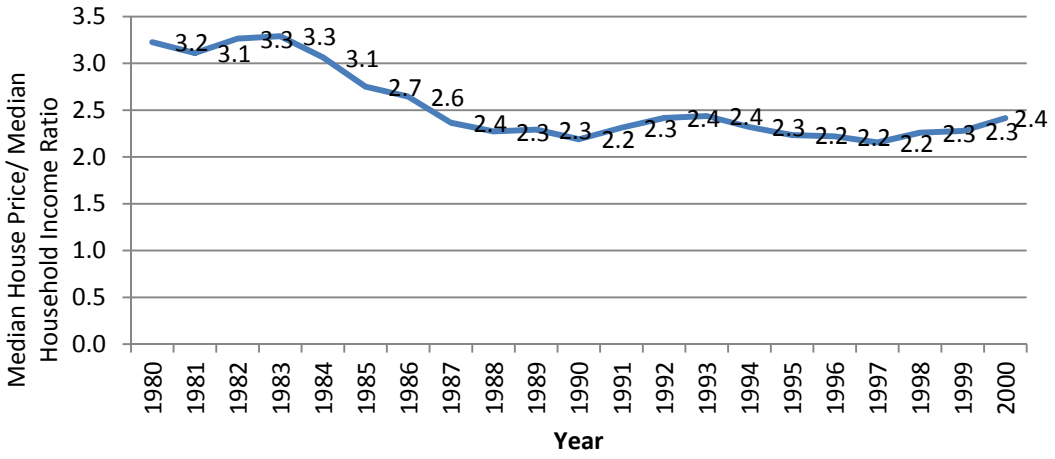

Figure 4 Ratio House Price/ Household Income, Houston MSA, 1980-2000
Source: Elaborated based on data from the State of the Nation's Housing 2007 from the Joint Center for Housing Studies of Harvard University

Unincorporated areas have not been considered in this research. Unincorporated areas are known for having a less stringent LURE when compared to local jurisdictions (Pendall, Puentes et al. 2006). Although unincorporated county areas in the H-GA are made up of just one third of the total population in this region, these areas have experienced a faster rate of growth in population (32% from 2000 to 2008) when compared to the incorporated areas (14%)[7].

The specific characteristics of the H-GA make this region a unique basis for the case study so as to contribute to the literature by creating an index characterizing LUREs for housing markets.

[7] Calculations based in 2000 US Census and 2008 US Census Estimates data.

4. METHODOLOGY AND DATA

Three methodological phases were involved in creating a composite indicator to reflect LUREs for housing markets in the H-GA and to validate the use of an index as a measure to characterize local LUREs: I) the design and implementation of an instrument to create an inventory of land use regulations in the H-GA; II) the creation of the LURE Index and analysis of the results; and III) the uncertainty and sensitivity analysis of the LURE Index (see Figure 5 for a workflow).

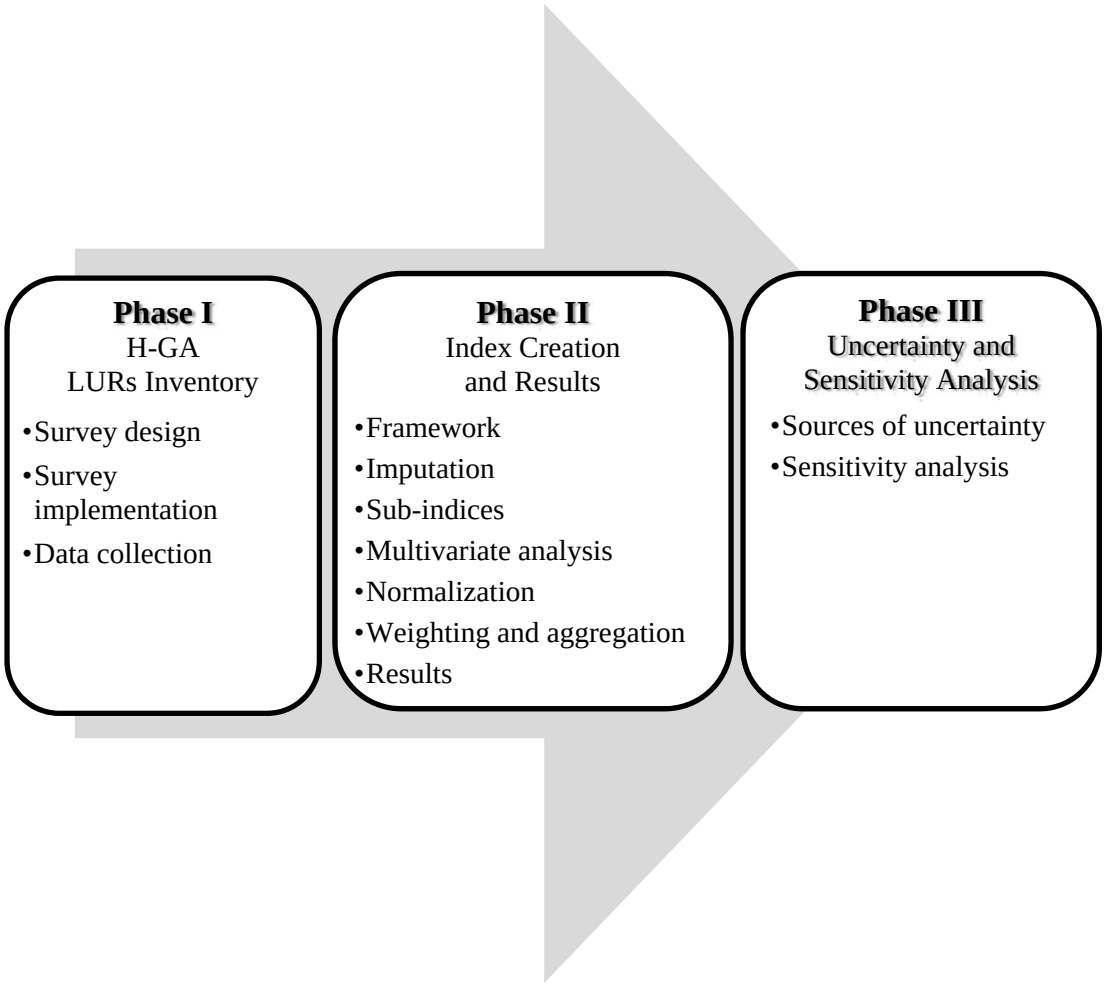

Figure 5 Workflow for the Creation and Validation of the LURE Index

During phase I the instrument (here after the LURE Survey) was developed and implemented in order to create an inventory of land use regulations in the H-GA. In phase II the LURE Index was created and results analyzed. Finally, in phase III an uncertainty and sensitivity analysis was performed to assess the statistical robustness of the LURE Index.

4.1. Phase I: The H-GA land use regulations inventory

The H-GA's land use regulatory inventory involved three steps: 1) the design of the LURE survey; 2) the implementation of the designed instrument in the H-GA; and, 3) data collection and analysis. Figure 6 summarizes the steps performed during this phase.

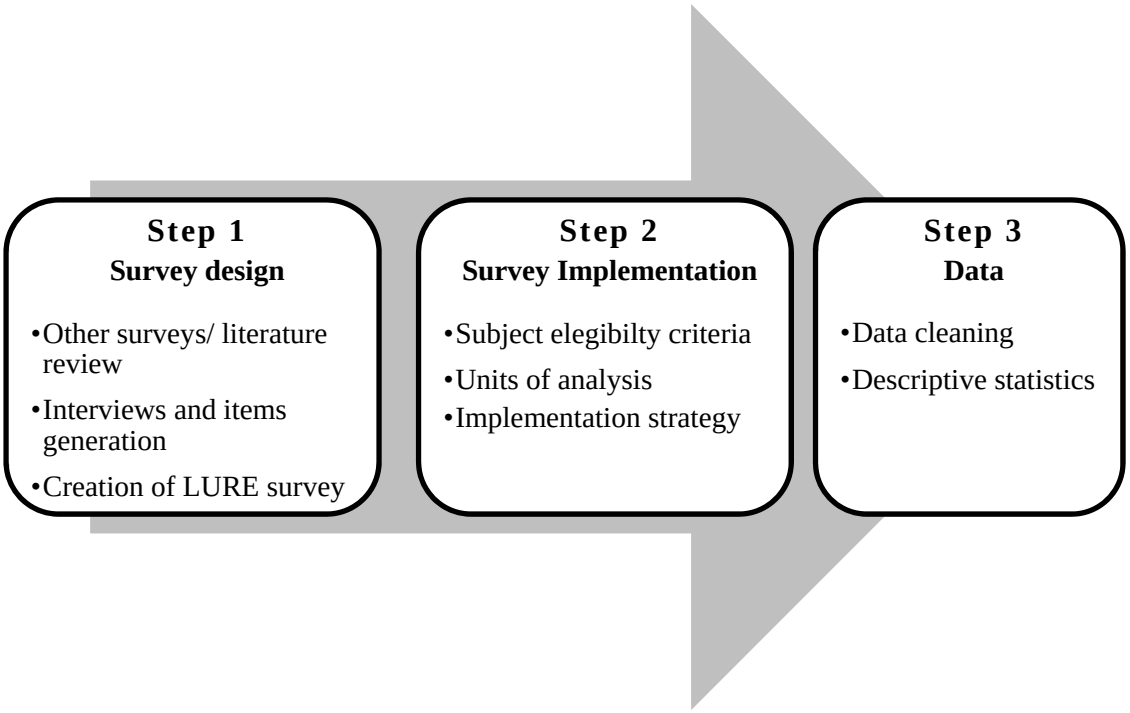

Figure 6 Phase I: Creation of the H-GA's Land Use Regulations Inventory

4.1.1. Step 1: LURE Survey Design

The LURE survey was created to identify those land use regulations related to housing markets in general and to housing supply specifically. It was designed based on the premise of being simple enough to generate relevant information and being easily implemented on a regular basis. The first step in the design process was based on a multi-methodological approach: a) using surveys from related studies which have used these types of indices previously; and b) conducting interviews with different experts and stakeholders in Texas (four city planning officials, four housing developers, and two law experts).

Two important objectives guided the design of the LURE survey: a) the reduction of non-responsiveness and b) the reduction of measurement error. For this purpose, two procedures of measurement development were conducted: 1) item generation and 2) cognitive interviews.

Once the LURE survey was designed, its properties were evaluated by sending it to a sample of city planning officials in 11 jurisdictions. Once the survey was validated, it was then sent to the entire sample of planner officials of the H-GA.

4.1.1.1. Item generation and cognitive Interviewing

A conceptual model outlying the domains that were relevant to the LURE Index was developed. A large survey with 60 items was generated in this initial phase so that poorly performing items could be deleted during the cognitive interviewing. Surveys

used in similar studies were used for this phase. Specifically the surveys implemented by the Wharton Project (Linneman, Summers et al. 1990; Quigley and Rosenthal 2005), Glickfeld and Levine (1992), Lewis and Neiman (2000), Pendall, Puentes and Martin. (2006); and Gyourko, Saiz and Summers (2008) (see appendix B, C , D and E for a copy of all these surveys).

Common questions in the surveys which attempted to measure similar regulatory measures were analyzed for agreement and particular aspects exclusively pertinent to the regulatory context were discarded (e.g. state requirements in California are obviously not similar to those in Texas). An important factor which made this survey distinctive when compared to surveys from other studies was that the final LURE survey had a short format (13 questions) in an attempt to prevent the low response rate which some of the other studies had experienced (Luger and Temkin 2000; Gyourko, Saiz et al. 2008).

Another important aspect related to the instrument design was that of the statutes framing the land use regulatory authority of local governments. Local governments are constrained by state statutes thus land use regulatory statutes were analyzed to be sure of the validity of some items. The Texas local code of government (Texas 2009) was used to understand and to validate the appropriateness of the type of questions used according to the contexts of the state and local laws. Two areas were analyzed specifically: a) title 2, subtitle A and C regarding organization, type, and boundaries of municipalities; and b) Title 7 regarding municipal, county, and more than one type of local government regulatory authority.

Before the cognitive interviews took place, approval from Texas A&M Institutional Review Board (IRB) was obtained. The long version of the survey made up of 60 questions was submitted for approval and once the approval was obtained, the cognitive interviews began.

Four cognitive interviews were performed.[8] Planning staff from local governments and housing developers from Texas cities were interviewed. Planning staff and housing developers from the cities of Bryan, College Station, Pflugerville and Houston were interviewed. These cognitive interviews were taped and recorded, transcribed, and analyzed to determine which items should be deleted or reworded, as well as whether the respondents mentioned new variables not previously included.

After other studies' surveys were reviewed, Texas state legal statutes were reviewed and the cognitive interviews were completed, the qualitative and quantitative data provided was compiled and analyzed[9] (Sudman, Bradburn et al. 1995; Schwarz and Sudman 1996).

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[8] According to Aday Aday, L. A. (1996). *Designing and conducting health surveys: A comprehensive guide. 2nd ed.* San Francisco: Jossey-Bassy., Sudman Sudman, S., N. M. Bradburn, et al. (1995). *Thinking About Answers: The Application of Cognitive Processes to Survey Methodology*, Jossey-Bass., and Schwarz Schwarz, N. and S. Sudman (1996). "Answering Questions: Methodology for Determining Cognitive and Communicative Processes in Survey Research." San Francisco CA: Jossey-Bass., cognitive interviewing techniques are now widely used (mainly in the health field) to gain information from respondents about how they formulate their answers to questionnaires.

[9] It is recommended that focus interviews be used in conjunction with "thinkaloud" cognitive interviewing techniques the development and pretesting of standardized measurement instruments, particularly in determining problems with items and understanding the cognitive process respondents use in answering questions.

Table 5 displays the final list of candidate variables obtained. The combined variables capture the different dimensions (sub-indices) affecting the price and production of housing specifically. The variables most frequently used in the literature reviewed are included. The selection of these variables using this mixed-approach of literature review and expert opinions had the advantage that the final list of candidate variables reflects both considerations from other indices (which is the main purpose of this review) and considerations from the specific regulatory environment of Texas.

Once the survey was completed, it was sent to 11 jurisdictions as a trail to look for any aspects which needed reviewed for adjustment. Once all the jurisdictions responded, the survey was refined into its final format. The final LURE survey was composed of 13 questions covering 10 dimensions (See appendix F for the final version of the LURE Survey).

4.1.1.2. A concluding caveat regarding the variables used in the final survey

It is true that the use of surveys with a simplified format (few questions) eliminated the use of some other variables (regulations) that could be worthy of consideration. For instance, the City of Houston is well known for its lack of zoning but at the same time it is also well known for the its varied methods of regulating land uses. Deed restrictions (covenants) are one of those elements used in order to provide sub-divisions land use regulations.

To look at the specific regulations in place in every jurisdiction in an attempt to take each one of them into account goes beyond the purpose of the creation of this index in

terms of being created easily and with simplicity. It is true that an analysis of the effect of land use regulations on housing markets as well as other factors inside a jurisdiction merit a deeper analysis , however, this is more suited with a cost–benefit analysis.

In addition, some regulations (variables) could have the same statistical effect, so the inclusion of both in the creation of the index could cause a double counting which in turn requires the subsequent removal of the variables from the index.

The factor analysis procedure in the creation of the index demonstrated in the following sections (sections 4.2.3 and 5.4.), shows how some of the variables used could be candidates for removal in future exercises due to the fact that they are either not statistically important or because they would produce a double counting.

Again, the creation of the index required variables that were easy and fast in the collection of information so that the index could be re-created with the capability of being a measure used for posteriori analysis. The analysis of the different surveys implemented in the creation of similar exercises shows how they utilized between one and 35 variables in all. If the collection of information on land use regulations merits the importance of being collected on a regular basis, then a survey with a short format is worthy of consideration (as shown in section 4.1.2. , this short format facilitated a high response level from the jurisdictions).

Table 5 Candidate Variables for Instrument Design and Index Creation

Dimension/ Sub-index	Indicator (Variable)
Local Government	Category of Municipality
Local Planning Approval	Zoning commission
	Planning commission
	Historic commission
	Board of adjustments
	Panel board of adjustments
	Neighborhood zoning areas
Local Planning Requirement	Comprehensive (master, general) plan
	Zoning ordinance
	Other ordinances governing plats, land development and subdivisions
	Jurisdiction is a unit in which the county applies its own subdivision provisions to new development
Local Affordable Housing	Multifamily housing units been built in the last two years
	Manufactured and modular housing been added to jurisdiction in the last two years
	Developers have to include “affordable housing” (however defined)
Density Restriction	Minimum lot size for single family units within the city limits
	Minimum lot size for single family units within the city’s extraterritorial jurisdiction (ETJ)
	Minimum floor area for single family units within the city limits
	Minimum street right-of-way width
Local Subdivision Requirements	Developers have to pay building permit fee
	Developers have to pay development review fees
Open Space	Developers have to supply mandatory dedication of space or open space (or fee in lieu of dedication)
Exactions	Developers have to pay allocable share of costs of infrastructure improvement
Supply Restriction	Measure limiting development beyond a boundary (such as urban limit line, urban growth boundary, greenbelt, or urban service area)
	Measure establishing a limit on growth (population limit or building permits in a given time frame)
	Measure which requires adequate service levels for residential development or service capacity as a condition of approval of residential development
	Measure which reduces the permitted residential density by general planning or rezoning
	Measure which re-designates or rezones residential land to agriculture or open space (e.g., shore line protection)
Local Standard Development Perception	Perception of jurisdiction’s standards for development when compared to surrounding jurisdictions
	Perception of jurisdiction’s standards for development when compared to county

4.1.2. Step 2: LURE Survey Implementation

Once the final LURE survey was completed, an on-line version was developed and an account on a survey host's website was created so that the instrument could be sent to the respondents.

4.1.2.1. Subject eligibility criteria and unit of analysis

The units of analysis used to create the LURE index were the 133 municipalities belonging to the H-GA. An internet link with the on-line version of the LURE survey was sent to all these jurisdictions. The survey was e-mailed to the Planning Directors of the areas where such an office existed. In the areas where there was no planning director, the survey was sent to either a local elected official (e.g., mayor, planning board chair, city clerk) or a municipal officer (e.g., city manager, city engineer, zoning enforcement officer).

All 133 jurisdictions received the LURE survey. No random sample was selected. All cities were considered eligible subjects. Table 6 displays the number of subjects to which the survey was sent and the final number of jurisdictions which completed the survey.

Table 6 Sampling of H-GA Jurisdictions

	Survey population	Sampling Frame	Sample	Completed Sample	
				N	%
Houston – Galveston Area (H-GA)	133	133	133	91	68.5
Total	**133**	**133**	**133**	**91**	**68.5**

4.1.2.2. Implementation strategy

Sponsorship

Another important step of the implementation strategy was to find sponsorship for the instrument (Dillman 2007). It is believed that the sponsorship from a legitimate authority was part of the success in obtaining a satisfactory level of response.

Response rates

The following are the steps which were implemented to achieve a high response rate (Dillman 2007):

1) Four contacts by e-mail mail with additional "special contact"

   - A brief pre-notice
   - On-line LURE survey
   - Thank you e-mail
   - Replacement e-mail (2-4 weeks after the first)
   - A final contact made by phone (a week after the 4th contact) so that the survey was answered using this mode.

2) Personalization of correspondence (e-mails in this case)

Three critical elements for increasing/predicting a high increase response were considered (Dillman 2007):

1) Rewards: (increase the reward of responding), giving reasons, contact info, and say thank you, asking for help, and appeal to common values.

1) Cost: (to reduce the perceived cost) avoiding subordinate language, avoiding embarrassment, avoiding inconvenience, and questions with short answers and easy appearance.

1) Trust (establishing of trust, so the ultimate reward will outweigh the cost of responding) sponsorship by legitimate authority (H-GAC) and pointing out the importance of this task.

Based on the strategy described above, Tables 7 and 8 display the response rates obtained with this approach and descriptive information regarding population and land area according to if jurisdictions responded or not.

Table 7 Response Rates by Size of Jurisdiction in Terms of Population

Population (2008)	Responses	Response rate (%)	Number in H-GA
Less than 2,500	34	53	64
2,500 to 5,000	16	76	21
5,000 to 10,000	8	67	12
10,000 to 50,000	25	93	27
50,000 to 100,000	6	86	7
100,000 and over	2	100	2
Total	**91**	**68**	**133**

Source: 2008 U.S. Census estimates. Retrieved January 12, 2010, from http://factfinder.census.gov/home/en/official_estimates_2008.html

Table 8 Population and Land Characteristics for Jurisdictions

	US Census Estimates 2008		Land area		Number of jurisdictions	
	Population	(%)	2000 (square miles)	(%)	N	(%)
Jurisdictions with no response	181,503	5	221	14	42	32
Jurisdictions which responded	3,470,566	95	1,336	86	91	68
Total	**3,652,069**	**100**	**1,557**	**100**	**133**	**100**

The time and economic costs of this phase of the implementation of the LURE survey were important. For instance, there was no access to a universal database containing all the contact information for of all of the jurisdictions. Thus it was necessary to access the

information via different sources such as jurisdictions' web sites and the Texas Municipal League.

4.1.3. Step 3: Data

Once the data from the responses to the LURE survey - both the on-line version and telephone responses - was collected, the process of "cleaning the data" was performed. Of the surveys received, 50 were obtained by the online version and 41 by telephone. During this procedure, the analysis concentrated on: a) missing data and b) extreme values.

In order to verify and correct strange or wrong values, jurisdictions were contacted once again to verify or request the missing information. When it was not possible to get information by direct contact, the ordinances of those specifics jurisdictions were reviewed[10].

Tables in appendix D display summarized information of the responses to the LURE survey. There is not an exhaustive statistical analysis of every response which goes beyond the main goal of this research. Nonetheless, the agreement with the H-GAC when the sponsorship of the LURE survey was granted was to make public both the data collected and a report with the statistical analysis of the responses. On the other hand, descriptive statistics of the results are presented on section 5.7.

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[10] Web site for ordinances: http://www.amlegal.com/library/tx/index.shtml

Once missing and extreme values were analyzed, verified and corrected, the information was used in phase II: creation of the LURE Index. Specifically the data was analyzed in terms of its pattern of missing values, so that imputations could be estimated. This database helped to establish the framework and specific dimensions for the creation of the index.

4.2. Phase II: Index creation

There is not yet an accepted standardized methodology for the creation of CIs. Nonetheless, the efforts performed in many disciplines by creating CIs and the advances of statistical software and computers have provided abundant literature.

The methodology in this research uses well known procedures already in place in some fields which have experience in the creation of CIs. Because this research focuses in creating a city-level index, particular attention was paid to the procedures and experiences of international organizations in creating CIs ranking different geographical locations. The United Nations (UN) and the Organization for Economic Co-operation and Development (OECD) are perhaps some of the more experienced organizations creating CIs to rank nations. The design of the methodology of this study has relied completely on the handbook created by the OECD (Nardo, Saisana et al. 2005).

4.2.1. The specifics of the methodology to create the LURE Index

The methodology for the construction of the LURE Index was designed in order to ensure a top quality indicator in terms of its statistical soundness and consistency. The methodology allowed that the LURE Index would include assessments following the requirements for measures in psychometric theory: validity, reliability and sensitivity to change (Nunnally 1978; Nunnally and Bernstein 1994).

Figure 7 shows the methodological workflow used to create the LURE Index followed by a description of each one of the steps taken to build the LURE Index and the specific procedures used. The specific procedures chosen for this process were the ones used to create similar indices so as to allow for more accurate validation. (Specifically Gyourko's index (2008)).

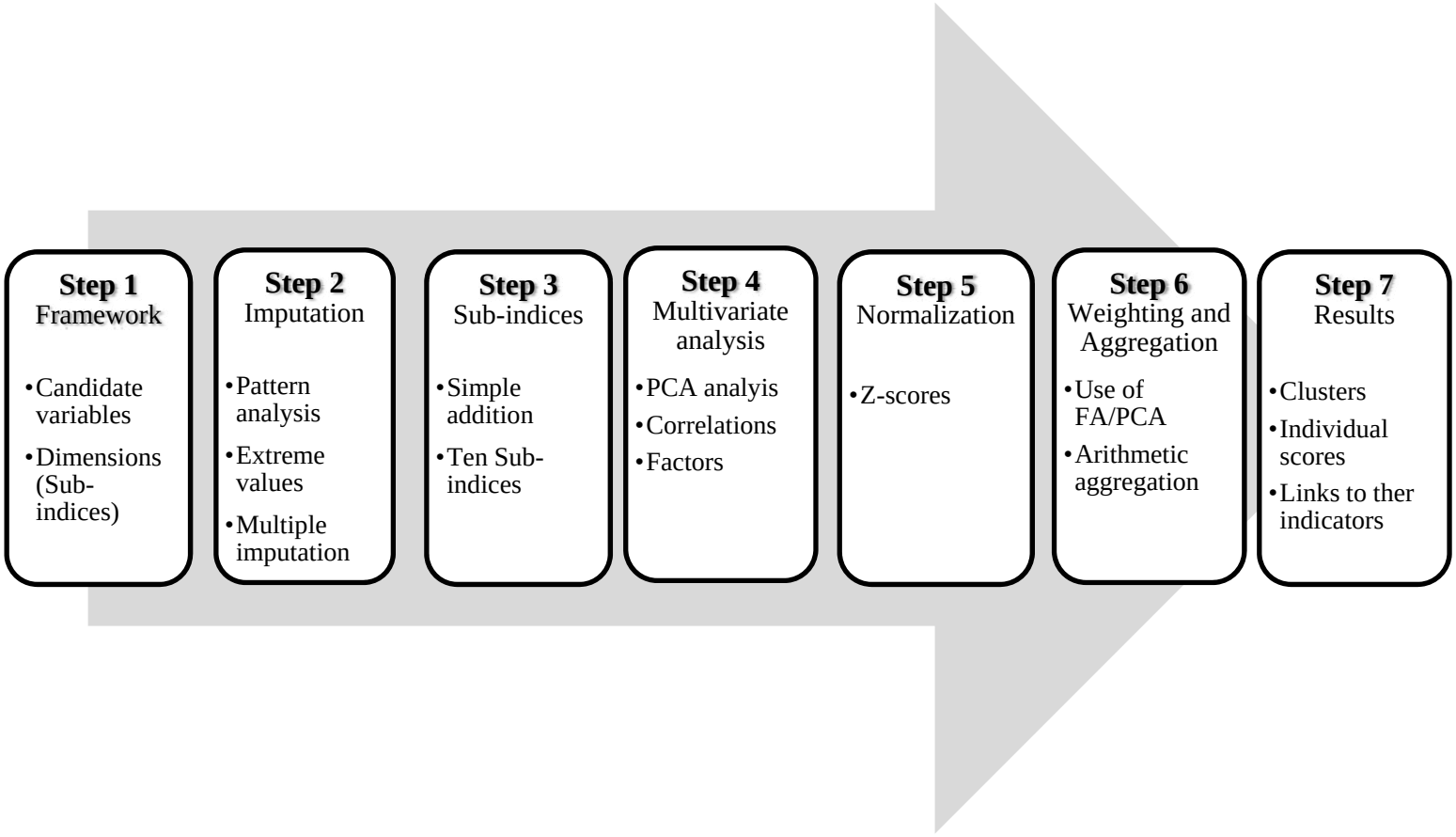


Figure 7 Workflow for the Specific Calculation of the LURE Index

Source: Elaborated based on Nardo, Saisana et al. (2005)

4.2.1.1. Framework

Authors such as Nardo, Saisana et al.(2005) recommend that among the specific steps of this process are: 1) definition and understanding of the phenomenon to be measured; 2) determination of sub-groups; and 3) selection of candidate variables.

4.2.1.2. Imputation

The creation of indices requires paying particular attention to the treatment of missing values, especially when dealing with a small number of observations or cases. Thus, the option of using an imputation procedure proves to be a useful tool. Three specific options for dealing with missing data are: 1) case deletion, 2) single imputation, and 3) multiple imputation.

It is important to consider that in case deletion, the consequences of not taking into account observations with missing values for a small data set could create methodological challenges such as large standard errors. On the other hand, case deletion requires an awareness of the differences between complete and incomplete samples, especially in terms of the pattern of missing values appearing in a random or not-random fashion. Nardo, Saisana et al.(2005) are detailed in citing and explaining three specific patterns: Missing completely at random, missing at random and not missing at random. Authors such as Little and Rubin (2002) state the rule of thumb is if a variable has more than 5% missing values, cases are not deleted.

An advantage of imputation procedures is that they could allow compensation for the lack of information that could be expensive to obtain in another way, and that could

statistically allow a minimization of bias. The imputation results for the creation of the LURE Index had to be checked for their statistical properties by looking at its distributional characteristics and possible negative values (a heuristic approach).

The imputation procedure was done by using the statistical software PAWS Missing values 18. An important advantage of using this software is the opportunity of having pooled outputs that estimates what the results would have been if the original data had no missing values. In addition, this procedure provided different completed sets of imputated values.

4.2.1.3. Multivariate analysis

Multivariate analysis allows assessing the suitability of a dataset and provides an understanding of the implications of the methodological choices (e.g. weighting, aggregation) during the development of an index or composite indicator. In particular, the principal component analysis (PCA) and factor analysis (FA) are the two multivariate methods recommended in order to: 1) reduce the number of variables and (2) detect structure in the relationships between variables - that is to classify variables (Johnson and Wichern 2007; Hair, Black et al. 2009).

Factor analysis was chosen from the family of multivariate techniques as the method to construct the city-level index of regulatory stringency. FA enabled the verification of the capacity of the LURE Index to capture the different dimensions or latent factors in the relationship between LUREs and housing markets. FA also helped to check if indeed the number of sub-indices could be representative of the multi-dimensional phenomenon of

measuring LUREs. FA was also used as a statistical procedure during the weighting step in the creation of the LURE Index.

Although FA was the multivariate method chosen to create the LURE Index, Equal Weighting (EW) was also used to create another set of indexes. This alternative provided comparisons to see if indeed some of these methods made a difference in the creation of the proposed index. Specifically, these other alternate indices were used in the phase III uncertainty and sensitivity analysis.

4.2.1.4. Normalization

When dealing with different variables (measured at different levels and units) in creating an index, it is important to standardize (normalization) the scores for each variable. This procedure is commonly done through a normalization technique. Table 9 shows the different normalization methods commonly used in literature. Whichever method chosen, special attention must be paid to data properties and the objectives of the index (Nardo, Saisana et al. 2005).

Due to the characteristics of the data and in order to fulfill the goal of creating an index that could be easy to understand and comparable with similar exercises, it was not necessary to normalize the values of each indicator. Nonetheless, Z-score was the normalization procedure used to apply to the values of the different sub-indices. Authors such as Nardo (2004) and Gyourko (2008) verify the usefulness of this approach.

Table 9 Normalization Methods

Method	Main characteristics
Ranking	Not affected by outliers. Allows the performance of units to be followed over time in terms of relative positions (rankings)
Standard scores (Z-scores)	Converts indicators to a common scale with a mean of zero and standard deviation of one. Indicators with extreme values have a greater effect on the composite indicator.
Min-Max	Normalizes indicators to have an identical range [0, 1] Extreme values/or outliers could distort the transformed indicator. Min-Max normalization could widen the range of indicators lying within a small interval, increasing the effect on the composite indicator more than the z-score transformation.
Distance to a reference unit	Measures the relative position of a given indicator vis-à-vis a reference point. (e.g. the reference unit could be the average unit of the group and would be assigned a value of 1, while other units would receive scores depending on their distance from the average. Is based on extreme values which could be unreliable outliers.)
Categorical scales	Assigns a score for each indicator. Often, the scores are based on the percentiles of the distribution of the indicator across units. Since the same percentile transformation is used for different years, any change in the definition of the indicator over time will not affect the transformed variable. Is difficult to follow increases over time. Excludes large amounts of information about the variance of the transformed indicators.
Indicators above or below the mean	Are transformed such that values around the mean receive 0, whereas those above/below a certain threshold receive 1 and -1 respectively. It is not affected by outliers. The arbitrariness of the threshold level and the omission of absolute level information are often criticized.
Cyclical indicators (OECD)	The results of business tendency surveys are usually combined into composite indicators to reduce the risk of false signals, and to better forecast cycles in economic activities.
Balance of opinions (EC)	Managers of firms from different sectors and of varying sizes are asked to express their opinion on their firm's performance
Percentage of annual differences over consecutive years	Represents the percentage growth with respect to the previous year instead of the absolute level. The transformation can be used only when the indicators are available for a number of years.

Note: Source (Freudenberg 2003; Jacobs, Smith et al. 2004; Nardo, Saisana et al. 2005)

4.2.1.5. Weighting and aggregation

The common practice of FA has been used in this research as the procedure to obtain weights for each one of the sub-indices (Gyourko, Saiz et al. 2008). This method fulfilled the objective of having an index that would be simple and easily comparable with similar exercises. Even though the approach of FA was used, the statistical properties of data were taken into account at all times so as to avoid a possible unbalance in the structure of the index. Nardo (2005) points out the risk of introducing into the index an element of double counting. Table 10 depicts the compatibility between different aggregation and weighting methods.

From the three different options of performing the aggregation (linear, geometric and multi-criteria), the linear approach was the one used for the creation of the LURE Index based on the fact that this is the technique used in most of the other similar indices.

Table 10 Aggregation and Weighting Methods

Weighting methods	**Aggregation Methods**		
	Linear [4]	Geometric [4]	Multi-criteria
Equal weighting (EW)	Yes	Yes	Yes
principal components analysis/ factor analysis (PCA/FA)[5]	Yes	Yes	Yes
Benefit of the doubt approach (BOD)	Yes[1]	No[2]	No[2]
Unobserved components model (UCM)	Yes	No[2]	No[2]
Budget allocation process (BAP)	Yes	Yes	Yes
Analytic hierarchy process (AHP)	Yes	Yes	No[3]
Conjoint analysis (CA)	Yes	Yes	No[3]

[1]. Normalized with the Min-Max method.
[2]. BOD requires additive aggregation, similar arguments apply to UCM.
[3]. At least with the multi-criteria methods requiring weights as importance coefficients.
[4]. With both linear and geometric aggregations weights are trade-offs and not "importance" coefficients
[5]. Weights cannot be estimated with these methods if no correlation exists among indicators

Note: Source (Nardo, Saisana et al. 2005)

4.2.1.6. Results

After the FA was completed, a hierarchical cluster analysis was used to group areas into homogeneous clusters based on similar characteristics across the set of variables chosen for this analysis.

The results section also involved the concept of decomposing the LURE Index so that the contribution of each sub-index and individual indicators could be identified, and as a result, have an extended analysis of jurisdiction performance (Nardo, Saisana et al. 2005).

4.2.1.7. Links to other indicators: validation of the LURE Index

Correlating the index created with other known measures is a useful way to look at the explanatory power of the LURE Index (Nardo, Saisana et al. 2005). It is important to point out that simple correlations do not necessarily provide a causality effect between the index created and the other reference measures used in this step. Nardo et al. (2005) advised caution so as to not correlate the index with already used indicators. Should that be the case, that specific indicator must be removed from the created index to avoid double counting.

4.3. Phase III: Uncertainty and sensitivity analysis

Because of the involvement of values judgments and the use of different methodological procedures to create the index, an assessment of the robustness of the index must be conducted. Uncertainty and sensitivity analysis are current procedures suggested in the

literature (Nardo, Saisana et al. 2005) as both procedures could improve the structure of the created index (Saisana, Saltelli et al. 2005; Gall 2007).

Among the different steps in assessing uncertainties are (Nardo, Saisana et al. 2005):

- Inclusion and exclusion of individual indicators
- Modeling data error based on the available information on variance estimation
- Using alternative editing schemes, *e.g.* single or multiple imputation
- Using alternative data normalization schemes, such as Mini-Max, standardization, use of rankings
- Using different weighting schemes, *e.g.* methods from the participatory family (budget allocation, analytic hierarchy process) and endogenous weighting (benefit of the doubt)
- Using different aggregation systems, *e.g.* linear, geometric mean of un-scaled variables, and multi-criteria ordering
- Using different plausible values for the weights

The approach used to assess the robustness of the LURE Index was based on: a) inclusion/exclusion of one indicator at a time, b) different normalization methods, c) different weighting aggregation schemes, and d) the use of the multiple imputated data sets created in the imputation step.

5. THE CREATION AND RESULTS OF THE LURE INDEX

Once the database of land use regulations from the H-GA was checked and verified for missing information, the next step was the calculation of the LURE Index. In section 1 the definition of the framework is given. In section 2 the results of the imputation process was compared against the original dataset values. In section 3 sub-indices were created by simple addition of values (scores). In section 4 the statistical dimensionality of the framework was assessed by PCA analysis. In section 5 sub-indices were normalized through standardized scores. In section 6 weights for the aggregation were obtained through FA/PCA analysis and the aggregation was done by simple addition. Finally, in section 7 cases (jurisdictions) are grouped by a clustering process and results are presented.

It is important to point out that during the steps of normalization, weighting and aggregation, there were also procedures and results that were later used to create alternative scenarios in order to assess the robustness of the LURE Index.

5.1. Framework

The conceptual framework for the creation of the LURE Index was defined by 10 sub-indices and 29 indicators/variables which were considered sufficient to capture the different dimensions characterizing the H-GA's LURE. Due to the fact that Gyourko and Saiz's (2008) index was an exceptionally well created composite indicator as far as methodology, (see section 2.4. Literature on related LUREs indices and inventories), the conceptual framework and specific procedures selected for the creation of this LURE Index follow the same approach. This made feasible the goal of creating the LURE Index to validate the use of these types of measures to characterize LUREs in general.

Table 11 shows the 10 sub-indices, the indicators and their coding, and score units. Nine of the ten sub-indices are similar to those create by Gyourko and Saiz (2008). The sub-index Local Government was a new addition in the creation of the LURE Index. Experts and stakeholders interviewed (see section 4.1.1. Step 1: LURE Survey Design) recommended the inclusion of this particular indicator due to its relevance for Texas jurisdictions. According to these opinions, the power granted to each jurisdiction depending on its category reflects the capacity of these communities to implement regulations beyond the ones established by the State of Texas.

Table 11 Framework for the LURE Index: Structure and Indicators

Sub-Indices	Indicator (Variable)	Indicator code	Indicator score
Local Government (LGI)	Category of Municipality	LGIgeneral	GL/HR/S
Local Planning Approval (LPAI)	Zoning commission	LPAIzc	0, 1
	Planning commission	LPAIpc	0, 1
	Historic commission	LPAIhc	0, 1
	Board of adjustments	LPAIba	0, 1
	Neighborhood zoning areas	LPAInza	0, 1
Local Planning Requirement (LPAIR)	Comprehensive (master, general) plan	LPAIcp	0/1/2
	Zoning ordinance	LPAIzo	0/1/2
	Other ordinances governing plats, land development and subdivisions	LPAIoo	0/1/2
	Jurisdiction is a unit in which the county applies its own subdivision provisions to new development	LPAIosp	0, 1
Local Affordable Housing (LAHI)	Multifamily housing units been built in the last two years	LAHImh	0, 1
	Manufactured and modular housing been added to jurisdiction in the last two years	LAHImm	0, 1
	Developers have to include “affordable housing” (however defined)	LAHIah	0, 1
Density Restriction (DRI)	Minimum lot size for single family units within the city limits	DRImlsfu	Sq. ft.
	Minimum lot size for single family units within the city’s extraterritorial jurisdiction (ETJ)	DRImlsfuetj	Sq. ft.
	Minimum floor area for single family units within the city limits	DRImfasfu	Sq. ft.
Local Subdivision Requirements (LSR)	Developers have to pay building permit fee	LSRIbpf	0, 1
	Developers have to pay development review fees	LSRIdrf	0, 1
Open Space (OSI)	Developers have to supply mandatory dedication of space or open space (or fee in lieu of dedication)	OSI	0, 1
Exactions (EI)	Developers have to pay allocable share of costs of infrastructure improvement	EI	0, 1
Supply Restriction (SRI)	Measure limiting development beyond a boundary (such as urban limit line, urban growth boundary, greenbelt, or urban service area)	SRIc	0, 1
	Measure establishing a limit on growth (population limit or building permits in a given time frame)	SRIgc	0, 1
	Measure which requires adequate service levels for residential development or service capacity as a condition of approval of residential development	SRIir	0, 1
	Measure which reduces the permitted residential density by general planning or rezoning	SRIpd	0, 1
	Measure which re-designates or rezones residential land to agriculture or open space (e.g., shore line protection)	SRIr	0, 1
Local Standard Development Perception (LSDPI)	Perception of jurisdiction’s standards for development when compared to surrounding jurisdictions	LSDPIsj	0/1/2
	Perception of jurisdiction’s standards for development when compared to county	LSDPIc	0/1/2

GL/HR/S = /General Law/ Home Rule/ Special Law
Y/N= yes/ No (y=1, n=0)
Y/N/P= Yes/ No/ In progres (y=2, P= 1, N=0)
0/1/2/ = Lower standards/ Comparable standards/ Higher standards

Two items from the LURE inventory were not considered in the framework after receiving and analyzing all the responses: 1) minimum street right-of-way width had almost a constant value for all responses so no variability was found and in some specific cases the response was found unreliable by either typing or wording errors; and 2) panel board of adjustment, a question which only applies to a municipality with a population of 500,000 or more. Only two respondents from two cities answer yes to this question. The sub-indices to which these variables belonged (DRI and LPAI) already had a good number of other indicators capturing these dimensions.

Some indicators were transformed so that the corresponding statistical procedure used in the following steps could be applied. Data values for the two questions related to perception of a jurisdiction's standards for development (LSDPIsj and LSDPIc) were transformed during the imputation stage in order to achieve convergence of the model used for multiple imputation (the original values for both variables were: 1/2/3/4/5 = The lowest standards/ Lower standards/ Comparable standards/ Higher standards/ The highest standards). The three variables defining the Density Restriction (DRI) sub-index were also transformed by obtaining the natural logarithm of their values. The reason for this was also in order to achieve convergence of the model during the multiple imputation procedure (see the following section).

5.2. Imputation and missing data

Three important steps characterized this stage: 1) the analysis of patterns of missing values, 2) the treatment of extreme values, and 3) the estimation of missing values. The

analysis of patterns allowed to obtain descriptive statistics measures of missing values in the data and was useful as an exploratory step in deciding which approach to take to address the presence of missing values. The multiple imputation procedure (hereafter MI) was the technique performed based on the pattern of missing values and the presence of some extreme values in the dataset.

5.2.1. Pattern analysis

As expressed in the methodology section, the option of deleting cases with missing values as a means of addressing the issue of missing values was not an option when creating the LURE Index. The data did not fulfill the rule of thumb of having less than 5% of missing values to the total number of cases in order for case deletion to be an option. Table 12 shows that only 12 variables had less than five% of missing values, 13 variables had between 5% and 20% and two above 20%.

Table 12 Proportion of Missing Values

Variables	N		
	Valid	Missing	%
Category of Municipality	91	0	0
Zoning commission	90	1	1
Planning commission	89	2	2
Historic commission	78	13	14
Board of adjustments	88	3	3
Neighborhood zoning areas	77	14	15
Comprehensive (master, general) plan	89	2	2
Zoning ordinance	91	0	0
Other ordinances governing plats, land development and subdivisions	87	4	4
Jurisdiction is a unit in which the county applies its own subdivision provisions to new development	81	10	11
Multifamily housing units been built in the last two years	90	1	1
Developers have to Include “affordable housing” (however defined)	81	10	11
Manufactured and modular housing been added to jurisdiction in the last two years	89	2	2
Minimum lot size SFR within city limits (sq.ft.)	72	19	21
Minimum lot size SFR within city's ETJ (sq.ft.)	67	24	26
Minimum floor area within city limits (sq.ft.)	77	14	15
Developers have to pay building permit fee	89	2	2
Developers have to pay development review fees	85	6	7
Developers have to supply mandatory dedication of space or open space (or fee in lieu of dedication)	79	12	13
Developers have to pay allocable share of costs of infrastructure improvement	76	15	16
Measure limiting development beyond a boundary (such as urban limit line, urban growth boundary, greenbelt, or urban service area)	79	12	13
Measure establishing a limit on growth (population limit or building permits in a given time frame)	82	9	10
Measure which requires adequate service levels for residential development or service capacity as a condition of approval of residential development	78	13	14
Measure which reduces the permitted residential density by general planning or rezoning	78	13	14
Measure which re-designates or rezones residential land to agriculture or open space (e.g., shore line protection)	81	10	11
Perception of jurisdiction’s standards for development when compared to surrounding jurisdictions	89	2	2
Perception of jurisdiction’s standards for development when compared to county	89	2	2

Figure 8 shows the overall summary of missing values. The *variable* pie chart shows that just two variables did not have missing values; the *cases* pie chart shows that 66 of 91 cases (jurisdictions) have at least one missing value on a variable; the *values* chart shows 250 of the 2639 values in the data (cases x variables) are missing. From this information it can be concluded that using case deletion as an option in dealing with missing values would lose much of the information in the dataset of the inventory of land use regulations.

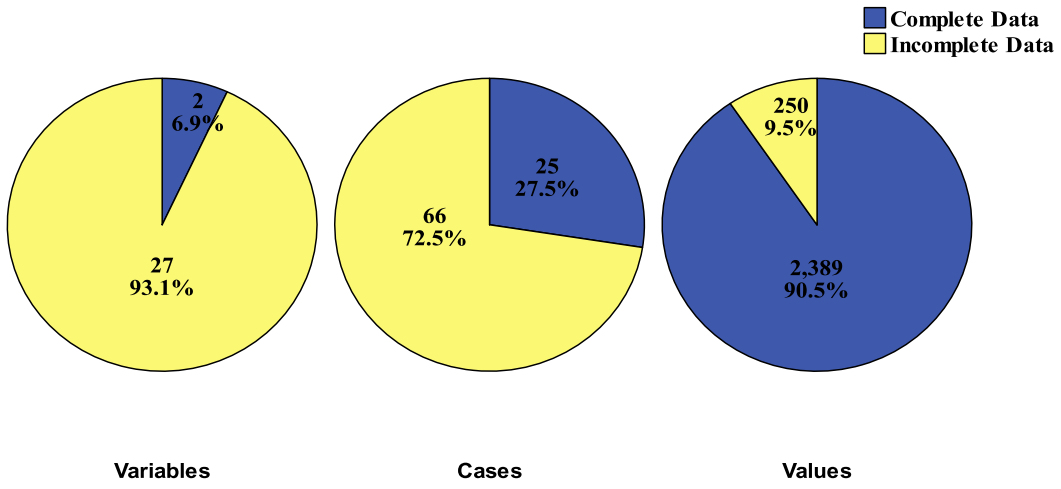


Figure 8 Overall Summary of Missing Values

Table 13 shows a statistically descriptive summary of all the variables having more than 10% of missing values. The mean and standard deviation is presented for the three of four scale ratio which variables had in the database. It was important to take into account

the characteristics of the data values for these three variables not only because of the number of missing values but also because of the distributional characteristics of those values which in turn made it necessary to make adjustments to the data before the MI procedure. These three quantitative variables were also among the top six variables with the biggest proportion of missing values.

Table 13 Variable Summary

Variables	Missing		Valid	Mean	Std. Deviation
	N	Percent	N		
Minimum lot size SFR within city's ETJ (sq.ft.)	23	25.3	68	2995.07	6320.41
Minimum lot size SFR within city limits (sq.ft.)	19	20.9	72	8849.10	8109.41
Developers have to pay allocable share of costs of infrastructure improvement	15	16.5	76		
Minimum floor area within city limits (sq.ft.)	14	15.4	77	360.00	577.736
Neighborhood zoning areas	14	15.4	77		
Measure which reduces the permitted residential density by general planning or rezoning	13	14.3	78		
Measure which requires adequate service levels for residential development or service capacity as a condition of approval of residential development	13	14.3	78		
Historic commission	13	14.3	78		
Measure limiting development beyond a boundary (such as urban limit line, urban growth boundary, greenbelt, or urban service area)	12	13.2	79		
Developers have to supply mandatory dedication of space or open space (or fee in lieu of dedication)	12	13.2	79		
Measure which re-designates or rezones residential land to agriculture or open space (e.g., shore line protection)	10	11.0	81		
Developers have to Include “affordable housing” (however defined)	10	11.0	81		
Jurisdiction is a unit in which the county applies its own subdivision provisions to new development	10	11.0	81		

a. Maximum number of variables shown: 30
b. Minimum percentage of missing values for variable to be included: 10.0%

Evaluating the missing value pattern of the variables was fundamental in order to select the most appropriate method for the MI procedure. Some imputation methods apply to specific patterns and others apply to any pattern. Little and Rubin (2002) mention that having a monotone pattern is rarely the case, however sometimes a missing-data pattern could be close to monotone behavior.

Figure 9 displays the missing-data pattern of the LURE Index dataset and includes each pattern that corresponds to a group of cases with the same pattern of incomplete and complete data. Pattern 1 (first row) represents cases not having missing values after the first row, every following pattern (row) represents those cases having missing values in those variables in the x axis (e.g. pattern 3 represents cases having missing values just on the variable SRIs (measure limiting development beyond a boundary). The chart orders the variables and patterns so that monotonicity[11] could be detected when present (Little and Rubin 2002). The ordering of variables and patterns verify if the dataset has either monotone or non-monotone characteristics.

[11] A monotonic relationship is one where *y* (thinking in *y* as a function of *x*) moves in only one direction (up or down) as *x* increases, but the relationship is not necessarily (but can be) linear

The chart revealed a tendency of the dataset to have a non-monotone characteristic. This can be identified by looking for the presence of “islands” of non-missing cells on the lower right portion of the chart. In addition, there are almost no “islands” of missing cells in the upper left portion of the chart which in turn suggests the presence of monotonicity. A practical approach to obtaining a pattern close to being monotone involves the deletion of some amount of data. However, this alternative implies the loss of substantial information. This alternative could have implied missing jurisdictions from the final stage of characterizing them by using the LURE Index, therefore this approach was not considered.

The characteristics of the missing value pattern made it necessary to impute values so that the dataset could achieve monotonicity. These non-monotone characteristics of the dataset made the use of the monotone method for the MI procedure in PASW 18 not feasible. The iterative Markov chain Monte Carlo (MCMC) method was the best suited for the MI procedure (see the following section related to the specifics of MI).

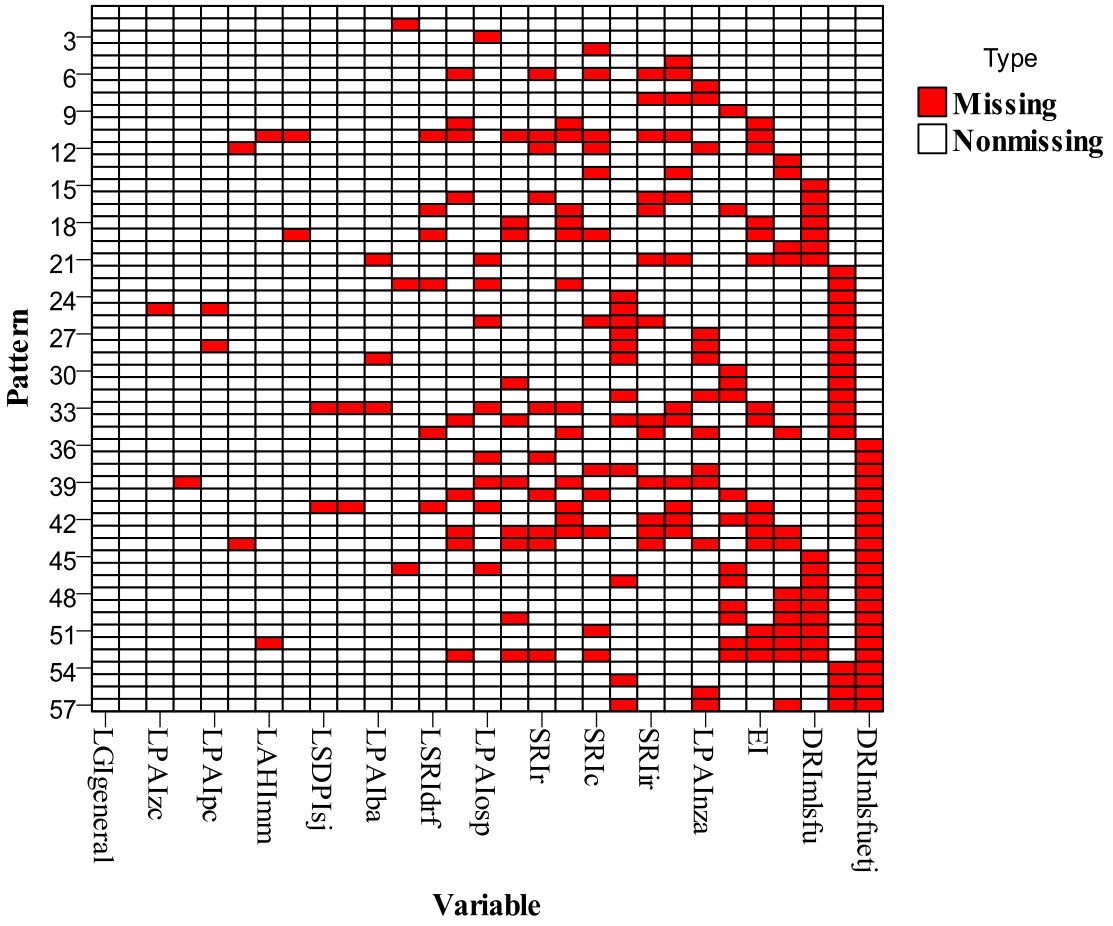


Figure 9 Missing Value Patterns

Figure 10 displays the proportion of cases for each pattern seen in Figure 6. It can be noted that over half of the cases in the dataset follow pattern 1 (cases with no missing values according to the pattern chart). Pattern 15 depicts cases with a missing value on DRImlsfu. Patterns 6, 27 and 54 are the only patterns among the 10 most frequently occurring patterns representing cases with missing values on more than one variable.

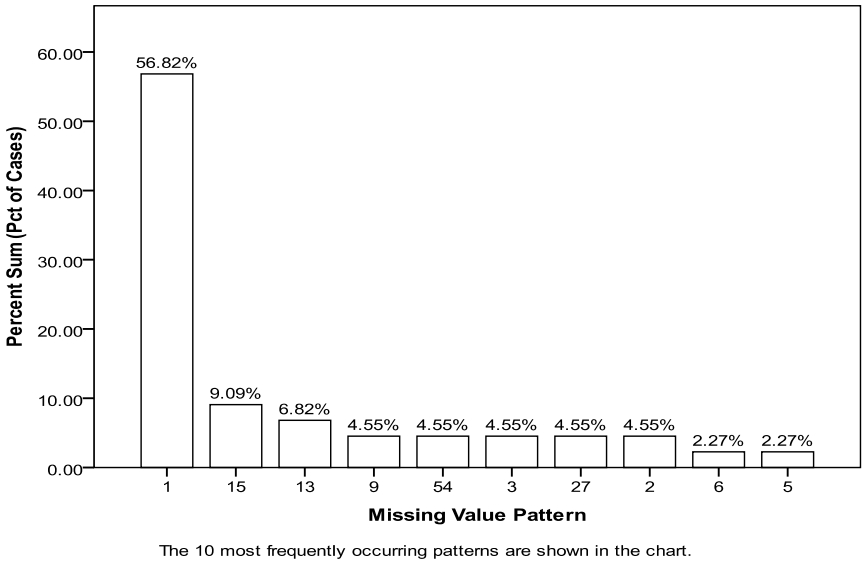


Figure 10 Missing Value Pattern

Finally, the analysis of the pattern of missing values did not reveal obstacles to the adoption of the MI procedure as a means of dealing with the presence of missing values in the dataset for the creation of the LURE Index.

5.2.2. Extreme values

Extreme values played an important role in the implementation of the MCMC procedure to perform MI of the missing values. In terms of the level of measurement, most of the indicators scores in the dataset are nominal (22 of 27 variables), following scale/ratio variables (3 of 27) and ordinal variables (2 of 27).

Because of the dominance of nominal variables, the analysis of extreme values was limited to those three scale/ratio variables. Table 14 displays the descriptive statistics for

the three variables. Only the two variables related to minimum lot size showed a high positive skewed distribution.

Table 14 Descriptive Statistics of the Only Four Quantitative Variables

Indicators	N	Min.	Max.	Mean	Std. Deviation	Skewness	
						Statistic	Std. Error
Minimum lot size SFR within city limits (sq.ft.)	72	1000	43,560	8,849.1	8,109.4	3.2	.28
Minimum lot size SFR within city's ETJ (sq.ft.)	67	0	43,560	3,039.7	6,357.2	4.4	.29
Minimum floor area within city limits (sq.ft.)	77	0	1,800	360.0	577.7	1.1	.27

Figure 11 and 12 show box plots of both lot size indicators. Specifically, five cases were identified in the *Minimum lot size SFR within city limits* variable and two in the *Minimum lot size SFR within city's ETJ* variable. All these cases were further inspected in the database and the verification of possible data error was addressed.

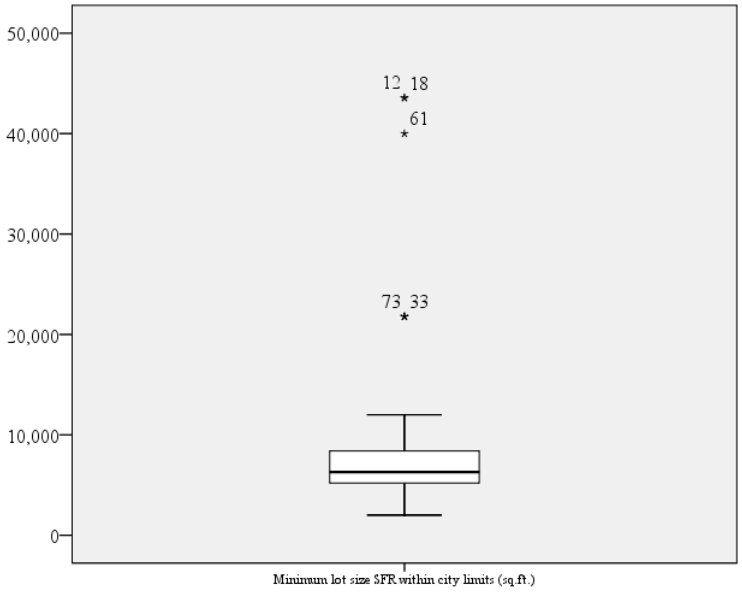


Figure 11 Indicator Minimum Lot Size SFR within City Limits (sq.ft.)

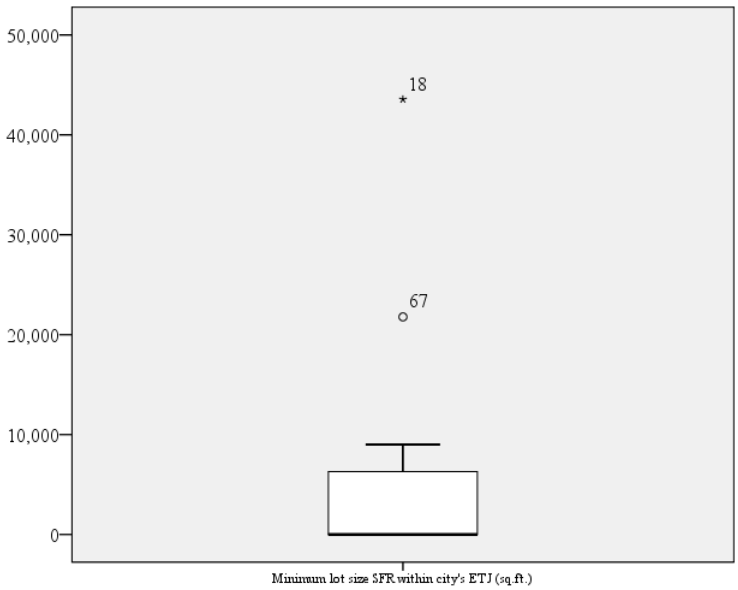


Figure 12 Minimum Lot Size SFR within City's ETJ (sq.ft.).

The skewness of the distribution of the values was due to the presence of scores of zero (cases in which the response to having a minimum standard was recorded as “no”). Further research (via phone calls) revealed that indeed minimum lot size standards are expected due to state requirements (minimum lot size requirements for on-site sewer facilities (OSSF) systems). On the other hand, high values were reviewed and there was no need for correction.

The absence of a value for minimum lot size for some cases made it necessary to make some adjustments. The approach taken in order to estimate missing values and to take into account those zero values in the imputation process was to produce imputations after changing those values to an assumed minimum that must exist on a health and an environmental basis. Based on this assumption, values were transformed into the minimum value (not zero) already recorded for other jurisdictions.

5.2.3. Multiple imputation

The MI procedure was preferred over the single imputation procedure not only because of the characteristics of the missing-data pattern of values but also because the procedure of MI in PASW 18 statistics allowed the creation of five multiple complete sets of data values. The MI procedure permitted producing outputs for each dataset, plus the possibility of estimation of what the results would have been if the original dataset had no missing values. In addition, these data sets were later used to create alternative scenarios which allowed testing the robustness of the LURE Index.

Table 15 and 16 show the specifications and results of the imputation process. From the 27 variables just two were not considered in the estimation of missing values because of no presence of missing values in them. Five complete data sets of imputations were obtained. The specific imputation procedure used was the iterative MCMC method which is suitable when the pattern of missing data is arbitrary (monotone or non-monotone).

MCMC fits a univariate (single dependent variable) model using all other variables as predictors for each iteration (steps) and variable. After this, the MCMC method imputes missing values for the variable being fit. After the maximum number of iterations is reached, MCMC saves the imputed values at the maximum iteration into the imputed dataset.

Table 15 Multiple Imputation Specifications

Imputation Method	**Fully Conditional Specification**
Number of Imputations	5
Model for Scale Variables	Linear Regression
Interactions Included in Models	(none)
Maximum Percentage of Missing Values	100.0%
Maximum Number of Parameters in Imputation Model	100

Table 16 Imputation Results

Imputation Method		**Fully Conditional Specification**
Fully Conditional Specification Method Iterations		60
Dependent Variables	Imputed	LPAIzc,LPAIpc,LPAIhc,LPAIba,LPAIpba,LPAInza,LPAIcp,LPAIoo,LPAIosp,LAHImh,LAHImm,LAHIah,LSRIbpf,LSRIdrf,OSI,EI,SRIc,SRIgc,SRIir,SRIpd,SRIr,LSDPIjsREC,LSDPIcREC,InDRImlsfu,InDRImlsfuetj,InDRImsrw,InDRImfasfu
	Not Imputed(Too Many Missing Values)	
	Not Imputed(No Missing Values)	
Imputation Sequence		LPAIzc,LPAIpc,LPAIhc,LPAIba,LPAIpba,LPAInza,LPAIcp,LPAIoo,LPAIosp,LAHImh,LAHImm,LAHIah,LSRIbpf,LSRIdrf,OSI,EI,SRIc,SRIgc,SRIir,SRIpd,SRIr,LSDPIjsREC,LSDPIcREC,InDRImlsfu,InDRImlsfuetj,InDRImsrw,InDRImfasfu

Scale variables were modeled through linear regression and categorical variables with a logistic regression.

5.2.3.1. Model accuracy

The accuracy of the MI modeling was checked by: a) verifying the presence of negative and out of bound values, and b) by assessing the model convergence.

Negative and out of bound values

The MI procedure produced descriptive statistics for the three scale ratio variables in the dataset. Statistics are displayed for: 1) the original data, 2) each set of imputed values, and 3) each complete dataset (combination of both original and imputed values). These tables allowed for any problem in the MI process to be checked. Table 17 shows the statistics for the minimum lot size for single family units within the city limits variable

(DRImlsfu). The presence of problems was detected when negative and out of bound values was seen in this table as well as the other two variables' tables (the other variables' tables are found in the appendix H). Another problem found was that most of the mean values were higher than those of the original data and imputed maximum values were lower than those of the original dataset. The MI procedure was executed again but this time, two approaches were taken to address these problems: 1) to run the model with constraint in the minimum bounds, and 2) the values for these three variables were transformed by obtaining their natural logarithm.

Table 17 Descriptive Statistics for Min. Lot Size within the City Limits

Data	Imputation	N	Mean	Std. Deviation	Minimum	Maximum
Original Data		72	8849.10	8109.415	1000.00	43560.00
Imputed Values	1	19	15503.45	9291.155	4265.59	34564.76
	2	19	7881.60	12004.626	-10985.06	29359.05
	3	19	5332.37	9939.459	-11420.68	32497.31
	4	19	10849.07	12681.147	-11963.92	36497.22
	5	19	14633.82	14656.504	-11324.15	41201.46
Complete Data After Imputation	1	91	10238.47	8748.761	1000.00	43560.00
	2	91	8647.09	8992.105	-10985.06	43560.00
	3	91	8114.84	8585.087	-11420.68	43560.00
	4	91	9266.67	9203.793	-11963.92	43560.00
	5	91	10056.90	10021.549	-11324.15	43560.00

Tables 18, 19 and 20 show the descriptive statistics obtained after the MI procedure was executed again. All values now performed well under reasonable bounds.

Table 18 Descriptive Statistics for Natural Logarithm of DRImlsfu

Data	Imputation	N	Mean	Std. Deviation	Minimum	Maximum
Original Data		72	8.87	.602	6.91	10.68
Imputed Values	1	19	8.78	.919	6.95	10.55
	2	19	8.58	.774	7.04	10.33
	3	19	8.79	.992	5.84	10.16
	4	19	8.70	.869	6.54	9.93
	5	19	8.63	.681	7.46	10.23
Complete Data After Imputation	1	91	8.85	.675	6.91	10.68
	2	91	8.81	.648	6.91	10.68
	3	91	8.85	.696	5.84	10.68
	4	91	8.83	.665	6.54	10.68
	5	91	8.82	.623	6.91	10.68

Table 19 Descriptive Statistics for Natural Logarithm of DRImlsfuetj

Data	Imputation	N	Mean	Std. Deviation	Minimum	Maximum
Original Data		68	8.19	.585	7.82	10.68
Imputed Values	1	23	8.02	.630	6.36	8.98
	2	23	7.98	.962	6.76	10.26
	3	23	7.79	.835	6.36	9.24
	4	23	7.56	1.029	5.24	9.10
	5	23	7.89	.882	5.83	9.17
Complete Data After Imputation	1	91	8.14	.598	6.36	10.68
	2	91	8.13	.699	6.76	10.68
	3	91	8.09	.674	6.36	10.68
	4	91	8.03	.767	5.24	10.68
	5	91	8.11	.679	5.83	10.68

Table 20 Descriptive Statistics for Natural Logarithm of DRImfasfu

Data	Imputation	N	Mean	Std. Deviation	Minimum	Maximum
Original Data		77	6.80	.218	6.68	7.50
Imputed Values	1	14	6.82	.357	6.35	7.47
	2	14	6.78	.255	6.26	7.22
	3	14	6.83	.273	6.26	7.31
	4	14	6.77	.449	5.71	7.34
	5	14	6.76	.318	6.14	7.27
Complete Data After Imputation	1	91	6.80	.242	6.35	7.50
	2	91	6.80	.223	6.26	7.50
	3	91	6.80	.226	6.26	7.50
	4	91	6.79	.263	5.71	7.50
	5	91	6.79	.235	6.14	7.50

MCMC Convergence

Model convergence was assessed by plotting the means and standard deviations by iteration and imputation for each scale ratio variable. PASW 18 missing values module allowed creating iteration and imputation numbers at the same time as running the model to obtain the estimation of missing values.

Figure 13 displays line charts which show the mean and standard deviation of the imputed values of lnDRImlsfu (natural logarithm of minimum lot size for single family units within the city limits) at each iteration of the MCMC imputation method (the plots for the other scale ratio variables can be found in the appendix). The diagnostic was done by looking at the patterns in the lines. Two things gave confidence in the imputation process: 1) no pattern was found in the lines, and 2) they looked suitably “random” (PASW 18 Manual).

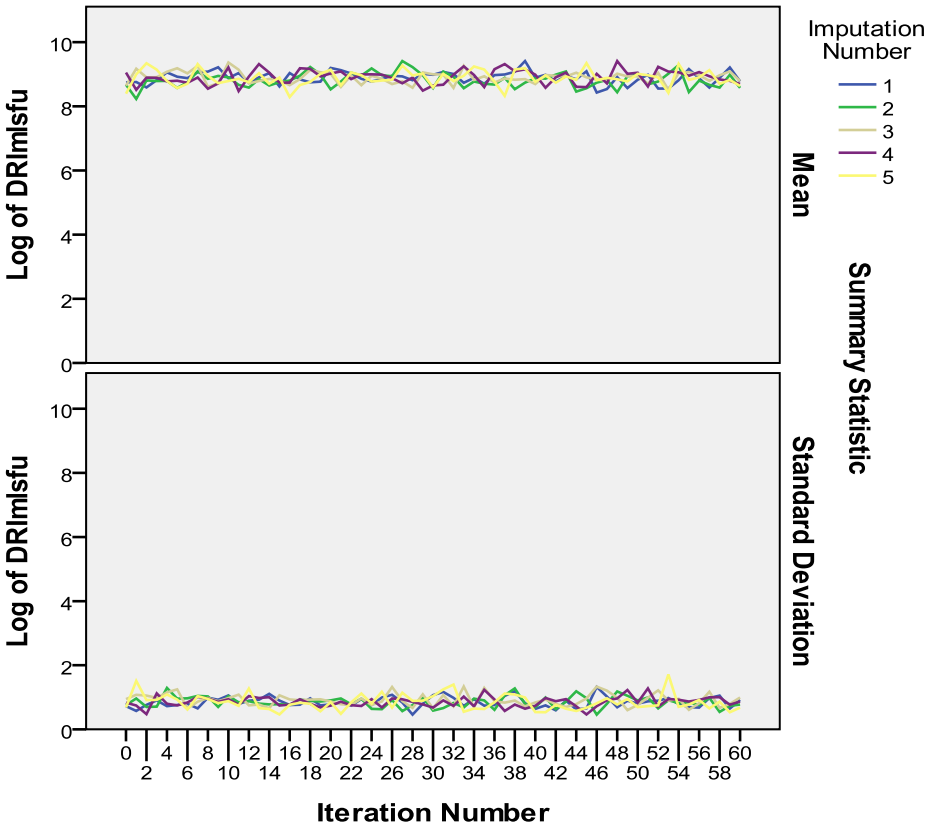


Figure 13 Iteration Data to Assess Convergence of Method

5.3. The LURE index and its ten sub-indices

Five complete datasets of imputed values were the result of the MI procedure. Since only one dataset was necessary for the creation of the LURE Index, a process of random selection between the five options was used to select one of the complete datasets for the creation of the LURE Index. The remaining datasets were later used to create scenarios (other alternative indices) to assist in the evaluation of robustness of the LURE Index (scenarios used in section 6 uncertainty and sensitivity analysis).

Ten sub-indices were created based on the framework and the data obtained by the LURE Survey (implementing the opinions of experts and stakeholders in sections 4.1.2 and 5.21 on survey design and framework).

The creation of the sub-indices was a straightforward process because most of the scores units for the indicators were the same; there was no need for the normalization of values. The advantage of this approach is that the richness of the values is preserved. This approach has been used before when dealing with the same units of measurement (Nardo M. and F. 2004). Sub-indices were created by the simple addition of the units. The following is a description of how every sub-index was processed.

5.3.1. The Local Government Sub-Index (LGI)

Only one variable defined this sub-index: the category of municipality. If a jurisdiction was a home rule jurisdiction then a value of 1 was received. If general law was the answer, then a value of zero was recorded. It was thought that the ability of home rule jurisdictions to implement their own regulations allowed them to have a more direct effect on housing markets (general law jurisdictions rely on what state law establishes regarding regulations so they are limited in enacting more stringent measures).

- Home Rule = 1 (greater influential role on housing markets)
- General = 0 (lower influence compared to Home Rule Jurisdictions)

5.3.2. Local Planning Approval (LPAI)

Five variables were used to create this sub-index. Jurisdictions were asked if they had some of the following entities: 1) zoning commission (LPAIzc), 2) planning commission (LPAIpc), 3) historic commission (LPAIhc), 4) board of adjustments (LPAIba), and 5) neighborhood zoning areas (LPAInza).

Whenever the response was a "yes" to having some of those entities a score of "1" was received. The assumption was the more entities involved in the regulatory process, the greater the impact on housing markets. The highest score achievable was five. The LPAI Sub-index could be summarized as:

$$LPAI = LPAIzc + LPAIpc + LPAIhc + LPAIba + LPAInza$$

5.3.3. Local Planning Approval Requirement (LPAIR)

The LPAIR Sub-index was formulated based on all the answers to questions number four (three items) and number five (one item). Question four asked jurisdictions about the existence of: 1) comprehensive (master, general) plan (LPAIcp); 2) zoning ordinance (LPAIzo); and 3) other ordinances governing plats, land development and subdivisions (LPAIoo). Question five asked if the jurisdiction was a unit in which the county applied its own subdivision provisions to new developments (LPAIosp).

The LPAIR Sub-index could be summarized as:

$$LPAIR = LPAIcp + LPAIzo + LPAIoo + LPAIosp$$

These questions detailed which specific documents communities used as a way to regulate their land use and development. The jurisdictions that did not use some of these documents are subjected to county subdivision provisions. Thus these communities can regulate their development in some way.

5.3.4. Local Affordable Housing (LAHI)

The LAHI Sub-index was formed from answers to questions six, seven and item three from question 12. Question six asked if multifamily housing units had been built in the last two years (LAHImh). Question seven asked if manufactured and modular housing had been added to the jurisdiction in the last two years (LAHImm). The specific question from question 12 asked if developers were required to include “affordable housing” (LAHIah).

The LAIH Sub-index could be summarized as:

$$LAHI = LAHImh + LAHImm + LAHIah$$

This was the only case where responses of “no” added a value of 1 to the sub-index. The assumption was that communities not adding either multifamily or manufactured housing to their development probably could be restricting the production of affordable housing.

5.3.5. Density Restriction (DRI)

Three questions were used to generate the DRI Sub-index. Questions eight asked about the minimum lot size for single family units within the city limits (nlDRImlsfu). Question nine requested information about minimum lot sizes for single family units within the city's extraterritorial jurisdiction (nlDRImlsfuetj). Question ten asked about the minimum floor area for single family units within the city limits (nlDRImfasfu). The DRI Sub-index could be summarized as:

$$DRI = nlDRImlsfu + nlDRImlsfuetj + nlDRImfasfu$$

These three variables were all transformed by using the natural logarithm function (see the multiple imputation stage for more details). Because these three questions related to the same unit of measure, simple addition was performed.

5.3.6. Local Subdivision Requirements (LSRI)

The LSR Sub-index was created using items one and two from question number 12. Item one asked if developers had to pay building permit fees (LSRIbpf) and item two asked if developer had to pay development review fees (LSRIdrf).

$$LSRI = LSRIbpf + LSRIdrf$$

5.3.7. Open Space (OSI)

The OSI Sub-index simply used item four of question number 12 reviewing whether developers had to supply mandatory dedication of space or open space. OSI could be stated as having a value of 1 if there was a “yes” answer and 0 otherwise.

5.3.8 Exactions (EI)

The EI Sub-index was formulated based on question number 12 whether developers had to pay an allocable share of costs of infrastructure improvement. The index received a 1 if “yes” was the answer and 0 if “no” was the answer.

5.3.9. Supply Restriction (SRI)

The SRI Sub-index was generated by all the answers to the items in question number 13: 1) measure limiting development beyond a boundary (SRIc); 2) measure establishing a limit on growth (SRIgc); 3) measure which required adequate service levels for residential development or service capacity as a condition of approval of residential development (SRIir); 4) measure which reduced the permitted residential density by general planning or rezoning (SRIpd); 5) measure which re-designated or rezoned residential land to agriculture or open space (SRIr). The SRI Sub-index could be summarized as:

$$SRI = SRIc + SRIgc + SRIir + SRIpd + SRIr.$$

For any ”yes” response in any of the measures that this question was recording a value of 1 was given. Thus, the SRI Sub-index had a maximum possible value of five points.

5.3.10. Local Standard Development Perception (LSDPI)

The two items from question number 14 were used to create the LSDPI Sub-index: 1) perception of a jurisdiction’s standards for development when compared to surrounding jurisdictions (LSDPIsj); and 2) perception of a jurisdiction’s standards for development when compared to the county (LSDPIc). The LSDPI could be summarized as:

$$LSDPI = LSDPIsj + LSDPIc$$

This was the only sub-index in which the values ranged from 0 to 2 because the possible answers for these questions ranged from 0 for lower standards, 1 for comparable standards, and 2 for higher standards.

5.4. Multivariate analysis

Multivariate analysis (MA) was used to: 1) assess the consistency of the LURE Index (statistical dimensionality of the framework);and 2) generate an alternative method of weighting for aggregation (see following section).

MA allowed for the verification of adequate correspondence between the theoretical structure (depicted by the different dimensions/sub-indices and indicators in the framework) established before the creation of the H-GA’s land use regulations inventory and the statistical structure seen in the collected data. FA was carried out to confirm the

number of dimensions/sub-indices (components). The hypothesis here was that the theoretical structure (framework) established in order to create the LURE Index was expected to have a correspondence with the same number of relevant statistical dimensions (factors) found in the collected data. If correspondence was found, then the collected data indeed endorsed the chosen framework.

Factor analysis was performed involving the following steps: 1) computation of correlation matrix (small partial correlation coefficients are a desired effect in order to perform FA); 2) extraction of factors (components); and 3) rotation of factors.

5.4.1. Observed correlations

Table 21displays the correlation coefficients among the ten sub-indices of the LURE Index. The only large coefficient observed was between the sub-indices LPAI and LPAIR (0.638). All the other correlation coefficients among the sub-indices were small, which is a good indicator that the different sub-indices are not highly correlated. Therefore it is clear that the ten dimensions/sub-indices established in advanced accurately capture the different aspects of the H-GA LURE and its effect on housing markets.

The following step was to look at the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy to test and compare the sizes of observed correlations against the sizes of partial correlation coefficients.

Table 21 Matrix of Observed Correlation Coefficients

Sub-Index	LGI	LPAI	LPAIR	LAHI	DRI	LSRI	OSI	EI	SRI	LSPDI
LGI	1	.284**	.260*	-.209*	-.033	.216*	.032	.277**	-.079	.211*
LPAI	.284**	1	**.638****	-.248*	-.121	.293**	.199	.176	.352**	.394**
LPAIR	.260*	**.638****	1	-.198	-.158	.341**	.189	.221*	.307**	.510**
LAHI	-.209*	-.248*	-.198	1	.033	-.017	-.157	-.093	-.214*	.112
DRI	-.033	-.121	-.158	.033	1	-.020	.010	-.019	-.186	.078
LSRI	.216*	.293**	.341**	-.017	-.020	1	.030	.326**	.365**	.414**
OSI	.032	.199	.189	-.157	.010	.030	1	.101	.355**	.214*
EI	.277**	.176	.221*	-.093	-.019	.326**	.101	1	.173	.237*
SRI	-.079	.352**	.307**	-.214*	-.186	.365**	.355**	.173	1	.344**
LSPDI	.211*	.394**	.510**	.112	.078	.414**	.214*	.237*	.344**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 22 shows the result of applying the KMO to the sub-indices. The overall measure is 0.665 which, although small, was considered enough to continue with FA (if the value is 1, it means that all partial correlation coefficients are small compared to the ordinary correlation coefficients). There is not a standard rule about which is a good KMO index to continue with FA.[12]

Table 22 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.665

[12] Kaiser (1974) declares measures below 0.60 as either miserable or unacceptable

A method of obtaining a higher KMO overall measure is by analyzing KMO measures for the individual variables to see if some of them could be removed. Table 23 displays the KMO values for all ten sub-indices. Density Restriction (DRI) and Local Affordable Housing (LAHI) are the only sub-indices with low KMO values (.321 and .441 values respectively). All the other eight sub-indices had values above 0.500, which was considered a large number and, as a result, elimination of any of these sub-indices was not necessary.

Although the elimination of the DRI and LAHI sub-indices could be an option to obtain a higher KMO index, this approach was not considered due to the fact that these sub-indices define an important aspect of the relation between land use regulations and housing markets. Nonetheless, the option of not using DRI for the creation of the LURE Index was the approach used to create some of the alternative scenarios to test the robustness of the LURE Index.

Table 23 Kaiser-Meyer-Olkin Measures of Sampling Adequacy (MSA)

Sub-Index	**MSA**
Local Government (LGI)	.565
Local Planning Approval (LPAI)	.772
Local Planning Approval Requirements (LPAIR)	.722
Local Affordable Housing (LAHI)	**.441**
Density Restriction (DRI)	**.321**
Local Subdivision Requirements (LSRI)	.743
Open Space (OSI)	.662
Exactions (EI)	.799
Supply Restriction (SRI)	.592
Local Standard Development Perception (LSDPI)	.674

5.4.2. Estimation and rotation of factors

Of the multiple statistical algorithms for extracting factors (Tabachnick and Fidell 2007), the principal component analysis (PCA) was the procedure used to estimate factors (hereafter components) from the correlation matrix of sub-indices. PCA was chosen because it was the simplest method and the solution obtained by PCA and other statistical algorithms rarely differ enough to matter (Joreskog 1979). The general model for PCA considered was:

$$X_i = A_{i1}F_1 + A_{i2}F_2 + \ldots\ldots + A_{ik}F_k + U_i$$

where:

i^{th} = standardized variable
F's = common factors
U = unique factor

Table 24 displays the components obtained through PCA and the percentage of the total variance in the sample explained by each factor. According to the results, it can be seen that the first four components account for 65% of the total variance. These results show that all ten sub-indices capture well the latent phenomenon. The fact that nearly five dimensions account for almost 65% of the variance shows precisely that the effect of LUREs on housing markets is indeed a multidimensional phenomenon. (In this instance, it is not considered necessary that a few factors must explain as much variance as possible).

Table 24 Total Variance Explained

Component	Initial Eigenvalues		
	Total	**% of Variance**	**Cumulative %**
1	3.040	30.398	30.398
2	1.275	12.745	43.143
3	1.207	12.065	55.208
4	1.044	10.444	65.651
5	.930	9.297	74.948
6	.778	7.783	82.731
7	.601	6.008	88.740
8	.440	4.400	93.139
9	.405	4.052	97.191
10	.281	2.809	100.000

Extraction Method: Principal Component Analysis.

Figure 14 displays the screen plot showing the total variance associated with each component. Usually the factors retained are those that appear before the screen begins. As the plot shows, after component number 1, the next four components contribute in the same proportion to most of the variance.

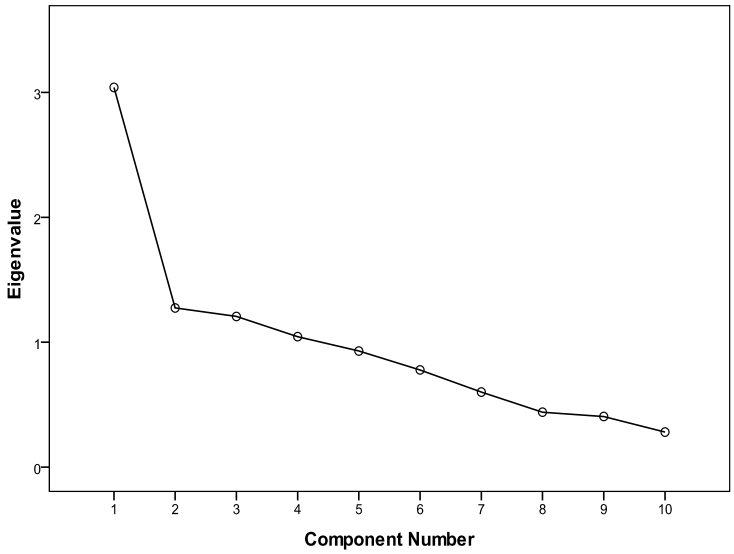


Figure 14 Screen Plot

Coefficients (factor loadings) were estimated through PCA and the Varimax with Kaiser Normalization method was used to produce the rotation. Table 25 displays the factor loadings after rotation.

Based in the FA performed on the ten sub-indices of the LURE Index, it was proven that all sub-indices perfectly capture the latent phenomenon intended to be captured by the index.

Table 25 Rotated Component Matrix [a]

	Component			
	1	2	3	4
Local Government	.772	.273	-.182	.112
Local Planning Approval	.729	.065	-.106	-.059
Local Planning Approval Requirements	.655	.250	.255	-.281
Local Affordable Housing	.561	.293	.362	-.270
Density Restriction	.544	-.072	.216	.123
Local Subdivision Requirements	.050	.767	.186	.194
Open Space	.318	.723	-.034	-.278
Exactions	.102	-.272	-.825	.072
Supply Restriction	.473	-.352	.601	.081
Local Standard Development Perception	.013	.024	-.032	.919

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 13 iterations.

5.5. Normalization

Because all values for the different variables used to create the ten sub-indices had the same metric, it was not necessary to perform normalization at this level. Nonetheless, in order to be able to compare the LURE Index with other exercises having a similar composite indicator (see Gyourko 2008), it was decided to perform a normalization of the ten sub-indices.

5.5.1. Normalization technique

The standard deviation from the mean procedure (Z-score) was the approach selected to create the LURE Index. This method was selected over the other alternatives because: 1) it is the most common method of standardization (Nardo, Saisana et al. 2005); 2) its desirable characteristics of converting variables to a normal distribution with a mean of 0 and a standard deviation of 1; and 3) it avoids introducing aggregation distortions due to differences in variable means (Freudenberg 2003).

Moreover, in order to assess the sensitivity of the index due to different standardization procedures available, the rescaling min-max method (distance from the most stringent and least stringent regulatory environment) was used to create the alternative indices used in the uncertainty and sensitivity analysis. (In this method extreme values can have a great effect on the composite index, especially if unreliable outliers are used. However, this method can widen the range of indicators with small intervals more than when using z-scores).

The Z-score procedure is defined as:

$$z = \frac{x - \bar{x}}{s}$$

where:

z = standard score
x = actual value
$\bar{x}$ = mean value
s = standard deviation

In the rescaling min-max method, the positioning is in relation to the global maximum and minimum. The index takes values between 0 (laggard) and 100 (leader). The Min-max procedure is defined as:

$$y = 100\ \frac{x - \min\,(x)}{\max(x) - \min(x)}$$

where:

y = normalized value
x = actual value

The Z-score and Min-max procedures allowed simultaneous normalization of all five complete estimated data sets produced during MI (see the section on imputation and missing data).

5.6. Weighting and aggregation

5.6.1. Weighting

FA was the technique selected for the weighting of the ten sub-indices of the LURE Index based on the following factors: 1) it is one of the most commonly used methods; and 2) it is the method used in other similar exercises creating LURE indices. Another method also used in related studies is equal weighting (EW) which was used in this research to create the alternative indices to assess the robustness of the LURE Index in the uncertainty and sensitivity analysis section.

The steps applied to obtain the weights were: 1) to use the information obtained in the multivariate analysis section regarding the total variance explained by the common

factors; 2) to use the rotation of factors from FA; and 3) the construction of weights based on the rotated component matrix obtained in step 2.

Once the factors were obtained (see Table 25 in the estimation and rotation of factors in the multivariate analysis section), the criteria used in deciding the number of factors to keep were: a) having Eigenvalues larger than one; b) the factor's contribution to the overall variance was more than 10%; and c) the combined factors altogether contributed in explaining more than 60% of the overall variance. Table 26 shows the total variance explained by the factors retained.

Table 26 Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.040	30.398	30.398	3.040	30.398	30.398
2	1.275	12.745	43.143	1.275	12.745	43.143
3	1.207	12.065	55.208	1.207	12.065	55.208
4	1.044	10.444	65.651	1.044	10.444	65.651

Extraction Method: Principal Component Analysis.

Table 27 displays the factor loadings obtained based on PCA. The construction of weights was done from this matrix of factor loadings after their rotation and the squaring of the factor loadings (Nicoletti, Scarpetta et al. 2000).

Table 27 Component Loadings Based on Principal Components

Sub-Index	Component				Squared component loading (scaled to unity sum)			
	1	2	3	4	1	2	3	4
Local Standard Development Perception (LSDPI)	.772	.273	-.182	.112	**0.02**	0.00	0.00	0.00
Local Subdivision Requirements (LSRI)	.729	.065	-.106	-.059	**0.02**	0.00	0.00	0.00
Local Planning Approval Requirements (LPAIR)	.655	.250	.255	-.281	**0.02**	0.00	0.00	0.01
Local Planning Approval (LPAI)	.561	.293	.362	-.270	**0.01**	0.01	0.01	0.01
Exactions (EI)	.544	-.072	.216	.123	**0.01**	0.00	0.00	0.00
Open Space (OSI)	.050	.767	.186	.194	0.00	**0.04**	0.00	0.00
Supply Restriction (SRI)	.318	.723	-.034	-.278	0.00	**0.03**	0.00	0.01
Local Affordable Housing (LAHI)	.102	-.272	-.825	.072	0.00	0.00	**0.05**	0.00
Local Government (LGI)	.473	-.352	.601	.081	0.01	0.01	**0.03**	0.00
Density Restriction (DRI)	.013	.024	-.032	.919	0.00	0.00	0.00	**0.07**
Total variance explained	25.04	15.40	13.66	11.53				

Table 28 displays the weights obtained by FA and used to aggregate the sub-indices to obtain the LURE Index.

Table 28 Weights Based on FA

Sub-Index	Weights
Local Standard Development Perception (LSDPI)	8
Local Subdivision Requirements (LSRI)	7
Local Planning Approval Requirements (LPAIR)	5
Local Planning Approval (LPAI)	4
Exactions (EI)	4
Open Space (OSI)	12
Supply Restriction (SRI)	11
Local Affordable Housing (LAHI)	16
Local Government (LGI)	9
Density Restriction (DRI)	24
Total	100

5.6.1.1. Weighting for the scenarios (alternative indices)

EW and FA were the procedures used for weighting to obtain the scenarios needed to test the robustness of the LURE Index. Table 29 shows examples of the values obtained using FA for the LURE Index and the values for EW. It is important to note that in the case of these scenarios, one of the approaches used was to obtain scenarios considering the exclusion of one of the sub-indices. When this was the case, the FA had to be calculated again to obtain weights for those scenarios. EW was simply re-calculated by dividing the total weight by the number of retained sub-indices.

Table 29 Weightings Used Based in FA and EW.

Weighting procedure	Sub- indices									
	LSDPI	LSRI	LPAIR	LPAI	EI	OSI	SRI	LAHI	LGI	DRI
FA	8	7	6	4	4	12	11	16	8	24
EW	10	10	10	10	10	10	10	10	10	10

Note: When scenarios where created excluding a sub-index, the values through EW were obtained simply by dividing 100/9= 11.11

5.6.2. Aggregation

Three aggregation procedures are commonly used in literature to create indices: a) linear aggregation; b) geometric mean; and c) a non-compensatory approach (Nardo, Saisana et al. 2005).

The linear aggregation method (weighted mean or arithmetic average) was used to create the LURE Index and alternative scenarios. Like in the other procedures, the decision to use this method was based on using the same procedures applied in similar studies. In addition, this approach has proven to be the simplest and easiest to communicate. Linear aggregation is useful when all indicators have the same measurement unit, thus the mathematical properties are respected. Linear aggregation's properties made it suitable for the characteristics of the dataset of the LURE Index.

The geometric aggregation method (weighted geometric mean or geometric average) is preferred when some degree of non-compensability between indicators and dimensions is desired and, in both linear and geometric approaches, the weights express trade-offs between indicators (Nardo, Saisana et al. 2005).

The third method is a non-compensatory procedure which does not allow compensability (multi-criteria approach -MCA-). MCA is better suited when highly different dimensions are aggregated in the index. Of the two latter methods, only geometric aggregation was used to create alternative scenarios.

The linear aggregation used to create the LURE Index is defined:

$$Index = \sum_{k=1}^{n} W_k X_k, \; where \; 0 \leq w_k \leq 1, and \; \sum_{k} w = 1$$

The geometric aggregation used to create alternative scenarios is defined:

$$Index = \prod_{k=1}^{n} x_k^{w_k}, where \; 0 \leq w_k \leq 1, and \; \sum_{k} w = 1$$

5.7. Results

After the ten sub-indices defining the LURE Index were created by the addition of the individual variable's score, these were normalized through the z-score method. Then, FA derived weights were applied and linear aggregation was performed to obtain the overall scores. Once the final scores were obtained, the LURE Index was created by normalizing the values through the z-score procedure.

5.7.1. LURE Index rankings

Table 30 shows the LURE Index for each one of the 91 jurisdictions. Every location has been ranked according to these values. The interpretation of the index is straight forward. High values (positive) mean that those jurisdictions have highly regulated housing markets in terms of the LURE Index. Low values (negative) mean that the markets are the less regulated.

The highest score was the city of Roman Forest (1.02 index score). The jurisdiction of Thompsons scored the lowest (-1.31 index score) making it the least regulated.

Table 30 LURE Index Values (Jurisdictions 1-45)

Ranking	Jurisdictions	LURE Index
1	Roman Forest	1.02
2	Sugar Land	.74
3	Katy	.67
4	Fulshear	.63
5	Palacios	.59
6	Brookside Village	.57
7	Spring Valley	.54
8	Tomball	.54
9	Willis	.50
10	El Lago	.48
11	Seabrook	.48
12	Taylor Lake Village	.44
13	Sealy	.41
14	Piney Point Village	.40
15	Lake Jackson	.38
16	Orchard	.38
17	El Campo	.38
18	Shenandoah	.36
19	Texas City	.35
20	Iowa Colony	.35
21	Simonton	.34
22	Friendswood	.33
23	Hedwig Village	.31
24	West University Place	.27
25	Hillshire	.26
26	Missouri City	.26
27	Dayton	.25
28	Clute	.23
29	Sweeny	.23
30	Quintana	.20
31	Surfside Beach	.18
32	Cut and shoot	.17
33	Deer Park	.15
34	Meadows Place	.15
35	Alvin	.13
36	Tiki Island	.13
37	Manvel	.11
38	Freeport	.11
39	Pleak	.10
40	Bay City	.10
41	Pearland	.09
42	Montgomery	.07
43	Humble	.07
44	Mont Belvieu	.07
45	Richwood	.07

Table 30 Continued

Ranking	Jurisdictions	LURE Index
46	Bellair	.06
47	Cleveland	.02
48	Shoreacres	.02
49	East Bernard	.02
50	Wharton	.01
51	Huntsville	.01
52	Eagle Lake	-.05
53	Pasadena	-.06
54	Jersey Village	-.06
55	Stafford	-.06
56	Magnolia	-.06
57	Bunker Hill Village	-.10
58	New Waverly	-.11
59	Old River-Winfree	-.11
60	Oak Ridge North	-.14
61	La Porte	-.15
62	Webster	-.15
63	Nassau Bay	-.16
64	Dickinson	-.17
65	Clear Lake Shores	-.17
66	Conroe	-.23
67	Brookshire	-.23
68	Santa Fe	-.24
69	Richmond	-.25
70	Beach City	-.26
71	West Columbia	-.28
72	La Marque	-.30
73	Bayou Vista	-.30
74	Baytown	-.35
75	League City	-.37
76	Houston	-.38
77	Angleton	-.39
78	Needville	-.42
79	Jones Creek	-.45
80	Arcola	-.45
81	Southside Place	-.47
82	Danbury	-.48
83	Holiday Lakes	-.56
84	Anahuac	-.69
85	Riverside	-.69
86	South Houston	-.70
87	Daisetta	-.73
88	Pine Island	-.80
89	Bonney	-.83
90	Splendora	-1.01
91	Thompsons	-1.31

5.7.2. Cluster analysis

Cluster analysis (CLA) was performed in order for the LURE Index to be easily compared with the latest studies creating this type of index and for the interpretation and communication of the results to be more easily understood. Pendall et al (2006) performed cluster analyses so that four groups were presented in their study. Gyourko et al. (2008) created three groups based on percentiles (one group for those jurisdictions located in the inter-quartile range and two other groups for the 25 and 75 percentiles). Creating clusters made the interpretation of the results more appropriate for all of the 91 jurisdictions and gave insight into the structure of the dataset.

From the two types of CLA techniques (hierarchical and non-hierarchical), the non-hierarchical method of *k*-means was selected to create the clusters for the 91 jurisdictions used in the LURE Index. Although k-means procedure requires the selection in advance of the number of clusters (Anderberg 1973), the hierarchical clustering procedure was used to estimate starting values for the *k*-means algorithm.

Because the k-means procedure assigns cases for which its distance to the cluster is the smallest, the impact of extreme values is important (Norusis 2010). In the case of the LURE Index, the scores were already standardized thus there was no necessity of making more adjustments to the values. Although the LURE Index scores were already normalized, it was detected that some cases with high values had an impact on the CLA.

Figure 15 is a plot of the distances to the cluster centers for all of the cases. Those cases with extreme values can be seen in Clusters 1 and 4. Nonetheless the impact of the cases with high values did not diminish the results achieved by the CLA. (To prove this, the extreme values were deleted and the results of CLA remained the same)

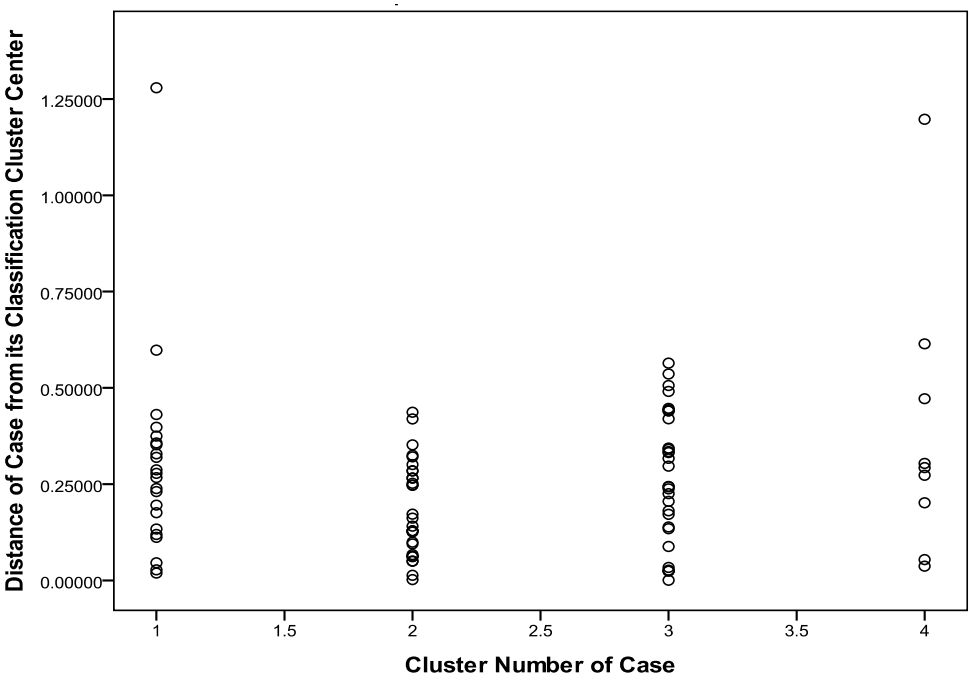


Figure 15 Plot of Distances to Cluster Centers

Once the clusters were obtained, names were assigned to them based on the degree of regulatory stringency. The most regulated, highly regulated, lightly regulated and less regulated were the family-names assigned to each cluster.

Table 31 displays the clusters obtained and the jurisdictions in each one according to CLA. The placement of the jurisdictions by means of the clustering procedure was the following: Cluster 1: 22 municipalities; Cluster 2 and Cluster 3: 30 jurisdictions; and Cluster 4: nine jurisdictions. It is remarkable how cluster 4 resulted in a smaller group than the others. The following detailed analysis offers insight into some of the reasons for these clustering results.

5.7.2.1. Cluster's and sub-indices' details

A detailed analysis of the LURE Index was performed with the following goals: 1) to look at the specific differences among clusters and 2) to look at the specific role of each sub-index and their variables in the creation of the LURE Index. In order to accomplish these goals, the analysis of the results was done in two steps: a) by comparing the means of the ten LURE Index's sub-indices among clusters and b) by comparing the individual variables' scores (responses) among clusters. With this approach it was possible to evaluate in detail the role of each specific variable in the creation of the ten sub-indices, and the relative importance of the sub-indices in the definition of the LURE Index. This approach also demonstrated the variance in the presence of regulatory measures across the H-GA.

Table 31 Results of clustering by K-means

Cluster 1 The most regulated	Cluster 2 Highly regulated	Cluster 3 Lightly regulated	Cluster 4 The less regulated
Brookside Village	Alvin	Angleton	Anahuac
El Campo	Bay City	Arcola	Bonney
El Lago	Bellair	Bayou Vista	Daisetta
Friendswood	Cleveland	Baytown	Holiday Lakes
Fulshear	Clute	Beach City	Pine Island
Iowa Colony	Cut and Shoot	Brookshire	Riverside
Katy	Dayton	Bunker Hill Village	South Houston
Lake Jackson	Deer Park	Clear Lake Shores	Splendora
Orchard	Eagle Lake	Conroe	Thompsons
Palacios	East Bernard	Danbury	
Piney Point Village	Freeport	Dickinson	
Roman Forest	Hedwig Village	Houston	
Seabrook	Hilshire Village	Jersey Village	
Sealy	Humble	Jones Creek	
Shenandoah	Huntsville	La Marque	
Simonton	Manvel	La Porte	
Spring Valley	Meadows Place	League City	
Sugar Land	Missouri City	Magnolia	
Taylor Lake Village	Mont Belvieu	Nassau Bay	
Texas City	Montgomery	Needville	
Tomball	Pearland	New Waverly	
Willis	Pleak	Oak Ridge North	
	Quintana	Old River-Winfree	
	Richwood	Pasadena	
	Shoreacres	Richmond	
	Surfside Beach	Santa Fe	
	Sweeny	Southside Place	
	Tiki Island	Stafford	
	West Univ. Place	Webster	
	Wharton	West Columbia	

5.7.2.2. Comparative means

Table 32 shows the means of the values of the ten sub-indices and of the local traits across clusters used as part of the analysis. Local traits were selected to establish if there

is a relationship between the clusters and some urban indicators. Other studies also used these same traits and found them to be related to the stringency of land use regulatory environments (e.g. Ihlanfeldt 2007; Gyourko, Saiz et al. 2008).

Table 32 Mean Comparison of Jurisdictions

Sub- indices/ local traits	Clusters			
	1 The most regulated	**2 Highly regulated**	**3 Lightly regulated**	**4 The less regulated**
Local Government (LGI)	.23	.07	.00	-.86
Local Planning Approval (LPAI)	.32	.16	-.06	-1.12
Local Planning Approval Requirements (LAPIR)	.35	.19	-.11	-1.12
Local Affordable Housing (LAHI)	.40	-.10	-.17	-.04
Density Restriction (DRI)	.63	.21	-.52	-.50
Local Subdivision Requirements (LSRI)	.47	.06	.06	-1.57
Open Space (OSI)	.76	.12	-.47	-.70
Exactions (EI)	.21	.27	-.07	-1.18
Supply Restriction (SRI)	.42	.06	-.06	-1.03
Local Standard Development Perception (LSDPI)	.56	.38	-.24	-1.85
Local traits				
Median family income (1999)	69,750	59,959	61,759	38,486
Median house value (2000)	128,031	111,840	111,210	47,700
Percentage White (2000)	80	77	74	72
Percentage Black (2000)	7	10	11	14
Population (US Census Estimates 2008)	12,435	13,414	92,344	2,690
Land area 2000 and 1990 (square miles)	8.9	8.4	28.5	3.1
Density of population per square mile 2000 and 1990	1,390	1,673	1,789	986

Figure 16 depicts the means of values for each cluster. It is clear that the differences in the means among clusters are important. This is precisely the purpose of CLA: to choose clusters so that the differences between them could be maximized. However, when looking with more detail at the differences between sub-indices, it can be seen that for every cluster, the differences were not the same across all the ten sub-indices. The latter is due to the variability in the proportion of jurisdictions in each cluster. Based on how the clusters were obtained, the proportion of jurisdictions in each cluster for each sub-index ideally must follow a descending order (the most regulated cluster with the greatest proportion and the less regulated with the least (or lesser) proportion). This is not always the case and for this reason, occasionally the means differences do not follow the same pattern.

When comparing clusters 1 and 2, the larger difference was in the LAHI sub-index (0.5 standard deviations). It can also be noted the value of the mean of the EI sub-index for cluster 2 was greater than for cluster 1. The reason is that cluster 1 had only 77% of its jurisdictions (17) which had the requirement for the developer to pay an allocable share of the costs of infrastructure improvement, and cluster 2 had 80%(24) of its jurisdictions which had this requirement.

The sub-index with the highest difference was DRI when comparing clusters 2 and 3 (0.73 standard deviations). The mean value for the LSRI index was the same in both clusters. The reason for this is the proportion of jurisdictions with the requirements for developers to pay building permit fees and development review fees is the same in both

clusters. The greatest difference between the mean values was between clusters 3 and 4. The Sub-index LSRI had the largest difference with 1.63 standard deviations. The proportion of jurisdictions in cluster 3 (97 and 63 percents for the two requirements) was more than double than those in cluster 4 (45 and 11 percent).

In the sub-indices LHAI and DRI, the mean values for cluster 4 were greater when compared to cluster 3. Although cluster 4 was the less regulated, it did not have a higher proportion of jurisdictions either having multifamily housing built the last two years or requiring developers to include affordable housing. It only had the highest proportion of jurisdictions with manufactured housing built in the last two years, but this was not sufficient to make the mean value for the LHAI sub-index lower than cluster 3. In regards to the DRI sub-index, the reason for the mean of cluster 4 being greater that cluster 3 was only because of the average of the minimum lot size requirement in cluster 4 (natural logarithm of 7.98) was greater than the minimum required in cluster 3 (7.87).

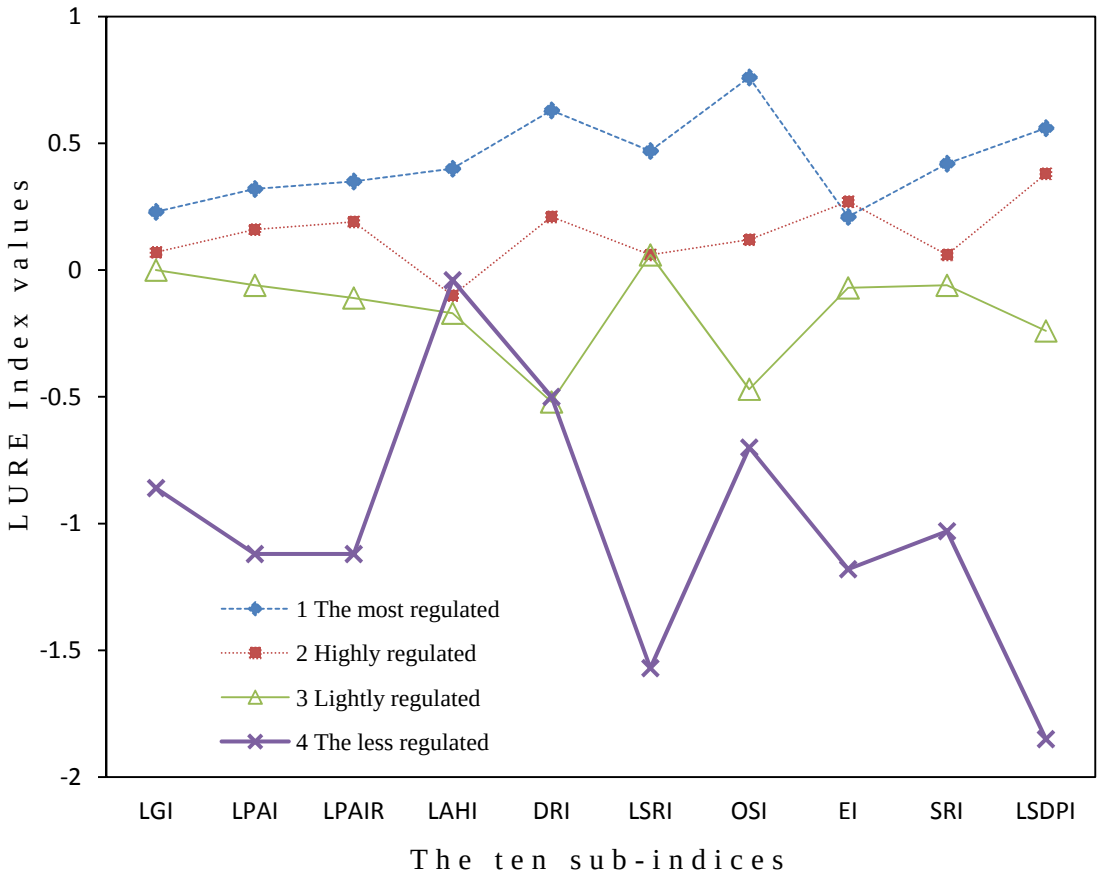


Figure 16 Means Plot for LURE Index Clusters

Figure 16 demonstrates the Means Plot for the LURE Index Clusters. Cluster 1 is where the most valuables houses are located. The median house value is more than 10 times the value of the other three clusters. In terms of distribution of races, there is a pattern, although small, in which cluster 1 has a higher percentage of white population (80%) when compared to the other clusters. On the other hand, cluster 4 has a higher percentage of black population (14%) when compared to the other clusters.

In terms of population, it is remarkable that cluster 3 (lightly regulated) has the higher mean population in it (92,344). This pattern also corresponds with the distribution of land being that cluster 3 is the one with the higher mean value (28.5 square miles). Density has a more irregular pattern, with cluster 3 having the higher mean value (1,789) and cluster 4 having the lowest (986).

From this description it can be concluded that there appears to be a relationship between the clusters created based on LURE Index scores and the distribution of mean values for median family income, median home values, and percentage of white and black population. The goal of this analysis was to characterize and describe what is happening based in the LURE Index. An in-depth analysis is needed in order to analyze the statistical significance of this.

The following is a more in-depth analysis of the meaning of the differences in the values for the sub-indices.

5.7.2.3. Individual scores (variables) and the ten sub-indices

The analysis was performed by comparing responses (scores) to individual variables. Because most of the scores of the indicators were based on a “yes” or “no” response to having a specific regulation, process, or measure, the analysis relied on the proportion of these responses. (Note: the stringency of the LURE was assumed as simple addition of “yes” scores to create the ten sub-indices).

The following is the corresponding analysis for each of the ten sub-indices defining the LURE Index.

The Local Government Sub-Index (LGI)

The LGI Sub-index was created based on whether the jurisdictions were either a general law or home rule category of municipality. Figure 17 displays the proportion of jurisdictions claiming to be a home rule municipality. The rest of the jurisdictions fell in the general law category.

The variance among the LURE Index clusters was similar between clusters 1, 2 and 3. There was no home rule municipality in cluster 4. Due to the important difference between the proportion of jurisdictions being either home rule (39) or general law (52), this variable could still be important for characterizing the LURE related to housing markets.

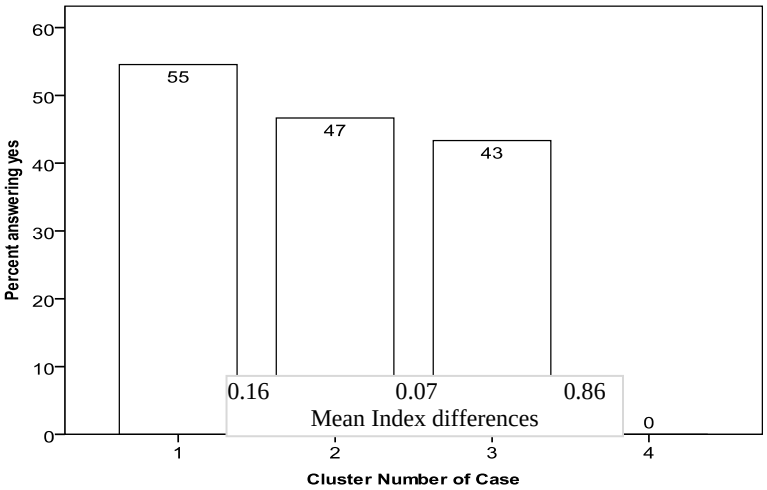


Figure 17 Jurisdictions in Home Rule Category

The Local Planning Approval Sub-Index (LPAI)

Figure 18 displays the proportion of jurisdictions in each cluster having scores of 1 for answering "yes". Each bar represents the proportion of cases for each one of the variables used to create the LPAI sub-index. Of the four clusters, number four is the one having only one jurisdiction with a zoning commission and neighborhood zoning area. In the other three variables, only two jurisdictions declared having in place a planning commission, historic commission and board of adjustment.

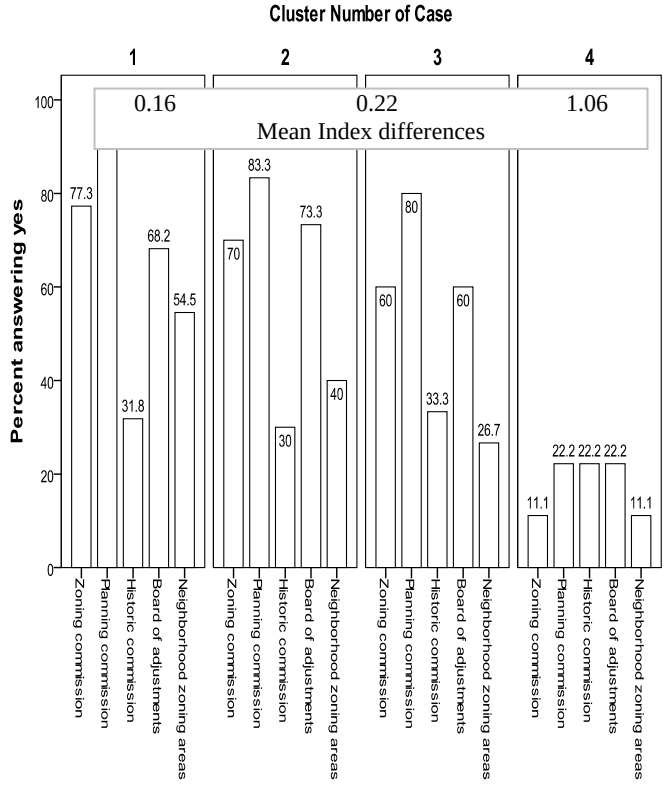


Figure 18 LPAI Sub-index

Cluster numbers 1, 2 and 3 showed a small difference in the proportion of responses among them. The variables accounting for these differences were board of adjustments and zoning and planning commissions. In all the clusters, the predominance of having a planning commission was the variable with the highest number of cases. The mean difference was more important between clusters 3 and 4 (1.06 standard deviations).

The high percentage of jurisdictions (at least those in clusters 1, 2 and 3) already having zoning and planning commissions in place could prevent this variable from being a good candidate for future use for measuring variability among communities.

Overall, 78% (71 out of the 91 jurisdictions) ranked by the LURE Index answered yes to having a planning commission; 63% to having zoning commissions and a board of adjustments; 36% to having neighborhood zoning areas; and 30% to having a historic commission.

The Local Planning Approval Requirement Sub-Index (LPAIR)

Figure 19 displays the proportion of responses for the variables making up the LPAIR Sub-index. The variable “having other ordinances governing plats, land development and subdivisions” had the higher proportion of jurisdictions answering “yes”.

The difference in proportions among the variables in the same cluster was not remarkable. This small variance could suggest their removal in future studies for use as indicators capturing variance among jurisdictions. 87% of jurisdictions (79 out of 91)

claimed having “other ordinances”; 68% having a zoning ordinance; and 66% had a comprehensive plan.

As far as the difference among the cluster’s mean for the LURE Index, cluster 4 was again the one on the extreme side with a difference of 1.01 standard deviations with cluster 3.

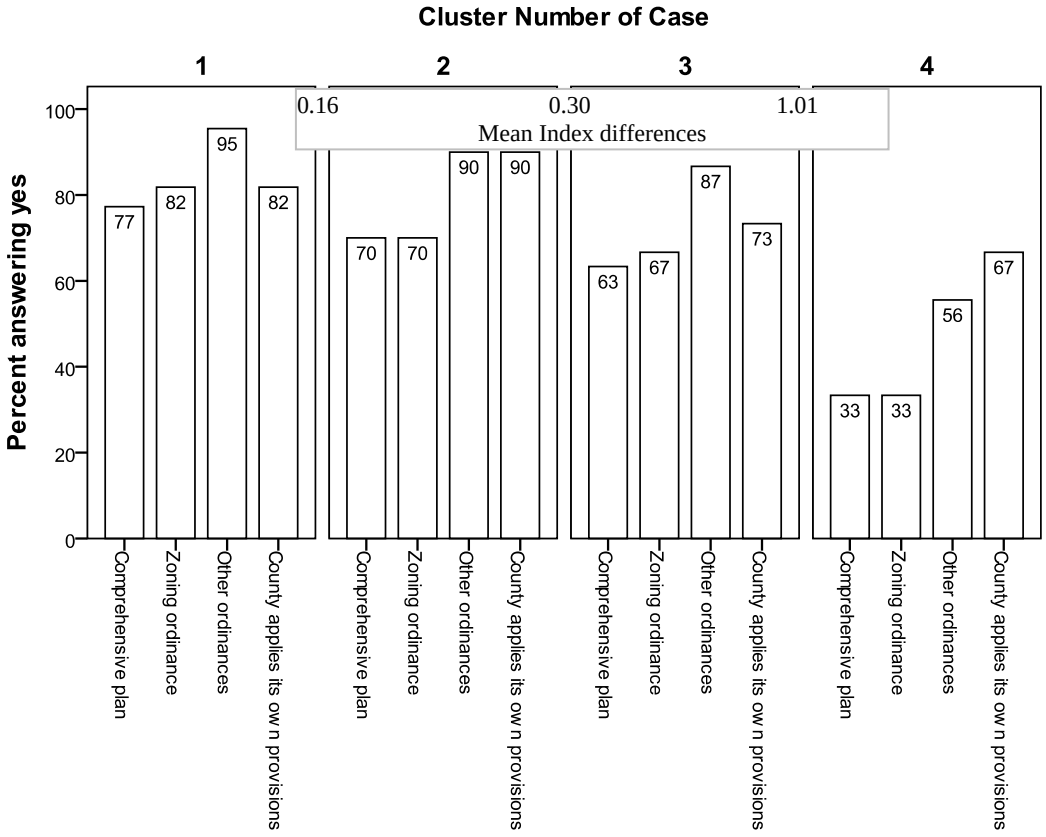


Figure 19 LPAIR Sub-Index

Note: Some of the original variable’s names were shortened for graphical purposes. The specific variables’ names are:
Comprehensive (master, general) plan
Zoning ordinance
Other ordinances governing plats, land development and subdivisions
Jurisdiction is a unit in which the county applies its own subdivision provisions to new development

The Local Affordable Housing Sub-Index (LAHI)

According to Figure 20, the LAHI Sub-index was the one from all ten sub-indices which had the smallest difference among all clusters (the difference between the highest and lowest value) with a mean index total value of 0.57 standard deviations (between cluster 1 and 3).

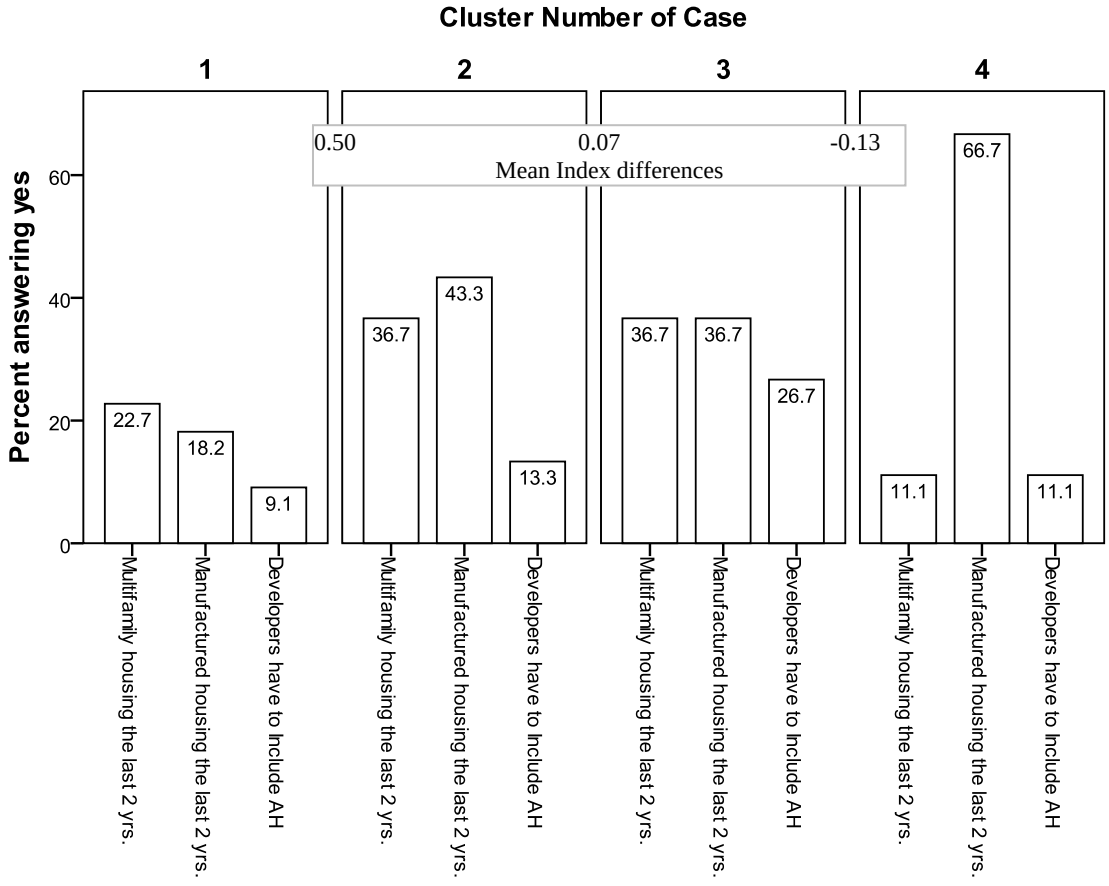


Figure 20 LAHI Sub-Index

Nonetheless, it is notable the variances among variables within the clusters. In cluster 4 (the least regulated), 66.7% of the jurisdictions claimed to have manufactured housing built in the last two years (more than double the value for the other variables and clusters).

Although the variance between clusters is not remarkable, the variables indicate what is happening in the H-GA in terms of affordable housing. From the 91 jurisdictions: 1) 15 (17%) claimed developers were required to include affordable housing; 2) 28 (31%) answered having multifamily housing built the last two years; and 3) 34 (37%) responded having manufactured housing built in the last two years.

The Density Restriction Sub-Index (DRI)

The mean index difference among the clusters in the DRI Sub-index was between clusters 2 and 3 (0.73 standard deviations). The DRI Sub-index was one of the three sub-indices in which the mean index value for a cluster did not follow the trend of being lower that the preceding cluster (cluster 4 had a higher value than cluster 3).

Table 33 displays mean values for the variables within clusters. The reason for the difference between cluster 3 and 4 is due to a higher value for the mean of the natural logarithm of minimum lot size within city's ETJ in cluster 4 (7.98) compared to cluster 3 (7.87). The other mean values for the other two variables across clusters follow the pattern of descending values (from cluster 1 to 4). This irregularity and the probability of a double counting because of the inclusion of very correlated variables in this sub-index

raises the question about the wisdom of including this variable in the creation of the Sub-index.

Table 33 Mean Comparison for Variables in the DRI Sub-Index by Clusters

Cluster		Log of Minimum lot size SFR within city limits (sq.ft.)	Log of Minimum floor area within city limits (sq.ft.)	Log of Minimum lot size SFR within city's ETJ (sq.ft.)
1	Mean	9.17	6.87	8.43
The most regulated	N	22	22	22
2	Mean	8.94	6.82	8.26
Highly regulated	N	30	30	30
3	Mean	8.63	6.75	**7.87**
Lightly regulated	N	30	30	30
4	Mean	8.53	6.75	**7.98**
The less regulated	N	9	9	9
Total	Mean	8.85	6.80	8.14
	N	91	91	91

The Local Subdivision Requirements Sub-Index (LSRI)

Figure 21 displays the LSRI sub-index. It is the sub-index with the second highest difference between the highest and lowest mean index value (2.04 standard deviations). It is also the sub-index in which there is no difference between two clusters and their mean index values (clusters 2 and 3).

The variability between the two variables within the clusters is important with the lower difference being in cluster 1 (a 13.6 points difference).

This sub-index has the variable which almost reaches 100 percent of the jurisdictions which have the requirement that developers pay building permit fees (84 of 91

jurisdictions). It is clear that if this continues to be the trend, its inclusion will not make a difference among jurisdictions.

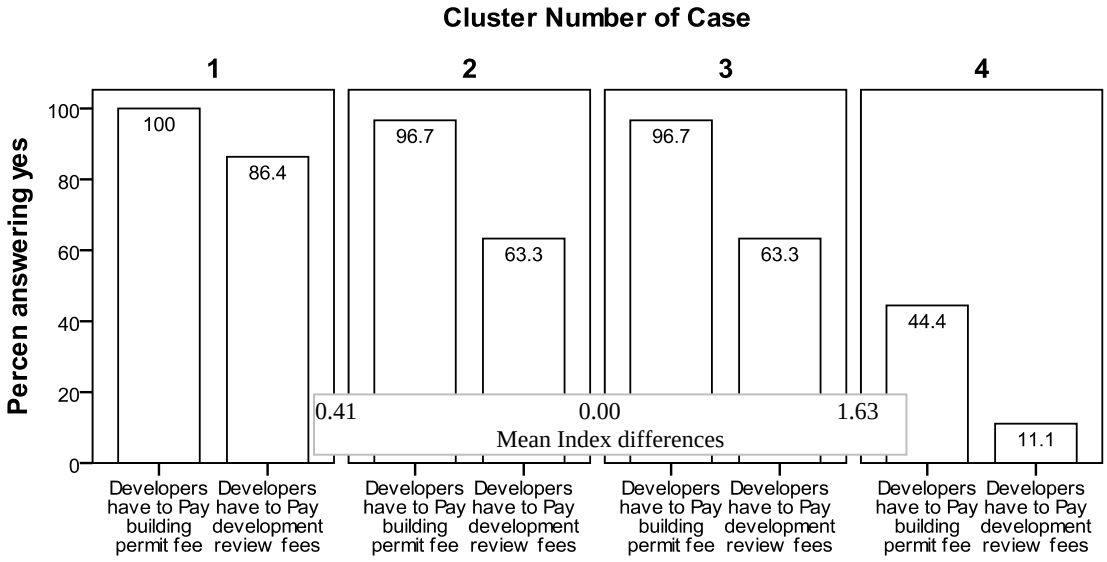


Figure 21 LSRI Sub-Index

The Open Space Sub-Index (OSI)

According to Figure 22, the developer's requirement of mandatory supply of the dedication of space or open space (or fee in lieu of dedication) shows an important variance among clusters. (The total observed mean index difference between the highest and lowest value is 1.46 standard deviations). 21 of 22 jurisdictions in cluster 1 have this type of requirement in place. At the other extreme, just 2 of 9 jurisdictions in cluster 4 have this requirement.

In general, only 52 of the 91 jurisdictions (57%) have this requirement in place. The still low proportion of jurisdictions imposing this type of measure makes this it feasible to continue to use this indicator for the characterization the Texas LURE.

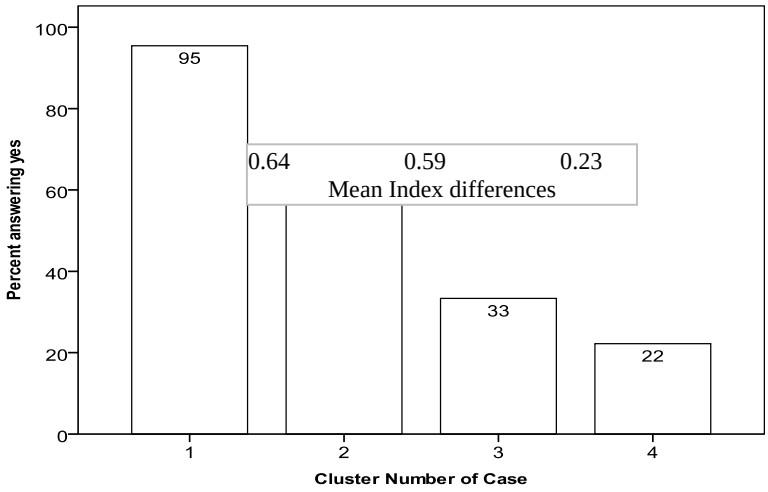


Figure 22 OSI Sub-Index

The Exactions Sub-Index (EI)

The requirement for the developer to pay an allocable share of the costs of infrastructure improvement was one of the three sub-indices in which the mean index value for a cluster (cluster 2 with a 0.27 value) was higher when compared to its preceding cluster (cluster 1 with a 0.21 value), making the mean value difference negative between clusters 1 and 2 (see Figure 23).

The variance among the clusters for the variables making up the EI Sub-index was small among clusters 1, 2 and 3 (0.34 standard deviations). On the other hand, the difference

between these three clusters and cluster 4 is high (1.18 standard deviations between clusters 3 and 4).

In general, 61 of 91 jurisdictions (67%) had this type of requirement already in place. The high proportion of jurisdictions in clusters 1, 2 and 3 already having this requirement suggests a trend that could make this variable not a good candidate for characterizing the LURE in the H-GA.

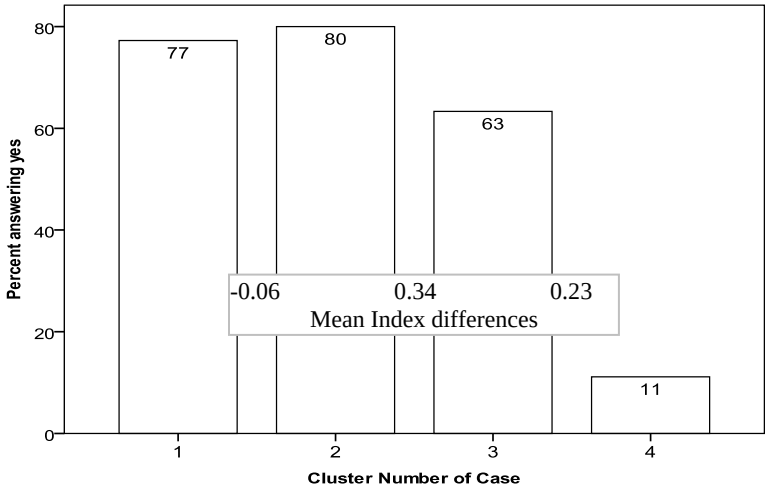
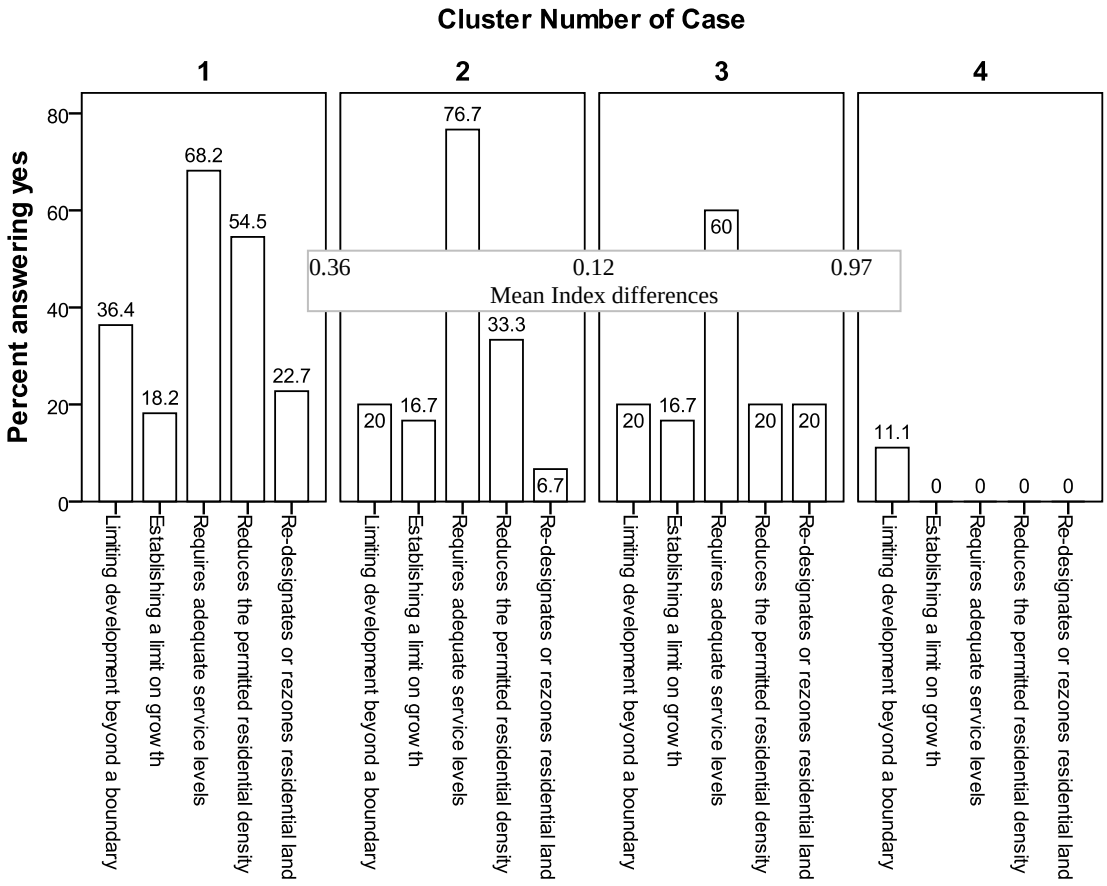


Figure 23 EI Sub-Index

The Supply Restriction Sub-Index (SRI)

Figure 24 shows that because of the difference in the diversity of variables included in the SRI Sub-index, this is probably the sub-index with more discrepancies among the

variables within the clusters and among the clusters. As can be seen, the height of the bars varies without a pattern within the clusters.



Note: Some of the original variable's names were shortened for graphical purposes.

Figure 24 SRI Sub-Index

Cluster 4 is the one in which the sub-index did not record any measure for four of the five variables (the other variable had just one jurisdiction). Having a measure which requires adequate service levels for residential development or service capacity as a

condition of approval of residential development was the variable with the most jurisdictions in the analysis (56 of 91). On the other hand, the variable having the least jurisdictions was a measure which re-designates or rezones residential land to agriculture or open space (13 of 91). The variance and the few numbers of jurisdictions recorded as implementing these measures make these variables good candidates to continue to be included in the LURE Index.

The Local Standard Development Perception Sub-Index (LSDPI)

The LSDPI Sub-index was the one with the highest mean difference index value among clusters (2.41 standard deviations). Moreover, this sub-index was also the one having the highest difference between two clusters in their mean index values (clusters 3 and 4 had a 1.61 standard deviation difference).

Figure 25 and Figure 26 display the proportion of responses for each one of the two variables used to create the LURE Index. It can be seen that there is a small difference between the proportions of clusters 1 and 2 (indeed the mean difference values was 0.18 standard deviations). The differences in proportions between the first two clusters and clusters 3 and 4 is higher (the mean difference value is 0.62 between clusters 2 and 3, and 1.61 between 3 and 4).

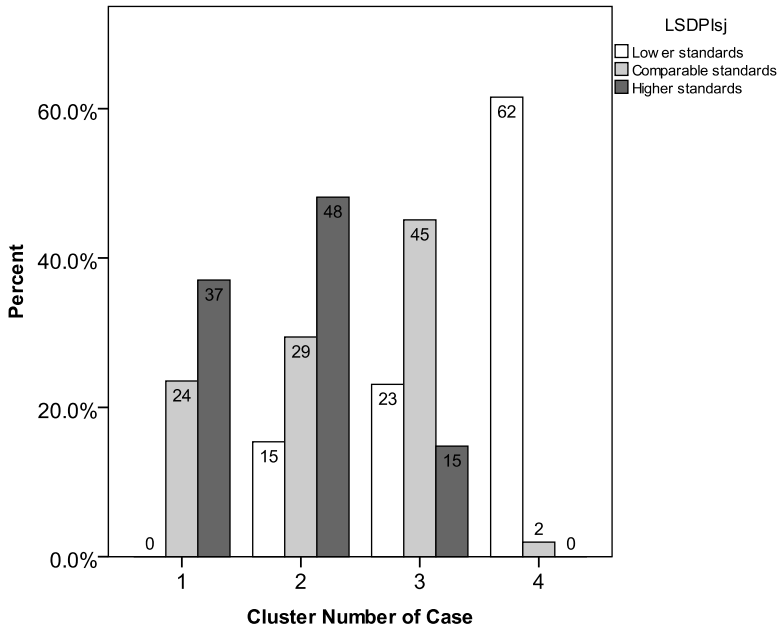


Figure 25 Perception of Jurisdiction's Standards for Surrounding Jurisdictions

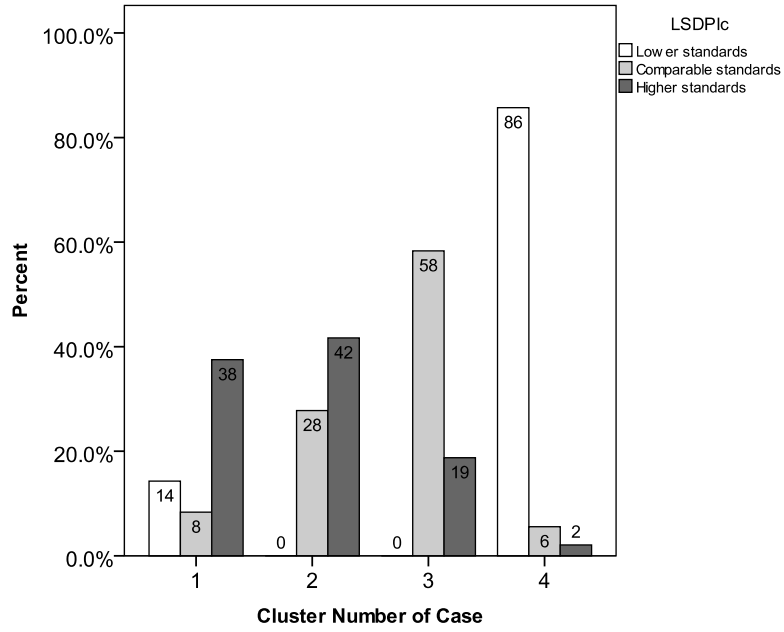


Figure 26 Perception of Jurisdiction's Standards for County

5.8. Validation of the LURE index: links to other indicators

As a way of statistically validating the LURE Index as a measure suitable for characterizing LUREs, it was correlated to known indicators that are believed to have a direct relationship with land use regulations. Some authors have found a high correlation between communities with a more restrictive LURE and local traits such as wealth and higher proportions of whites and homeowners (Baldassare and Protash 1982; Burnell and Burnell 1989; Donovan and Neiman 1992; Bates and Santerre 1994; Gyourko, Saiz et al. 2008).

Table 34 Correlations between the LURE Index and Local Traits

Indicators	**Pearson Correlation (Sig. 2-tailed)**
Percentage Black (2000)	-.246* (.019)
Percent families below poverty line (2000)	-.236* (.025)
Percentage White (2000)	.177 º (.093)
Median family income (1999)	.230* (.028)
Median house value (2000)	.188 º (.074)

*. Correlation is significant at the 0.05 level (2-tailed).

º. Correlation is significant at the 0.10 level (2-tailed).

Table 34 above demonstrates the correlation values between the LURE index and the local traits of: 1) percentage of black and white population; 2) percentage of families

below poverty line; 3) median family income; and 4) median house value. All five variables had a significant relationship with the regulatory stringency of the jurisdictions characterized by the LURE index. Based on a 90% percent confidence interval, it could be said that the null hypothesis of a lack of relation between the LURE index and these four local indicators can be rejected. These correlation results validate the appropriateness of composite indices as measures in characterizing LUREs for housing markets.

6. UNCERTAINTY AND SENSITIVITY ANALYSIS

The main goal of the uncertainty and sensitivity analysis was to evaluate the properties of the LURE Index. A robustness and sensitivity analysis was performed, and data on related local traits such as median housing values were used for validation of the index. Another goal of this analysis was to address criticisms that sometimes emerge against ranking systems created based solely on a simple weighted summation of indicators (Nardo, Saisana et al. 2005).

A multi-modeling procedure was performed in this stage being the most ad-hoc way to assess the robustness of the LURE index. An analysis of uncertainty and sensitivity was carried out in two steps: 1) the creation of scenarios with different sources of uncertainty; and 2) the plotting in a frequency matrix of all the different ranks derived from such scenarios.

Methodologically, every procedure implemented in the creation of an index potentially induces uncertainty into the final composite index. All the procedures such as the imputation of missing values, the standardization of indicators, the weighting process and the final aggregation are potential sources of uncertainty.

To rely solely on the index created without taking into account an uncertainty analysis could lead to skewed characterization and decision making compromising the purpose for which the LURE Index was created. An uncertainty analysis helps to determine whether the results change drastically when methodological assumptions are varied within a reasonable range of possibilities (Saltelli, Chan et al. 2000; Saisana and

Tarantola 2002; Saisana, Saltelli et al. 2005; Saltelli, Ratto et al. 2008; Saisana, Annoni et al. 2009).

Among the advantages of considering scenarios as an approach in the analysis were: 1) testing of the robustness of the LURE Index; 2) increasing the transparency on how the index was created; 3) identifying of jurisdictions in which regulatory environment stringency increases or decreases; and 4) comparing the LURE Index results to similar exercises.

The uncertainty analysis of the LURE Index took into account all possible sources of uncertainly. The analysis was performed through a multi-modeling approach (MMA) taking into account the main sources of uncertainty. The analysis involved the assessment of the impact of alternative models (scenarios) on the jurisdictions' ranks. Each model or scenario was basically a new index created with alternative methodological options (imputations, normalization, weighting and aggregation). These options were also selected so that they could be suited for the type of dataset and specific framework established.

The MMA was performed by creating 56 different scenarios (new indices). The scenarios were created based on possible combinations of four main procedures used to create the LURE Index:

- The four complete datasets created during multiple imputation
- The normalization

- The weighting for each sub-index
- The aggregation rule
- The number of sub-indices included

After the creation of these scenarios, the creation of simulated ranks was performed and the identification of ranks feasible for being sensitive and/or non-representative.

The following are the specifics of each procedure in which the assumptions (methodological options) were changed and the number of alternative scenarios obtained.

6.1. Complete Datasets from MI

In order to have a complete database to create the LURE index, four of the five complete datasets obtained during the MI procedure were also used to create the alternative scenarios. Figure 27 describes the workflow of the process of using these complete databases.

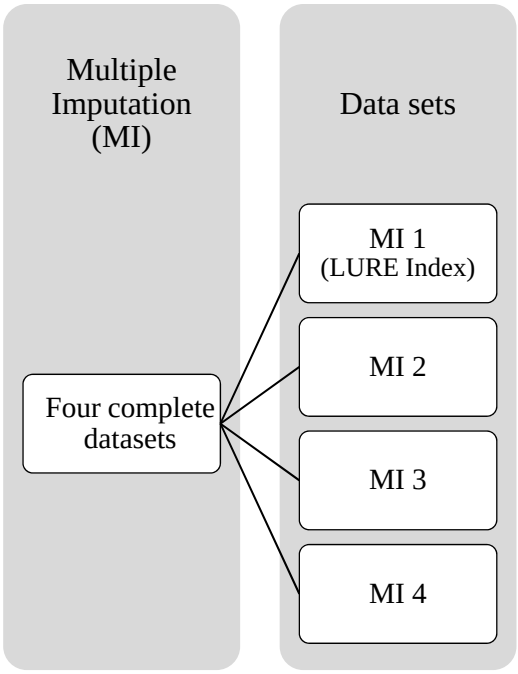


Figure 27 Workflow For the Use of the Four Complete Datasets

6.2. Normalization

Z-score was the procedure used to create the LURE Index. A second alternative also suited for the creation of scenarios was the min-max procedure (see the section on normalization for the specifics of this procedure). Having three more MI datasets permitted the creation of not only the four scenarios using the min-max normalization procedure but also of three scenarios using z-scores as well (see Figure 28).

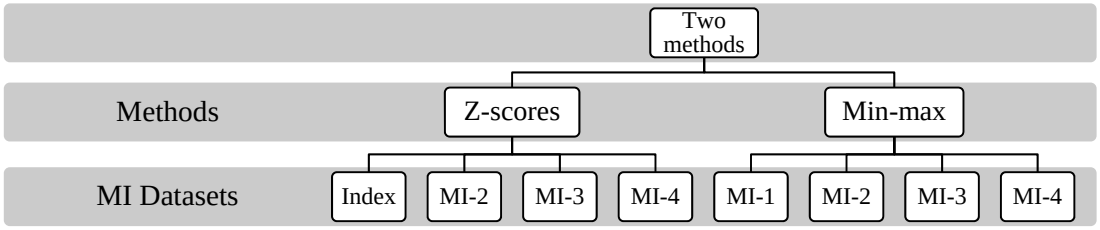


Figure 28 Normalization Approach

6.3. Weighting

In the LURE Index a FA procedure was performed to calculate weights for the sub-indices. From the seven datasets created by multiple imputation and the two normalization procedures, two more scenarios were created for each one of these (see Figure 29 for z-scores scenarios and Figure 30 for min-max scenarios). A scenario where weights were based on FA and scenarios where EW was the second procedure considered. Thus, 15 scenarios were created taking in account the two weighting options. (One scenario was created applying WE to the z-score-MI-1 dataset – the FA option refers to the LURE Index).

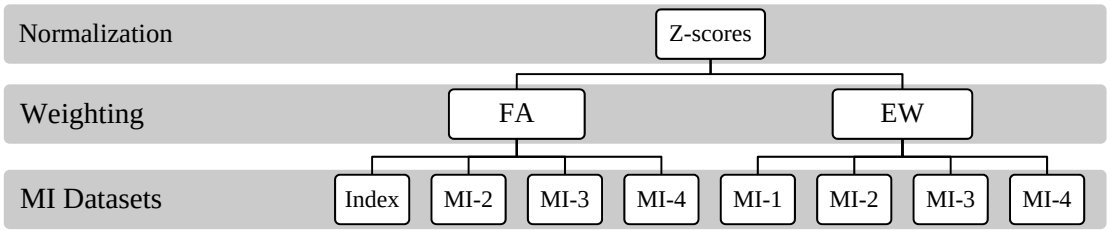


Figure 29 Scenarios with Z-score Normalization and FA and EW

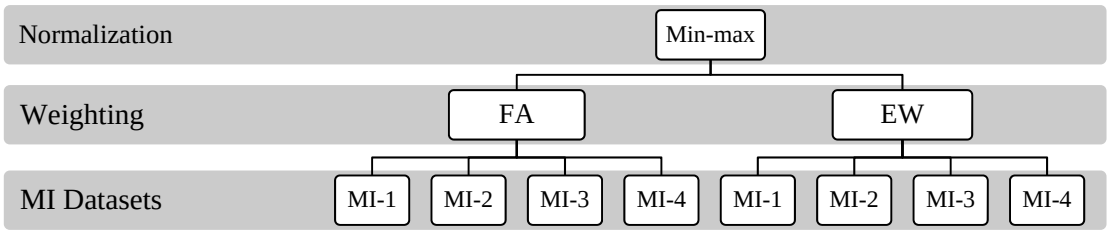


Figure 30 Scenarios with Min-max Normalization and FA and EW

6.4. Aggregation rules

Linear aggregation was the procedure used to create the LURE Index scores. Although Geometric Aggregation (GA) was the second procedure best suited for the creation of the LURE Index, this procedure was only used to create a single scenario. The reason for this was because GA does not allow negative values. This was not feasible for scenarios obtained with the z-score normalization. On the other hand, the min-max scenarios had values of zero as minimums. As a result, use of the GA procedure was restricted. Prior to

this limitation, only four scenarios were created in which min-max values of zero were transformed to 1 so that GA could be used.

6.5. Sub-indices considered

The approach of excluding one sub-index or indicator to produce an alternative scenario has been tried with a degree of success before. Saisanna (2008) used this procedure in order to test the robustness of inference. This approach could be just the same as assigning a weight of zero to a sub-index.

For this research only two sub-indices were excluded (one a time) as a means of taking into account this procedure in the uncertainty analysis of the LURE Index. The two sub-indices selected for this alternative were the Density Restriction Sub-Index (DRI) and the Local Subdivision Requirement Sub-Index (LSRI). 32 more scenarios were obtained with this procedure (see Figure 31 and Figure 32) making a total of 51 scenarios for the analysis of the robustness of the LURE Index.

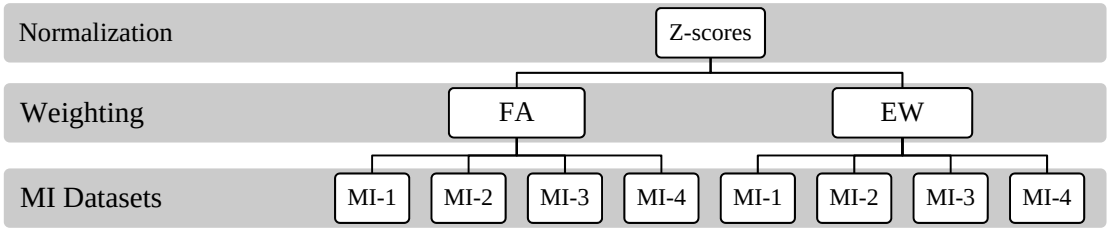


Figure 31 Scenarios Excluding the DRI and LSRI Sub-indices with Z-scores

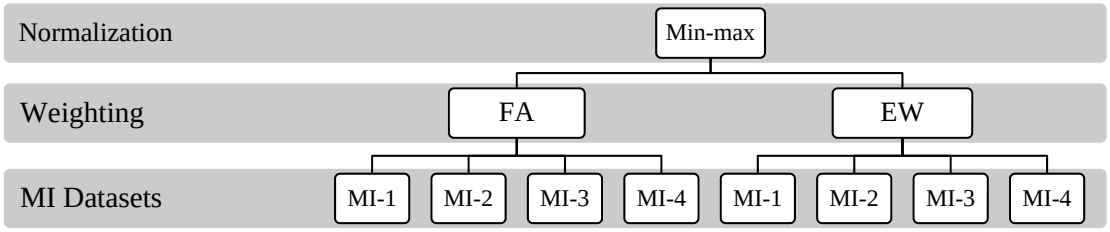


Figure 32 Scenarios Excluding the DRI and LSRI Sub-indices with Min-max

The multiple assumptions and possible procedures that can be used to create an index would result in a much larger number of possible scenarios beyond the ones obtained here. Even so, it was considered that the scenarios produced were enough for this research's purposes.

6.6. Uncertainty results

Table 35 shows the frequencies of the jurisdictions' index ranks calculated across all 51 scenarios. This frequency matrix resumes the ranking while making the uncertainty explicit (Saisana, Annoni et al. 2009). In general, the results tend to be stable. Nonetheless, the shift in rankings of some jurisdictions makes evident how sensitive they are to changes in the assumptions.

Rankings of scenarios were compared against the LURE Index rankings. The approach used was to compare the LURE Index ranks against the median ranks across all 51 scenarios. Jurisdictions were considered to be stable in their results if the difference

between the LURE rankings and the median ranking based in the scenarios for these jurisdictions was less than 10 places. It was also considered a stable result when these jurisdictions also had more than 30% of their rankings (15 out of 51 scenarios at least) in an interval of a shift of five places.

From the cluster of most regulated places, it was found that places such as Sugar Land, Palacios, Spring Valley, Tomball, Willis, Seabrook, Sealy, Lake Jackson, El Campo, Texas City, Iowa Colony, and Friendswood had a stable result for each scenario. These represent more than 50 % of the jurisdictions in this cluster (12 out of 22). On the other hand, places such as Brookside Village and Piney Point Village showed a higher impact on the variability of their rankings (a shift of more than 20 places).

The rankings for the cluster of highly regulated places were the most susceptible to the assumptions from all four clusters. Only 11 out of 30 jurisdictions in this cluster were stable in their shift of places. Jurisdictions such as Meadows Place, Humble, Richwood, Shoreacres, and Wharton were the most stable in their rankings.

The cluster of lightly regulated jurisdictions had a changing pattern. Some places such as Magnolia, New Waverly, Old River Winfree, Oak Ridge North, Beach City, West Columbia, La Marque, and Bayou Vista were very stable while others were very susceptible to the assumptions, especially Southside Place and Danbury. In the cluster of less regulated jurisdictions, all the nine places had a stable pattern under the different scenarios. 43 out of the 91 jurisdictions had a stable pattern in their rankings.

Table 35 Frequency Matrix of Scenarios (LURE Index ranks 1-91)

Jurisdiction	1 Rank 1-5	2 Rank 6-10	3 Rank 11-15	4 Rank 16-20	5 Rank 21-25	6 Rank 26-30	7 Rank 31-35	8 Rank 36-40	9 Rank 41-45	10 Rank 46-50	11 Rank 51-55	12 Rank 56-60	13 Rank 61-65	14 Rank 66-70	15 Rank 71-75	16 Rank 76-80	17 Rank 81-85	18 Rank 86-91	LURE Index Rankings	median from scenarios
Cluster 1																				
Roman Forest	25	8	10	10	20	27													1	20
Sugar Land	100	100																	2	2
Katy	22	16	6	20	6	12	8												3	18
Fulshear	6	8	12	29	29	12													4	20
Palacios	**82**	14																	5	2
Brookside Village			10	10	20	22	18	6	12										6	28
Spring Valley		35	29	18															7	13
Tomball	10	33	31	25															8	12
Willis	**96**																		9	2
El Lago			16	8	24		12		10	6	8								10	23
Seabrook	49	35	12																11	6
Taylor Lake Village		6	14	12	8	8	10	12	8	16									12	33
Sealy				16	31	16	18	12											13	25
Piney Point Village						8		6	14	8	20	14	12	12					14	52
Lake Jackson	16	45	31	8															15	9
Orchard					10	12	14	14	25	14	8								16	39
El Campo	22	33	20	8	10	8													17	9
Shenandoah					8	16	8	18	20	10	10								18	39
Texas City	12	**65**	10	8															19	8
Iowa Colony				18	**59**	22													20	23
Simonton									8	6	16	22	24	14					21	57
Friendswood		33	37	20	6														22	11
CLUSTER 2																				
Hedwig Village					6	20		10	25	8				8					23	42
West Univ. Place			25	47	20	6													24	18
Hillshire									10	10	8	6	12	27	22				25	66
Missouri City	18	51	22	8															26	9
Dayton		8	47	31	12														27	15

Notes: Frequency greater than 50%

Frequency between 30% and 50%

Only frequencies above 5% are showed

Table 35 Continued

Jurisdiction	1 Rank 1-5	2 Rank 6-10	3 Rank 11-15	4 Rank 16-20	5 Rank 21-25	6 Rank 26-30	7 Rank 31-35	8 Rank 36-40	9 Rank 41-45	10 Rank 46-50	11 Rank 51-55	12 Rank 56-60	13 Rank 61-65	14 Rank 66-70	15 Rank 71-75	16 Rank 76-80	17 Rank 81-85	18 Rank 86-91	LURE Index Rankings	median from scenarios
Clute	12	45	31	12															28	10
Sweeny					14		22	14	18	16	6								29	37
Quintana							12	12	12	8	8	6	8	14	14	6			30	54
Surfside Beach			6	25	18	27	8	6	6										31	25
Cut and shoot													6	6	6	20	24	27	32	81
Deer Park		18	31	31	6	6													33	15
Meadows Place					10	24	6	12	6	8	8	16							34	37
Alvin			8		20	25	18	18	6										35	29
Tiki Island							6					16	20	18	18	8			36	65
Manvel								8	16	18	29	18	6	6					37	53
Freeport			18	29	24	18	6												38	21
Pleak								8	10	20	20	25	10						39	54
Bay City												18	18	35	22				40	68
Pearland			22	41	27														41	18
Montgomery			6	10	16	16	12	6							12	14			42	32
Humble						12	10	14	20	14	8	18	6						43	45
Mont Belvieu					8	18	33	18	8	6									44	33
Richwood							14	18	18	25	14	8							45	45
Bellair										8	25	27	12	18	8				46	58
Cleveland					16	45	18	12											47	29
Shoreacres						6	12	12	16	18	12	18	6						48	48
East Bernard														18	37	33			49	74
Wharton							8	10	16	22	20	16	8						50	50
Huntsville				12	31	18	18	10		8									51	27
Eagle Lake						16	37	29		6									52	35
CLUSTER 3																				
Pasadena											14	14	25	18	22				53	64
Jersey Village							22	24	20	24	8								54	41
Stafford										16	24	14	24	18					55	58
Magnolia										8	10	18	51	14					56	62
Bunker Hill Village									8	12	8	14	10	25	18				57	64
New Waverly						8	33	14					10	12					58	35

Notes: Frequency greater than 50%
Frequency between 30% and 50%
Only frequencies above 5% are showed

Table 35 Continued

Jurisdiction	1 Rank 1-5	2 Rank 6-10	3 Rank 11-15	4 Rank 16-20	5 Rank 21-25	6 Rank 26-30	7 Rank 31-35	8 Rank 36-40	9 Rank 41-45	10 Rank 46-50	11 Rank 51-55	12 Rank 56-60	13 Rank 61-65	14 Rank 66-70	15 Rank 71-75	16 Rank 76-80	17 Rank 81-85	18 Rank 86-91	LURE Index Rankings	median from scenarios
Old River Winfree												6	6	14	31	29	10		59	74
Oak Ridge North													18	18	47	18			60	72
La Porte		14	20	12	6		12	24											61	24
Webster							8	14	12	29	24	6							62	47
Nassau Bay						6	14	27	18	14	10	8							63	41
Dickinson							16	24	22	20	8								64	42
Clear Lake Shores										6	20	29	18	18					65	59
Conroe								6	12		22	18	22	10					66	58
Brookshire										6	6	8	10	14	14	27	16		67	74
Santa Fe								6		8	10	27	22	18					68	60
Richmond							6	6	16	10	18	8	12	12	6				69	52
Beach City														6	29	**57**			70	76
West Columbia																16	**63**	14	71	83
La Marque															25	45	20		72	78
Bayou Vista													6	8	20	16	41	10	73	81
Baytown								6		8	12	16	16	20	16	6			74	63
League City						6	8	16	22	18	10	6							75	44
Houston									6			16	22	24	6	10	6		76	65
Angleton									16	22	24	18	8						77	53
Needville													6	6	49	14	18	8	78	74
Jones Creek															6	**63**	31		79	80
Arcola												12	14	31	27	14			80	70
Southside Place	12	10	6	6	8	6	10	10	16		8								81	33
Danbury					14	25	14	18	8	8									82	33
CLUSTER 4																				
Holiday Lakes																	20	**80**	83	87
Anahuac														6	6	49	39		84	80
Riverside																8	**67**	25	85	84
South Houston																	45	**55**	86	86
Daisetta																10	41	49	87	85
Pine Island																		100	88	91
Bonney																		**96**	89	89
Splendora																		100	90	90
Thompsons												6			8	12	39	31	91	83

Notes: Frequency greater than 50%

Frequency between 30% and 50%

Only frequencies above 5% are showed

Figure 33 is a plot of the correlation between the LURE Index and an alternative index created under the EW assumption. From the plot, it can be seen that the both indices offer similar results.

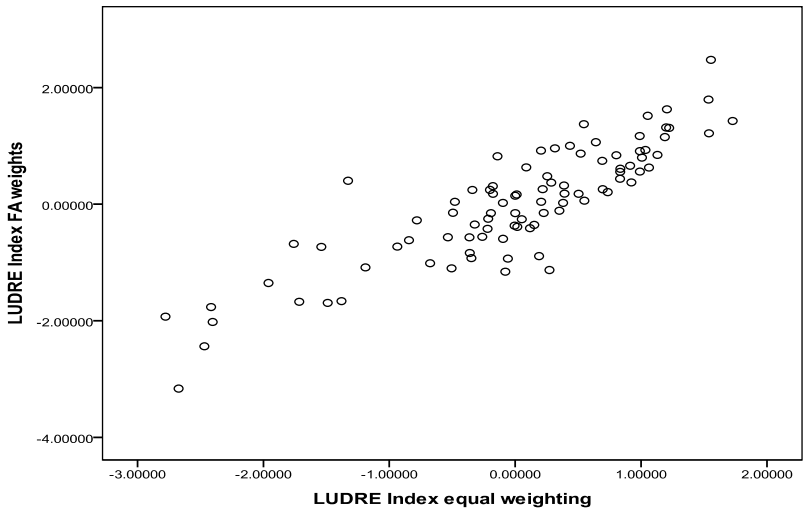


Figure 33 Correlations Between the LURE Index and EW Scenario

Table 36 depicts the correlation coefficients of this comparison. All four alternatives are statistically related to the LURE Index. It appears that the weighting procedure has an important influence on these correlations. Although statistically significant, the correlation value between the LURE Index and the alternative index produced with geometric weighting had the lowest value.

Table 36 Correlation Coefficients between LURE Index and Four Alternatives

	LURE Index
Index Z-scores Linear aggregation EW	.869**
Index Min-max Linear aggregation EW	.793**
Index Min-max Geometric aggregation EW	.671**
Index Min-max Linear aggregation FA	.917**

**. Correlation is significant at the 0.01 level (2-tailed).

7. CONCLUSIONS AND FURTHER RESEARCH

The LURE Index has been created with the specific objectives of: 1) validating the use of an index as an appropriate measure to characterize land use regulatory environments for housing markets; and 2) reflecting local regulatory environments in the Houston-Galveston Area.

The creation and assessment of the LURE Index verifies the hypothesis stating that such types of indices, when properly created, are reliable and valid measures to characterize the LUREs for housing markets of local jurisdictions. The statistical procedures of: a) factors analysis, b) correlations, and c) the uncertainty and sensitivity analysis confirmed this.

In terms of the creation of the index, the theoretical framework used for the creation of the LURE Index proved to be the correct one. Factor analysis proved that the LURE Index is a measure capable of capturing the latent factors linking housing markets and land use regulations. At least four to five dimensions (from the ten established in the theoretical framework) were detected by the statistical procedure as capturing more than 65% of the total variance in the sample of the LURE Index data.

In order to validate the LURE Index, correlations were performed between the index and the specific local traits of: a) proportion of black and white population; b) median housing values; and c) median family income in the H-GA. The index showed significant statistical correlation with these other indicators at the 0.10 and 0.05

significant levels. These results validate similar correlations found in the literature with identical local characteristics (Ihlanfeldt 2007; Gyourko, Saiz et al. 2008).

Statistical analysis also showed that two of the ten sub-indices of the LURE index (Density Restriction (DRI) and Local Affordable Housing (LAHI)) contribute poorly to the capture of the latent factor between land use regulations and housing markets. In order to deal with this detected weakness, further research could include the refining of the variables selected for these sub-indices and the re-creation of the LURE Index.

7.1. Regarding the literature review and methodology

The creation of the LURE inventory of land use regulations in the H-GA by using an instrument created based on similar exercises, and the posteriori use of this data for the creation of the LURE Index, proves that although local and state contexts are politically and geographically different, most of the indicators used indeed help to characterize LUREs in terms of their stringency.

In regards to the design and implementation of the LURE Survey, almost a 70% level of response was achieved because of the different strategies used. Although time consuming, a mixed-approach of using both internet based and telephone surveys made it possible to obtain such a high level of response. It is thought that having had the H-GAC as the sponsor of the survey was also an important dynamic. The framework for the design of the LURE survey and creation of the LURE Index was established following experiences in similar exercises and based on interviews with experts and

stakeholders in Texas. Nonetheless, it was clear after the statistical analysis that some variables could be either excluded or new ones added. For this purpose, further research could involve dissemination of results and subsequent feedback could be used to refine the framework.

7.2. Regarding the LURE index's findings and other indices

The LURE Index scores were correlated with local traits and the results were compared against the findings of Gyourko, Saiz and Summers (2008) specifically. These authors correlated their index with the same variables. The results found are similar to these authors' findings (see Table 32 for the specific values mentioned below).

According to both indices' results, highly regulated jurisdictions tend to be so almost across the board (in every sub-index value). In general, highly regulated jurisdictions are richer and with much higher housing values than lightly and less regulated. Median family income in highly regulated jurisdictions is higher at more than $30,000 and a correlation value of 0.23 with the overall index (more than $20,000 for Gyourko et. al. 2008). Median house value is almost three times the value in highly regulated jurisdictions with a correlation value of 0.188 (double the value for Gyourko et. al. 2008).

Highly regulated jurisdictions have a greater fraction of white households but the difference was modest in lightly regulated jurisdictions. Highly regulated jurisdictions are physically larger and less densely populated (22 per cent less). These similarities confirm the validity of an index as a legitimate measure to characterize housing markets.

7.3. Regarding the LURE index's cluster and specific variables

After the LURE Index scores were obtained, cluster families were created using the statistical technique of *k*-means. Four families were created according to jurisdictions' regulatory stringency characteristics: a) the most regulated (cluster 1 with 22 jurisdictions); b) the highly regulated (cluster 2 with 30 jurisdictions); c) the lightly regulated (cluster 3 with 30 jurisdictions); and d) the less regulated (cluster 4 with nine jurisdictions).

Once the cluster families were defined, jurisdictions were contrasted across the full distribution of the LURE Index values. For this purpose, the average sub-index values for each cluster were obtained. After this, the mean comparison and decomposition analysis were the procedures used to analyze the results of the LURE Index.

The decomposition analysis, performed to ascertain the role of each variable, revealed three patterns:

- The number and variability in the implementation of some regulatory measures across jurisdictions allow for the relying on these variables as capable of characterizing the LUREs of jurisdictions.

- Some variables did not contribute significantly to the characterization mainly due to the large number of jurisdictions already having in place these regulatory measures.

- Other variables helped to characterize the jurisdictions' LUREs, nonetheless it was detected that in the near future these variables would not be considered good indicators of variability among places.

The inclusion of variables with similar characteristics such as minimum lot sizes could have created double counting and as a result skewed the distribution of values. If this was the case, different stages in the creation of the LURE Index could have been affected. Further research could involve the exclusion of some variables. (The results of the section on multivariate analysis could be of helpful for this).

7.4. Regarding the Index statistical robustness

The LURE Index has proven to be a statistically sound composite measure. An uncertainty and sensitivity analysis was performed in order to assess the statistical robustness of the LURE Index.

51 scenarios (alternative indices) under different conditions of uncertainty were created in order to test the robustness of the LURE Index. Median comparison and sensitivity to ranking changes for the index was checked. The scenarios were created under different conditions: a) four MI datasets; b) two types of normalization and aggregation procedures; c) exclusion of sub-indices; and d) two weighting mechanisms.

The LURE Index proved in general to be statistically robust to different sources of uncertainty. The sensitivity of the LURE Index under different scenarios was stable at the higher and lower level of rankings (specifically jurisdictions in clusters 1 and 4) but

showed some degree of variability in the middle section of ranked jurisdictions (clusters 2 and 3). Although the number of scenarios was significant, further research could involve the use of more scenarios, taking into account other procedures not used in this study (e.g. non compensatory aggregation, more scenarios excluding other variables).

7.5. Future research

After showing that the created LURE Index is a statistically sounded measure capable of characterizing the land use and development regulatory landscape of jurisdictions in the H-GA, further research could involve the implementation of the LURE Survey in the rest of state of Texas. This would be helpful in the increased amount of information available regarding the effect of land use regulations on other variables such housing values, rent prices, etc., and could be achieved by including the index as an independent variable in empirical analysis (e.g. hedonic modeling).

In summary, the results of the creation and assessment of the LURE Index verifies that an index of these characteristics is a valid and reliable measure to characterize LUREs for housing markets.

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APPENDIX A

Average WRLURI Values in Metropolitan Areas

Rank	Metropolitan Area	WRLURI
1	Providence- Fall River-Warwick, RI-MA	1.79
2	Boston, MA-NH	1.54
3	Monmouth-Ocean, NJ	1.21
4	Philadelphia, PA	1.03
5	Seattle-Bellevue-Everett, WA	1.01
6	San Francisco, CA	0.90
7	Denver, CO	0.85
8	Nassau-Suffolk, NY	0.80
9	Bergen-Passaic, NJ	0.71
10	Fort Lauderdale, FL	0.70
11	Phoenix-Mesa, AZ	0.70
12	New York, NY	0.63
13	Riverside-San Bernardino, CA	0.61
14	Newark, NJ	0.60
15	Springfield, MA	0.58
16	Harrisburg-Lebanon-Carlise, PA	0.55
17	Oakland, CA	0.52
18	Los Angeles-Long Beach, CA	0.51
19	Hartford, CT	0.50
20	San Diego, CA	0.48
21	Orange County, CA	0.39
22	Minneapolis-St. Paul, MN-WI	0.34
23	Washington, DC-MD-VA-WV	0.33
24	Portland-Vancouver, OR-WA	0.29
25	Milwaukee-Waukesha, WI	1.21
26	Akron, OH	1.03
27	Detroit, MI	1.01
28	Allentown-Bethlehem-Easton, PA	0.90
29	Chicago, IL	0.85
30	Pittsburgh, PA	0.80
31	Atlanta, GA	0.71
32	Scranton-Wilkes-Barre-Hazelton, PA	0.70
33	Salt Lake City-Ogden, UT	0.70
34	Grand Rapids-Muskegon-Holland, MI	0.63
35	Cleveland-Lorain-Elyria, OH	0.61
36	Rochester, NY	0.60
37	Tampa-St. Petersburg-Clearwater, FL	0.58
38	Houston, TX	-0.19
39	San Antonio, TX	-0.24
40	Fort Worth-Arlington, TX	-0.27
41	Dallas, TX	-0.35
42	Oklahoma City, OK	-0.41
43	Dayton-Springfield, OH	-0.50
44	Cincinnati, OH-KY-IN	-0.56
45	St. Louis, MO-IL	-0.72
46	Indianapolis, IN	-0.76
47	Kansas City, MO-KS	-0.80

Source: Elaborated based on data from Gyourko et al. 2008

APPENDIX B

Glickfeld/Levine Survey

League of California Cities
1400 K STREET • SACRAMENTO, CA 95814 • (916) 444-5790

Sacramento, CA.
November, 1988

TO: City Managers (City Clerks in Non-Manager Cities)

RE: SURVEY ON LOCAL GROWTH CONTROL AND GROWTH MANAGEMENT MEASURES

The League of California Cities is sending this survey on local growth control and growth management measures to all cities in the state. The results will provide a database that describes the scope and nature of growth control and growth management measures being undertaken in local jurisdictions in California. This data base will be used to assist individual cities now considering growth control and growth management measures by providing information on the types and impacts of such measures. This information will also be considered by the League's Growth Control Task Force in developing policies on growth control and growth management. In addition, we anticipate that the next legislative session will be focused on growth control and growth management restrictions.

This survey asks for information on all growth control or growth management measures undertaken in your jurisdiction, whether adopted as an ordinance by the city council or through the initiative ballot process. While people may have different definitions of growth control and growth management measures, for the purposes of this questionnaire such measures are those that control the rate, intensity, type and distribution of development in the jurisdiction.

We would like you to identify measures that are applicable citywide, or have an impact on the entire jurisdiction even though it may be limited to a particular geographical area. Advisory measures, short-term restrictions (such as a zoning moratorium to prepare a community plan), single site or project restrictions which do not have a jurisdictionwide effect, or measures which are no longer in effect should be excluded.

Only one survey per jurisdiction should be completed. Please have the staff person who is the most knowledgeable on the purpose, content and impacts of your city's growth control and growth management measures complete this survey. In many jurisdictions, the Planning Director would probably be the appropriate person.

Please fill out and return this survey even if you do not currently have any growth control or growth management measures. It is extremely important that every jurisdiction respond to this survey. We apologize for the length of this survey, but please respond to all of the questions. Please return this survey as soon as possible, but no later than December 30.

Thank you for your assistance. The results of this survey should be available in February, 1989.

LEAGUE OF CALIFORNIA CITIES
SURVEY ON GROWTH CONTROL

RETURN BY DECEMBER 30.

GENERAL INFORMATION

1. NAME OF JURISDICTION: _____

2. NAME OF RESPONDENT: _____

3. TITLE OF RESPONDENT: _____

4. POPULATION: not coded;replaced with standardized data

5. GEOGRAPHIC LOCATION: not coded; replaced with standardized data

Check one of the following:

a._____ Northern Coastal
b._____ Northern Foothill/Mountain
c._____ Northern Inland
d._____ Northern Desert
e._____ Central Coastal
f._____ Central Foothill/Mountain
g._____ Central Inland
h._____ Central Desert
i._____ Southern Coastal
j._____ Southern Foothill/Mountain
k._____ Southern Inland
l._____ Southern Desert

6. DEVELOPMENT CHARACTER

Check one of the following that describes the character of your city:

a._____ Urban/Suburban
b._____ Rural

7. GROWTH DEMAND

Check one of the following that best fits your city:

a._____ There is a strong market demand for housing development in our jurisdiction.

b._____ There is a strong market demand for commercial and industrial development in our jurisdiction.

c._____ Both a. and b..

d._____ There is a lack of a strong demand for growth in our jurisdiction.

e._____ Other (Please Explain)_____

_____.

8. PLANNING DOCUMENT STATUS

Please check below all applicable statements regarding the status of your city's required planning documents.

a._____ Our general plan is complete (i.e., includes all state mandated elements).
Please note year of adoption:_____

b._____ We are currently in the process of updating our general plan.

c._____ We are currently in the process of updating one or more state mandated general plan elements.

not coded d._____ Our general plan is incomplete or over 10 years old.

e._____ We have asked for or received a general plan extension from the State Office of Planning and Research.

f._____ We have adopted a general plan growth management element or are currently developing such an element.

not coded g._____ Our housing element is complete and finally adopted.
Please note year of adoption:_____.

not coded h._____ We only have a draft housing element.

not coded i. According to the State Department of Housing, Community Development (HCD), our adopted housing element has been deemed:

(1)_____ In compliance. (2)_____ Out of compliance.

(3)_____ Obsolete (4)_____ No determination/unknown.

not coded j. According to HCD, our draft housing element has been deemed:

(1)_____ In compliance. (2)_____ Out of compliance.

(3)_____ Obsolete. (4)_____ No determination/unknown.

- -

II. RESIDENTIAL GROWTH CONTROL AND GROWTH MANAGEMENT MEASURES

9. POPULATION GROWTH LIMITATIONS

Does your city have a measure* which establishes a population growth limit or restricts the level of population growth for a given time frame (i.e., annual basis)?

**"Measure" includes initiatives adopted by the voters or regulatory ordinances adopted by the city council. It excludes resolutions or other policy statements.*

a._____ YES b._____ NO

If YES, adopted by (1)_____ initiative or (2)_____ ordinance.
(3)_____ year enacted.

10. HOUSING PERMIT LIMITATIONS

Does your city have a measure which restricts the total number of permitted residential building permits in a given time frame (i.e., annual basis) for:

a._____ YES b._____ NO

If YES, applies to (1)_____ single family or (2)_____ multiple family or (3)_____ both

If YES, total # of permitted units:(4) _____ per (5)_____.

If YES, adopted by (6)_____ initiative or (7)_____ ordinance.
(8)_____ year enacted.

11. HOUSING INFRASTRUCTURE REQUIREMENTS

Does your city have a measure which specifically requires adequate service levels (i.e., road capacity/traffic congestion) or service capacity (i.e., water, sewers, etc.) prior to or as a condition of approval of a residential development?

a. _____ YES b. _____ NO

If YES, adopted by (1)_____ initiative or (2)_____ ordinance.
(3)_____ year enacted.

12. HOUSING DENSITY AND LOCATIONAL RESTRICTIONS

Does your city have a measure which did any of the following (check all applicable responses):

a._____ Reduced the permitted residential density by general plan amendment or rezoning.

Applicable to: (1)_____ Entire City or (2)_____ Part of City
Adopted by: (3)_____ initiative or (4)_____ ordinance.
Year enacted: (5)_____.

b._____ Requires voter approval to increase residential densities.

Applicable to: (1)_____ Entire City or (2)_____ Part of City
Adopted by: (3)_____ initiative or (4)_____ ordinance.
Year enacted: (5)_____.

c._____ Requires super majority council vote to increase residential densities.

Applicable to: (1)_____ Entire City or (2)_____ Part of City
Adopted by: (3)_____ initiative or (4)_____ ordinance.
Year enacted: (5)_____.

d._____ Redesignated or rezoned land previously designated for residential development to agriculture or open space (i.e., hillside or ridge preservation).

Adopted by: (1)_____ initiative or (2)_____ ordinance.
(3)_____ year enacted.

IF YOU ANSWERED YES TO QUESTIONS 9, 10, OR 11, OR CHECKED A RESPONSE TO QUESTION 12, PLEASE ANSWER THE FOLLOWING QUESTIONS 13 - 15. IF YOU ANSWERED NO OR DID NOT CHECK A RESPONSE TO QUESTIONS 9-12, GO TO QUESTION 16.

13. PURPOSES OF RESIDENTIAL GROWTH CONTROL AND GROWTH MANAGEMENT MEASURES

Please check all of the applicable purposes for all of your city's residential growth control or growth management measures as listed below:

a._____ Air Quality
b._____ Water Quality
c._____ Agricultural Land Preservation
d._____ Open Space/Ridgeline Preservation
e._____ Limitation of Urban Sprawl
f._____ Preservation of Sensitive Environmental Areas
g._____ Reduction in Traffic Congestion
h._____ Sewer Capacity Limitations
i._____ Water Quantity Limitations
j._____ Rapid Population/Housing Growth
k._____ Quantity of High Density Housing Developments
l._____ Quantity of Low Income Housing Developments
m._____ Quality of Life Preservation
n._____ Other: (please specify)_____
o._____ Information not available
p._____ Not applicable - no residential growth control or growth management measures

14. IMPACTS OF RESIDENTIAL GROWTH CONTROL AND GROWTH MANAGEMENT MEASURES

Please check all of the applicable impacts of all of your city's residential growth control or growth management measures as listed below:

a._____ Increase in housing costs above inflation rates.
b._____ Reduction in the historical level of new housing development.
c._____ Increase in average commute distances.
d._____ Increase in traffic levels/congestion.
e._____ Decrease in projected traffic levels/congestion.
f._____ Reduction in projected population levels.
g._____ Other. (Please specify):_____
_____
h._____ Information not available.

15. LOW-MODERATE INCOME HOUSING EXEMPTIONS

Does your city exempt low and/or moderate income housing units (i.e., affordable to families with an income of 120% or less of the median) from application of your residential growth control/growth management measures?

a._____ YES. b._____ NO. c._____ Not applicable - no residential growth control or growth management measures.

16. LOW-MODERATE INCOME HOUSING INCENTIVES

Does your city provide any incentives (i.e., density bonus, financial subsidies, etc.) for construction of low and/or moderate income housing units?

a._____ YES. b._____ NO.

If YES, please specify: _____

_____.

- -

III. COMMERCIAL AND/OR INDUSTRIAL GROWTH CONTROL AND GROWTH MANAGEMENT MEASURES

17. SQUARE FOOTAGE LIMITATIONS

Does your city have a measure that restricts the amount of square footage that can be built within a given time frame for:

a. Commercial (i.e., retail and office): (1)_____ YES (2)_____ NO

If YES, applicable to: (3) _____ Entire City or (4)_____ Part of City
If YES, adopted by: (5)_____ initiative or (6)_____ ordinance
(7) _____ year enacted.

b. Industrial (light industrial/warehouse): (1)_____ YES (2)_____ NO

If YES, applicable to: (3) _____ Entire City or (4)_____ Part of City.
If YES, adopted by: (5) _____ initiative or (6) _____ ordinance
(7) _____ year enacted.

18. COMMERCIAL/INDUSTRIAL INFRASTRUCTURE REQUIREMENTS

Does your city have a measure that specifically requires adequate service levels (i.e., road capacity/traffic congestion) or service capacity (i.e., water, sewer, etc.) prior to or as a condition of approval of commercial and/or industrial development?

a._____ YES b._____ NO

If YES, adopted by: (1)_____ initiative or (2)_____ ordinance
(3)_____ year enacted.

19. COMMERCIAL/INDUSTRIAL LOCATIONAL RESTRICTIONS

Does your city have a measure which redesignated or rezoned land previously designated for commercial and/or industrial development?

a._____ YES b._____ NO

If YES, applicable to: (1) ____ Entire City or (2) ____ Part of City.
If YES, adopted by: (3)_____ initiative or (4)_____ ordinance
(5)_____ year enacted.
If YES, redesignated to: (6)_____ residential (7)_____ agriculture
(8)_____ other, Specify:_____

20. COMMERCIAL BUILDING HEIGHT LIMITATIONS

Does your city have a measure adopted within the last 5 years, which restricts the permitted height of commercial/office buildings?

a._____ YES b._____ NO

If YES, applicable to: (1)___ Entire City or (2)___ Part of City.

If YES, adopted by: (3)_____ initiative or (4)_____ ordinance
(4)_____ year enacted.

IF YOU ANSWERED YES TO QUESTIONS 17, 18, 19 OR 20, PLEASE ANSWER THE FOLLOWING QUESTIONS 21 - 22. IF YOU ANSWERED NO, GO TO QUESTION 23.

21. PURPOSES OF COMMERCIAL AND/OR INDUSTRIAL GROWTH CONTROL AND GROWTH MANAGEMENT MEASURES

Please check all of the applicable purposes for all of your city's commercial/industrial growth control or growth management measures as listed below:

a._____ Air Quality Preservation
b._____ Water Quality Preservation
c._____ Agricultural Land Preservation
d._____ Open Space Preservation
e._____ Limitation of Urban Sprawl
f._____ Preservation of Sensitive Environmental Areas
g._____ Reduction in Traffic Congestion
h._____ Sewer Capacity Limitation
i._____ Water Quantity Limitation
j._____ Quality of Life Preservation
k._____ Other (please specify):_____
l._____ Information Not Available
m._____ Not applicable -- no commercial/industrial growth control or growth management measures.

22. IMPACTS OF COMMERCIAL/INDUSTRIAL GROWTH AND GROWTH MANAGEMENT MEASURES

Please check below all of the applicable impacts of all of your city's commercial/industrial growth control or growth management measures as listed below:

a._____ Increase in the average commute distance
b._____ Increase in traffic levels/congestion
c._____ Decrease in projected traffic levels/congestion
d._____ Reduction in the historical level of new commercial/industrial development.
e._____ Loss of projected new commercial, office or industrial developments/employers
f._____ Reduction in projected employment levels
g._____ Reductions in projected sales tax revenues
h._____ Reductions in projected property tax revenues
i._____ Increase in the historical level of residential development
j._____ Other (please specify):_____
k._____ Information not available
l._____ Not applicable -- no commercial/industrial growth control or growth management measures

23. JOBS/HOUSING BALANCE

Has your city enacted a policy or ordinance which specifies a desired or required ratio of the number of housing units per the number of jobs within a given area or within the entire city?

a._____ YES b._____ NO

If YES, what is that ratio or percentage:_____

24. JOBS/HOUSING LINKAGE

Has your city enacted an ordinance to require commercial/industrial developers to pay in-lieu fees for housing development or to construct housing units as a condition of development approval?

a._____ YES b._____ NO

- -

IV. OTHER GROWTH CONTROL AND GROWTH MANAGEMENT MEASURES

25. URBAN LIMIT LINE/GREENBELT

Has your city established an urban limit line or greenbelt, other than the boundaries of your city, beyond which residential, commercial and/or industrial development is not currently permitted?

a._____ YES b._____ NO

If YES, adopted by: (1)_____ initiative or (2)_____ ordinance.
(3)_____ year enacted.

26. OTHER MEASURES

Does your city have other existing or pending measures which fall under the definition of growth control or growth management which are not covered under the prior questions?

a._____ YES b._____ NO

If YES, please describe: (1)_____

If YES, adopted by: (2)_____ initiative or (3)_____ ordinance or (4)_____ pending and (5)_____ year enacted.

- -

V. MONITORING AND EVALUATION OF GROWTH CONTROL AND GROWTH MANAGEMENT MEASURES

27. MONITORING BENEFITS AND IMPACTS

Has your city established a program for monitoring or measuring the benefits and impacts of your growth control or growth management measures?

a._____ YES b._____ NO

28. EVALUATING BENEFITS AND IMPACTS

Have any studies been conducted by the city or any other public or private agency or group to analyze the benefits and impacts of your growth control or growth management measures?

a._____ YES b._____ NO c._____ Don't Know

If YES, please list the titles and authors of these studies below:

_____

_____

_____

- -

VI. GENERAL COMMENTS

29. Please use the space below to write any comments on growth control and growth management measures which were not included in the prior questions or any comments you may have on this survey.

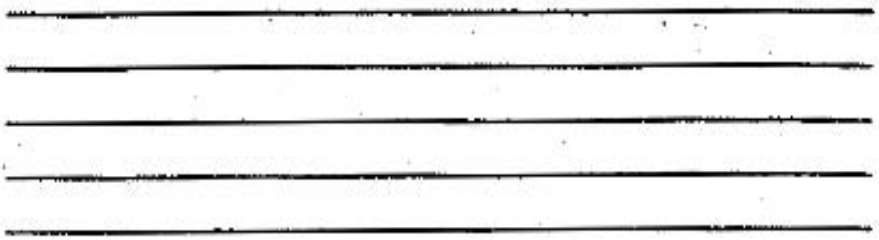
_____

_____

_____

_____

_____



Please return this survey by December 30 to:

League of California Cities
Attn: Sheryl Patterson
1400 K Street, 4th Floor
Sacramento, CA 95814

GROWTH.leg

APPENDIX C

Wharton Urban Decentralization Project

WHARTON URBAN DECENTRALIZATION PROJECT

(with the cooperation of the International City Managers Association)

****

DEVELOPMENT REGULATION SURVEY QUESTIONNAIRE

I. JURISDICTION

Name of Jurisdiction _____ Zip Code _____

1. Type of Jurisdiction: [ ] City
[ ] County
[ ] Township
[ ] Town, Village, or Borough
[ ] Other ____

2. Size of Jurisdiction: ____ Square miles

3. Population

a) Current Population Estimate _____

b) Annual Population Growth Rate

Past 5 years _____ % per year

Projected next 5 years _____ % per year

II. DEVELOPMENT POLICIES

The following questions concern public policies and actions that affect the supply of land for single-family detached housing. Please give us the benefit of your opinion.

4. What is the main building code utilized by your community?

Building Officials and Code Administrators (BOCA)	[ ]
Southern Building Code (SBCCI)	[ ]
Uniform Building Code (UBC/ICBO)	[ ]
Council of American Building Officials (CABO)	[ ]
Other	[ ]

5. Please rate the importance of the following factors, on a scale of 1 to 5, to the development process in your community. (1 = not at all important to 5 = very important)

	Not Important 1	2	3	4	Very Important 5	Not Sure
Population Growth	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Population density	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Adequate infrastructure	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Land costs	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Regulation	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Development standards	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Comprehensive planning	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Tax rates	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Quality of life	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other specify	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

6. On a scale of 1 to 5, please rate the effectiveness of each of the following growth management techniques in controlling growth in your community. (1 = not effective to 5 = very effective).

	Not Important 1	2	3	4	Very Important 5	Not Sure
Adequate facilities	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Ordinances	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Building permits	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Population limits	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Exactions/impact fees	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Urban service boundary	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Farm protection	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Zoning ordinance	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other specify	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

7. How did the time to obtain a routine single-family project approval (zoning and subdivision) change during the period from 1983 to 1988?

Shortened considerably	Shortened somewhat	No change	Increased somewhat	Increased considerably	No opinion
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

8. What is the typical amount of time between application for rezoning and issuance of a building permit for the development of:

	Less than fifty single-family units	Fifty or more single-family units	Office building of under 100,000 square ft.
Less than 3 mons.	[ ]	[ ]	[ ]
3 to 6 months	[ ]	[ ]	[ ]
7 to 12 months	[ ]	[ ]	[ ]
13 to 24 months	[ ]	[ ]	[ ]
More than 24 months	[ ]	[ ]	[ ]

9. What is the typical amount of time between application for subdivision approval and the issuance of a building permit (assume proper zoning already in place) for the development of:

	Less than fifty single-family units	Fifty or more single-family units	Office building of under 100,000 square ft.
Less than 3 mons.	[ ]	[ ]	[ ]
3 to 6 months	[ ]	[ ]	[ ]
7 to 12 months	[ ]	[ ]	[ ]
13 to 24 months	[ ]	[ ]	[ ]
More than 24 months	[ ]	[ ]	[ ]

10. How does the acreage of land zoned for the following land uses compare to demand?

	Far more than demanded	More than demanded	About right	Less than demanded	Far less than demanded	No opinion/ not sure
Single Family	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Multi/Family	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Commercial	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Industrial	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

11. How does the current availability of land zoned for the following single-family residential lot sizes compare to demand?

	Far more than demanded	More than demanded	About right	Less than demanded	Far less than demanded	No opinion/ not sure
Less than 4,000 sq. ft.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
4,000 - 6,000 sq.ft.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
6,000 - 10,000 sq. ft.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
10,000 - 20,000 sq. ft.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Over 20,000 sq. ft.	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

12. How many single-family lots have been approved for development (with full services) for each of the following lot sizes during the past 12 months? If zero, please indicate "0".

	Number of Lots
Less than 4,000 sq. ft.	_____
4,000 - 8,000 sq. ft.	_____
8,000 - 10,000 sq. ft.	_____
10,000 - 20,000 sq. ft.	_____
Over 20,000 sq.ft.	_____

13. How many acres of land have been approved for development (with full services) for each of the following land uses during the last 12 months? If zero, please indicate "0".

	Acreage
Multi-family	_____
Office	_____
Retail	_____
Industrial	_____

14. Approximately what percentage of applications for zoning changes were approved in your community during the past 12 months?

[ ] 100-90% [ ] 89-60% [ ] 59-30% [ ] 29-10% [ ] 10-0%

15. How has the provision of roads and sewers kept pace with growth needs?

Much more than needed	Slightly more than needed	About right	Less than needed	Far less than needed	No opinion/ not sure
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

16. For a typical 2,000 - 3,000 sq. ft. single family home (for example, with 3 bedrooms and 2 baths), please indicate which fees/exactions are imposed in your area and associated characteristics:

	Amount (dollar or set-aside acreage)	Unit of impact (e.g. per sq. ft.)	Assessed at the time of: Zoning	Assessed at the time of: Sub-division	Assessed at the time of: Permit	Paid at the time of: Zoning	Paid at the time of: Sub-division	Paid at the time of: Permit
Schools	___	_____	___	___	___	___	___	___
Parks	___	_____	___	___	___	___	___	___
Sewer	___	_____	___	___	___	___	___	___
Fire Houses	___	_____	___	___	___	___	___	___
Libraries	___	_____	___	___	___	___	___	___
Community Centers	___	_____	___	___	___	___	___	___
Others	___	_____	___	___	___	___	___	___

We do not use fees/exactions _____

17. Which of the following techniques does your community use to regulate the conversion of land from agricultural/open space to residential, commercial or industrial use?

[ ] Agricultural Land Conversion Tax
[ ] Transfer of Development Rights
[ ] Land Banking
[ ] Real Estate Transfer Tax
[ ] Urban Development Boundaries
[ ] Water/Sewer provision Staging Plan
[ ] Historic Preservation Requirements
[ ] Other

18. In your community, how prevalent are the following modes of introducing growth management policies?

	Very prevalent	Somewhat prevalent	Not prevalent	Not sure/do not know
Citizen referendum	[ ]	[ ]	[ ]	[ ]
Legislative action by the municipality	[ ]	[ ]	[ ]	[ ]
Legislative action by the county	[ ]	[ ]	[ ]	[ ]
Legislative action by the state	[ ]	[ ]	[ ]	[ ]
Administrative action by public authorities	[ ]	[ ]	[ ]	[ ]

19. How much has the cost of lot development, including subdivision, increased from 1983-1988?

[ ] None [ ]1-9% [ ] 10-19% [ ] 20-29%
[ ] 30-39% [ ] 40-49% [ ] 50% or more

20. How would you describe your jurisdiction?

[ ] High growth area
[ ] Medium growth area
[ ] Slow growth area
[ ] No growth area

21. In your opinion, how do living conditions in this community compare to five years ago?

[ ] Better [ ] Worse
[ ] About the same [ ] Not sure/do not know

22. In your opinion, who should pay for roads, sewers, and schools when a new residential development is built?

[ ] Developers [ ] All residents in the city
[ ] Users [ ] New residents
[ ] Share between developers and new residents

23. Name_____

24. Title_____

25. Organization_____

26. Status: [1] Public
[2] Private
[3] Non Profit

27. Address_____

28. Telephone_____

29. How long have you worked or lived in the community?
_____ years.

30. Check this box if you would like to receive a copy of the results of this survey. [ ]

THANK YOU

November 1989

APPENDIX D

Pendall and Puentes Survey

Land-Use Policies and Housing:
A National Survey on Local Residential Development Regulation

This survey seeks important information about planning and zoning in communities with over 5,000 residents in the 53 largest metropolitan areas in the United States. Please answer all the questions to the best of your ability. While accuracy is important to us, your time is also important, so please **provide your best estimates for any information that is not readily available**. If you wish to comment on any questions or qualify your answers, feel free to use the space in the margins; there is also space for comments on the back of the survey form. Your comments will be read and taken into account.

Thank you very much for your help.

The Department of City and Regional Planning
Cornell University
106 W. Sibley Hall
Ithaca, NY 14853

Name of respondent: _____
Title: _____
Name of Community: _____
City: _____ State: _____ Zip: _____
Telephone number: ( ) ____-_____ Fax: ( ) ____-_____
E-mail: _____ Date of Response: _____

A. Planning and Zoning

The first two questions concern overall regulations, including comprehensive planning and zoning that are currently in force in your jurisdiction. (Some states do not require their communities to adopt a plan or zoning ordinance)

1. Does your jurisdiction have a comprehensive (master, general) plan?
____ No.
____ Yes.
If you answered "yes," what year was the Land Use element of the plan last updated?
_____ (year)

2. Does your jurisdiction have a zoning ordinance?
____ No.
____ Yes.
If you answered "yes," what year was the ordinance last updated? _____ (year)

If you answered "no" to questions 1 and 2, please skip to Section C.

B. Zoning for Housing

The next few questions concern the availability of land in your community for development of multi-family housing. Even if your community does not allow multi-family housing development, please answer the questions.

3. What is the theoretical maximum number of dwelling units that may be constructed per net acre in your community, in areas zoned in the **highest residential density category?**
____ Less than 4
____ 4-7
____ 8-15
____ 16-30
____ more than 30

4. How has the maximum permitted density **changed since 1994?**
____ Stayed approximately the same (within 10%)
____ Reduced more than 10%.
____ Increased more than 10%.
____ Don't know.

5. Does your jurisdiction permit the placement of new mobile homes?
____ No.
____ Yes; double-wide only.
____ Yes; double- or single-wide.

6. Assume your jurisdiction has a vacant 5-acre parcel. If a developer wanted to build 40 units of 2-story apartments and was flexible with planning, landscaping and building configuration, would there be an existing zoning category that would allow such development?

____ No.
____ Yes; by right.
____ Yes; by special permit, PUD, or other special procedure.

7. Does your jurisdiction require a **popular vote** (ballot measure) **of the jurisdiction's residents as a precondition to rezoning?**

____ No.
____ No; but a town meeting is required.
____ Yes; for any rezoning.
____ Yes; for selected rezoning of:

_____
_____
_____
_____

C. Jurisdiction Expansion Potential

These questions will help us understand whether development in your jurisdiction can expand into undeveloped areas at or beyond the jurisdiction's current boundaries.

8. Is a popular vote required as a precondition to annexation in your jurisdiction? (Please answer "no" if the only vote required is that of landowners or residents in **the area to be annexed**.)

____ No.
____ Yes, a binding referendum has been required since _____ (year).
____ Yes, an advisory referendum has been required since _____ (year).

9. Does your jurisdiction currently have any of the following?: (Please check "yes" or "no")

____No ____YesUSB/USA in place since _____ (year)
____No ____YesUGB in place since _____ (year)
____No ____YesGreenbelt in place since _____ (year)
____No ____YesUrban limit line in place since _____ (year)

D. Other Regulations Pertaining to Housing

The next few questions concern other local regulations that your jurisdiction uses for the management of residential growth, including growth (rate) controls, moratoria, and adequate public facilities ordinances.

10. Does your jurisdiction currently have a measure that explicitly restricts the pace of residential growth?

____ No.
____ Yes; population growth limited to _____ percent per year; adopted _____ (year).
____ Yes; residential building permit issuance limited to _____ (number) per year; adopted _____ (year).

11. Does your jurisdiction currently have a moratorium on issuance of new residential building permits or the processing of subdivision maps covering all or part of the jurisdiction's geographic area? (Please include moratoria imposed by either your community or another unit of government or utility district.)

____ No.

____ Yes; **a jurisdiction-wide moratorium.**
____ Yes; **a moratorium covering part of the jurisdiction** (specific zoning districts, geographic areas, environmental zones, etc.) that affects
____**less than half** of the jurisdiction's undeveloped land area.
____**more than half** of the jurisdiction's undeveloped land area.

Moratorium in force since _____ (year);
____ Moratorium will expire _____ (year).
____ Moratorium does not have a definite expiration date.

If you answered "no" to both question 10 and question 11, please skip the next two questions and go to question 14.

12. **Does your current residential growth control or moratorium offer exemptions or incentives for affordable housing**?
____ No.
____ Yes; projects that consist mostly (more than 50%) of affordable housing are exempt from the control.
____ Yes; the permit allocation system gives preference to affordable housing.

13. **Apart from any residential-growth limiting measures currently in force,** has your jurisdiction had **other growth-limiting measures** that lasted more than a year since 1980?
____ No.
____ Don't know.
____ Yes; growth rate or building permit cap from _____(year) to_____(year)
____ Yes; permit or subdivision moratoria (including moratoria imposed by either your jurisdiction or another unit of government or utility district)
____ Yes; jurisdiction-wide moratorium from _____(year) to_____ (year)
____ Yes; moratorium on part of the jurisdiction from _____(year) to_____(year)

14. Does your jurisdiction charge **impact fees**?
____ No.
____ Yes; we impose fees based on a case by case review of project off-site impacts.
____ Yes; (we review projects) and fees are imposed at a flat rate of
$_____ / square foot.
$_____ / single-family unit.
$_____ / multi-family unit.

If so, **fees apply to**: (please check all that apply)
____ Schools
____ Stormwater
____ Transportation facilities (roads, highways, transit)
____ Public safety facilities (police, fire stations)
____ Water supply and/or wastewater treatment, supply, delivery, and/or storage facilities
____ Parks, recreation and/or open space facilities
____ Water supply
____ Waste water treatment
____ Other: _____
_____
_____

[THE FOLLOWING QUESTION ASKED BY EMAIL]

Does your jurisdiction have an **"adequate public facilities ordinance"** or some other ordinance that requires **off-site** public facilities (schools, roads, public safety facilities, water and waste-water facilities, parks, etc.) to meet or exceed specified levels of service (capacity levels) as a precondition of residential development?

____ No.
____ No; we do not have a formal ordinance, but we review projects on a case-by-case level and impose conditions of approval to ensure that projects mitigate their off-site impacts through fees.
____ Yes; we have a formal ordinance that began in _____(year) and applies to (check all that apply):
- ____ Schools
- ____ Storm water
- ____ Transportation facilities (roads, highways, transit)
- ____ Public safety facilities (police, fire stations)
- ____ Water supply and/or wastewater treatment, supply, delivery, and/or storage facilities
- ____ Parks, recreation and/or open space facilities
- ____ Other: _____
  _____
  _____

E. Affordable Housing

The final questions are on "affordable housing" in your jurisdiction. (We define affordable housing as units guaranteed to remain affordable for at least five years to households earning less than 120 percent of area median income.)

15. Does your jurisdiction use any incentives or requirements to encourage **private-sector builders to develop affordable housing?**(Please check all that apply.)

____ No.
____ Yes; residential density bonus (to developers of market-rate housing who agree to provide affordable housing units).
____ Yes; inclusionary zoning (developers of market-rate housing are required to include affordable housing units in their developments,
at least _____ percent of the units must be affordable.
____ Yes; developers may satisfy this requirement by paying a fee instead of building housing on site.
____ Yes, we provide "fast-tracking" (expediated permitting) for builders who agree to provide some affordable housing.
____ Yes; we require linkage fees (monies collected to help support or develop affordable housing) from non-residential builders.
____ Yes; other:
_____

16. What **other programs** does your jurisdiction use to encourage affordable housing construction and substantial rehabilitation? (Please check all that apply.)

____ We use public funds or provide staff to support local non-profits.
____ We work with the public housing authority to build new affordable housing and/or substantially rehabilitate existing uninhabitable units.
____ We arrange for purchase of existing private-sector units for conversion to long-term affordability.
____ We have adopted an ordinance providing for waivers of planning or development impact fees on affordable housing projects.
____ Other programs in place (please list programs):

17. Approximately how many affordable housing units, assisted by either the public or private sector, are there in your jurisdiction (see definition above)?

If you cannot answer this question, please indicate in the space provided below the name and telephone number of someone who can.

____ There is no government-assisted affordable housing in this jurisdiction.
____ # of units built or substantially rehabilitated by the public housing agency or a non-profit with federal, state, or local subsidies (including existing private-sector units bought and made affordable).
____ # of units built or substantially rehabilitated by private-sector developers as a result of a local government regulatory incentive or requirement (condition of approval).
____ # of units built or substantially rehabilitated by private-sector developers with federal housing programs (e.g. LIHTC, HOPE VI, Section 235/236, etc.).
____ # of units total.
____ Number of these housing units built between 1990 and 2002 (inclusive)
____ Please call _____ at (____)_____ to obtain this information.

18. Does your community have a local affordable housing funding mechanism?
____ No.
____ Yes; this fund is dedicated solely for affordable housing.
____ Yes; this fund may also be used for projects other than affordable housing.

19. **Compared to your jurisdiction's current level of regulation** on land use and residential development, how would you describe your jurisdiction in: (please check)

	more regulated	about the same	less regulated	no regulation
1970	___	___	___	___
1980	___	___	___	___
1990	___	___	___	___

Thank you for your assistance. Please feel free to write additional comments or questions about the survey on the back page.

Is there anything else we should know about planning and zoning for residential development in your community? If so, please use this space for that purpose.

We very much appreciate your contribution to this effort. If you would like a summary of our results, please print your name and address on the **back of the return envelope**. We will see that you get a summary.

APPENDIX E

Gyourko et al. Survey on Residential Land-Use Regulation

Zell/Lurie Real Estate Center
Wharton School, University of Pennsylvania

SURVEY ON RESIDENTIAL LAND-USE REGULATION

JURISDICTION

Name of Jurisdiction _____ Zip Code _____

Type of Jurisdiction _____

_____

(City, County, Township, Town, Village, Borough)

Size of Jurisdiction _____ square miles

Population
Current population estimate _____
Population growth: Past 5 years _____ % Projected next 5 years _____ %

GENERAL CHARACTERISTICS OF LAND REGULATORY PROCESS

1. In your community, how involved are the following organizations in affecting residential building activities and/or growth management procedures? Please rate the importance of each on a scale of 1 to 5 by circling the appropiate number (1 = not at all involved; 5 = very involved).

- Local Council, Managers, Commissioners	1	2	3	4	5
- Community pressure	1	2	3	4	5
- County legislature	1	2	3	4	5
- State legislature	1	2	3	4	5
- Local courts	1	2	3	4	5
- State courts	1	2	3	4	5

2. Which of the following are required to approve zoning changes, and by what vote?

	Yes	Yes, by simple majority	Yes, by more than simple majority	No
- Local Planning commission				
- Local Zoning Board				
- Local Council, Managers, Commissioners				
- County Board of Commissioners				
- County Zoning Board				
- Environmental Review Board				

3. Which of the following are required to approve a new project that does not need rezoning, and by what vote?

	Yes	Yes, by simple majority	Yes, by more than simple majority	No
- Planning Commission				
- Local Council, Managers, Commissioners				
- County Board				
- Environmental Review Board				
- Public Health Office				
- Design Review Board				

4. On a scale of 1 to 5, please rate the importance of each of the following factors in regulating the rate of residential development in your community (1 = not at all important; 5 = very important). Please circle the appropriate number.

	Single family units					Multi family units				
- Supply of land	1	2	3	4	5	1	2	3	4	5
- Cost of new infrastructure	1	2	3	4	5	1	2	3	4	5
- Density restrictions	1	2	3	4	5	1	2	3	4	5
- Impact fees/exactions	1	2	3	4	5	1	2	3	4	5
- City budget constriants	1	2	3	4	5	1	2	3	4	5
- City Council opposition to growth	1	2	3	4	5	1	2	3	4	5
- Citizen opposition to growth	1	2	3	4	5	1	2	3	4	5
- School crowding	1	2	3	4	5	1	2	3	4	5
- Length of review process for zoning	1	2	3	4	5	1	2	3	4	5
- Length of review process for building permits	1	2	3	4	5	1	2	3	4	5
- Length of review process for land development plan	1	2	3	4	5	1	2	3	4	5

RULES OF RESIDENTIAL LAND USE REGULATION

5. Does your community place annual limits on the total allowable:

	Yes	No
- No. of building permits – single family?		
- No. of building permits – multi-family?		
- No. of residential units authorized for construction – single family?		
- No. of residential units authorized for construction – multi-family?		
- No. of multi-family dwellings?		
- No. of units in multi-family dwellings?		

6. To build, do developers have to meet these requirements?

	Yes	No
- Meet the minimum lot size requirement? If yes: ½ acre or more _____ ½ acre or less _____ 1 acre or more _____ 2 acres or more _____		
- Include "affordable housing" (however defined)?		
- Supply mandatory dedication of space or open space (or fee in lieu of dedication)?		
- Pay allocable share of costs of infrastructure improvement?		

SPECIFIC CHARACTERISTICS

7. How does the acreage of land zoned for the following land uses compare to demand?

	Far more than demanded	More than demanded	About right	Less than demanded	Far less than demanded
- Single-family					
- Multi-family					
- Commercial					
- Industrial					

8. How much has the cost of lot development, including subdivisions, increased in the last 10 years? Please circle the appropriate category.

0–20% 21–40% 41–60% 61–80% 81–100% >100%

9. How much has the cost of a single family lot increased in the last 10 years? Please circle the appropriate category.

0–20% 21–40% 41–60% 61–80% 81–100% >100%

10. What is the current length of time required to complete the review of residential projects in your community?

For single-family units: _____ months For multi-family units: _____ months

11. Over the last 10 years, how did the length of time required to complete the review and approval of residential projects in your community change?

	no change	somewhat longer	considerably longer
- Single-family units			
- Multi-family units			

12. What is the typical amount of time between application for rezoning and issuance of a building permit for development of:

	Less than 3 mos.	3 to 6 mos.	7 to 12 mos.	13 to 24 mos.	If above 24, How long?
- Less than 50 single family units					
- 50 or more single family units					
- Multi-family units					

13. What is the typical amount of time between application for subdivision approval and the issuance of a building permit (assume proper zoning is already in place) for the development of:

	Less than 3 mos.	3 to 6 mos.	7 to 12 mos.	13 to 24 mos.	If above 24, How long?
- Less than 50 single family units					
- 50 or more single family units					
- Multi-family units					

14. How many applications for zoning changes were submitted in your community in the last 12 months?

_____

15. How many applications for zoning changes were approved in your community in the last 12 months?

_____

In the event we might need to clarify any of the answers to the above questions, we would appreciate the following information, which will be held in total confidence.

Name _____
Title _____
Organization _____
Address _____
_____
Phone _____
Fax _____
E-mail _____

Please check this box if you would like to receive the results of this survey. ☐

Thank you very much for taking the time to complete this survey.

June 2004

APPENDIX F

Lure Survey on Residential Land-Use Regulations

The Houston-Galveston Area Council is sponsoring this survey to support research efforts at Texas A&M University. This questionnaire is aimed to create the first data base that describes the nature of land used and development regulations in local jurisdictions in this area.

The survey will take approximately 10 minutes to complete. Your participation is voluntary. You may decide not to participate or to withdraw at any time. Your responses will remain strictly confidential. If you have any questions, please contact the principal investigator: Luis Estevez by sending an e-mail to estevez@tamu.edu.

The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only the principal investigator will have access to the records.

This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (979)458-4067 or irb@tamu.edu.

Thank you for your assistance. Please feel free to fill out the information at the end of this survey if you would like to receive the results of this survey.

1. JURISDICTION

Name of Jurisdiction:

County:

2. In which category of municipality does your jurisdiction falls?

	Select
General Law	◯
Home Rule	◯
Special-law	◯
Don't know	◯

Add any comment

Notes:

- General Law cities can do only those things specifi¬cally authorized or permitted by state or federal law.
- Home Rule cities are the reverse of general law cit¬ies. Instead of looking to state law to determine what they may do, as gen¬eral law cities must, home rule cities look to the state constitution and state statutes to determine what they may not do. Thus, if a proposed home rule city action has not been prohibited or pre-empted by the state, the city generally can proceed.
- A special-law municipality is a municipality which operates under a municipal charter granted by a local law enacted by the Congress of the Republic of Texas or by the legislature. A special-law municipality that has amended its municipal charter as authorized by Article XI, Section 5, of the Texas Constitution is also a home-rule municipality.

3. Does your jurisdiction have any of the following? (check all that apply)

	Yes	No	Don't know
Zoning commission	◯	◯	◯
Planning commission	◯	◯	◯
Historic commission	◯	◯	◯
Board of adjustments	◯	◯	◯
Panel board of adjustments	◯	◯	◯
Neighborhood zoning areas	◯	◯	◯

Add any comment

4. Does your jurisdiction have some of the following documents (approved by governing body)? (check all that apply)

	yes	No	In progress	Don't know
Comprehensive (master, general) plan	◯	◯	◯	◯
Zoning ordinance	◯	◯	◯	◯
Other ordinances governing plats, land development and subdivisions	◯	◯	◯	◯

Add any comment

5. Is your jurisdiction a unit in which the county applies its own subdivision provisions to new development?

◯ Yes ◯ No ◯ Don't know

Add any comment

6. Have been multifamily housing units built the last two years in your jurisdiction?

◯ Yes ◯ No ◯ Don't know

Add any comment

7. Have manufactured and modular housing been added to your jurisdictior this last two years?

◯ Yes ◯ No ◯ Don't know

Add any comment

8. To build, do developers have to meet a minimum lot size for single family unit Within the city limits?

☐ No

☐ Yes

If yes, what is the minimum lot size (Sq. ft.):

9. To build, do developers have to meet a minimum lot size for single family unit Within the city's ETJ?

◯ No

◯ Yes

If yes, what is the minimum lot size (Sq. ft.):

10. To build, do developers have to meet a minimum Floor area for single family unit within the city limits?

◯ No

◯ Yes

If Yes, what is the minimum floor area (sq. ft.):

11. To build, do developers have to meet a minimum street right-of-way width?

◯ No

◯ yes

If Yes, what is the minimum street right-of-way width (linear feet):

12. To build, do developers have to meet these requirements?

	Yes	No	Don't know
To pay building permit fee	◯	◯	◯
To pay development review fees	◯	◯	◯
Include "affordable housing" (however defined)	◯	◯	◯
Supply mandatory dedication of space or open space (or fee in lieu of dedication)	◯	◯	◯
Pay allocable share of costs of infrastructure improvement?	◯	◯	◯

Add any comment

13. Does your jurisdiction have a measure which:

	Yes	No	Don't Know
Limit development beyond a boundary (such as urban limit line, urban growth boundary, greenbelt, or urban service area)	◯	◯	◯
Establishes a limit on growth (population limit or building permits in a given time frame)?	◯	◯	◯
Requires adequate service levels for residential development or service capacity as a condition of approval of residential development	◯	◯	◯
Reduces the permitted residential density by general planning or rezoning	◯	◯	◯
Re-designates or rezones residential land to agriculture or open space (e.g., shore line protection)	◯	◯	◯

Add any comment

14. How do you perceive your jurisdiction's standards for housing development when compared to:

	The lowest standards	Lower standards	Comparable standards	Higher standards	The highest standards
Surrounding jurisdictions	◯	◯	◯	◯	◯
Your county	◯	◯	◯	◯	◯

Add any comment

15. Please give any of the following information if you would like to receive the results of this survey.

Thank you very much for taking the time to complete this survey.

Email Address:

Phone Number:

APPENDIX G

Summarized data collected by the LURE survey

Summarized Data Collected by Population and Land Area Characteristics

Variable (Indicator)		Jurisdictions		US Census Estimates 2008		Land area 2000 and 1990 combined	
		N	(%)	Population	(%)	Square miles	(%)
Category of Municipality	General Law	52	57.1	202,441	5.8	199.19	14.9
	Home Rule	39	42.9	3,268,112	94.2	1,137.23	85.1
Zoning commission		56	61.5	811,980	23.4	512.70	38.4
Planning commission		69	75.8	3,387,662	97.6	1,267.33	94.9
Historic commission		20	22.0	2,674,543	77.1	844.51	63.2
Board of adjustments		56	61.5	3,137,037	90.4	1,124.34	84.2
Panel board of adjustments		2	2.2	2,280,673	65.7	610.32	45.7
Neighborhood zoning areas		30	33.0	408,484	11.8	249.11	18.6
Comprehensive (master, general) plan	Yes	59	64.8	3,316,663	95.6	1,223.57	91.6
	In Progress	7	7.7	36,505	1.1	22.80	1.7
Zoning ordinance	Yes	62	68.1	905,555	26.1	565.83	42.4
	In Progress	2	2.2	2,146	0.1	9.90	0.7
Other ordinances governing plats, land development and subdivisions		77	84.6	1,141,222	32.9	699.11	52.3
Jurisdiction is a unit in which the county applies its own subdivision provisions to new development		15	16.5	367,924	10.6	234.90	17.6
Multifamily housing units been built in the last two years		27	29.7	3,089,597	89.0	1,095.11	82.0
Manufactured and modular housing been added to jurisdiction in the last two years		33	36.3	2,744,022	79.1	958.32	71.7
Minimum lot size for single family units within the city limits		82	90.1	3,456,934	99.6	1,314.22	98.4
Minimum lot size for single family units within the city limits (sq.ft.)		72	79.1	1,165,094	33.6	707.58	53.0
Minimum lot size for single family units within the city's extraterritorial jurisdiction (ETJ)		40	44.0	2,779,137	80.1	952.84	71.3
Minimum floor area for single family units within the city limits		36	39.6	2,491,073	71.8	728.43	54.5
Minimum floor area for single family units within the city limits (sq. ft.)		23	25.3	160,378	4.6	92.14	6.9
Minimum street right-of-way width		76	83.5	3,383,539	97.5	1,271.29	95.2

Summarized Data Collected by Population and Land Area Characteristics

Variable (Indicator)		Jurisdictions		US Census Estimates 2008		Land area 2000 and 1990 combined	
		N	(%)	Population	(%)	Square miles	(%)
Developers have to Pay building permit fee		83	91.2	3,459,088	99.7	1,309.72	98.0
Developers have to Pay development review fees		56	61.5	3,087,356	89.0	1,124.17	84.1
Developers have to include “affordable housing” (however defined)		9	9.9	2,416,848	69.6	742.45	55.6
Developers have to supply mandatory dedication of space or open space (or fee in lieu of dedication)		42	46.2	807,998	23.3	512.58	38.4
Developers have to pay allocable share of costs of infrastructure improvement		55	60.4	3,168,177	91.3	1,158.44	86.7
Measure limiting development beyond a boundary (such as urban limit line, urban growth boundary, greenbelt, or urban service area)		15	16.5	364,911	10.5	241.50	18.1
Measure establishing a limit on growth (population limit or building permits in a given time frame)		8	8.8	92,294	2.7	91.44	6.8
Measure which requires adequate service levels for residential development or service capacity as a condition of approval of residential development		48	52.7	2,922,871	84.2	1,033.32	77.3
Measure which reduces the permitted residential density by general planning or rezoning		22	24.2	421,889	12.2	275.22	20.6
Measure which re-designates or rezones residential land to agriculture or open space (e.g., shore line protection)		8	8.8	136,832	3.9	108.45	8.1
Perception of jurisdiction’s standards for development when compared to Surrounding jurisdictions	The lowest standards	3	3.3	19,049	0.5	5.93	0.4
	Lower standards	10	11.0	172,495	5.0	119.07	8.9
	Comparable standards	51	56.0	3,008,253	86.7	1,065.82	79.8
	Higher standards	16	17.6	240,631	6.9	129.60	9.7
	The highest standards	9	9.9	26,577	0.8	11.10	0.8
Perception of jurisdiction’s standards for development when compared to county	The lowest standards	3	3.3	17,884	0.5	10.23	0.8
	Lower standards	3	3.3	2,353	0.1	12.10	0.9
	Comparable standards	36	39.6	2,705,677	78.0	828.46	62.0
	Higher standards	37	40.7	671,909	19.4	408.16	30.6
	The highest standards	10	11.0	69,182	2.0	72.57	5.4

APPENDIX H

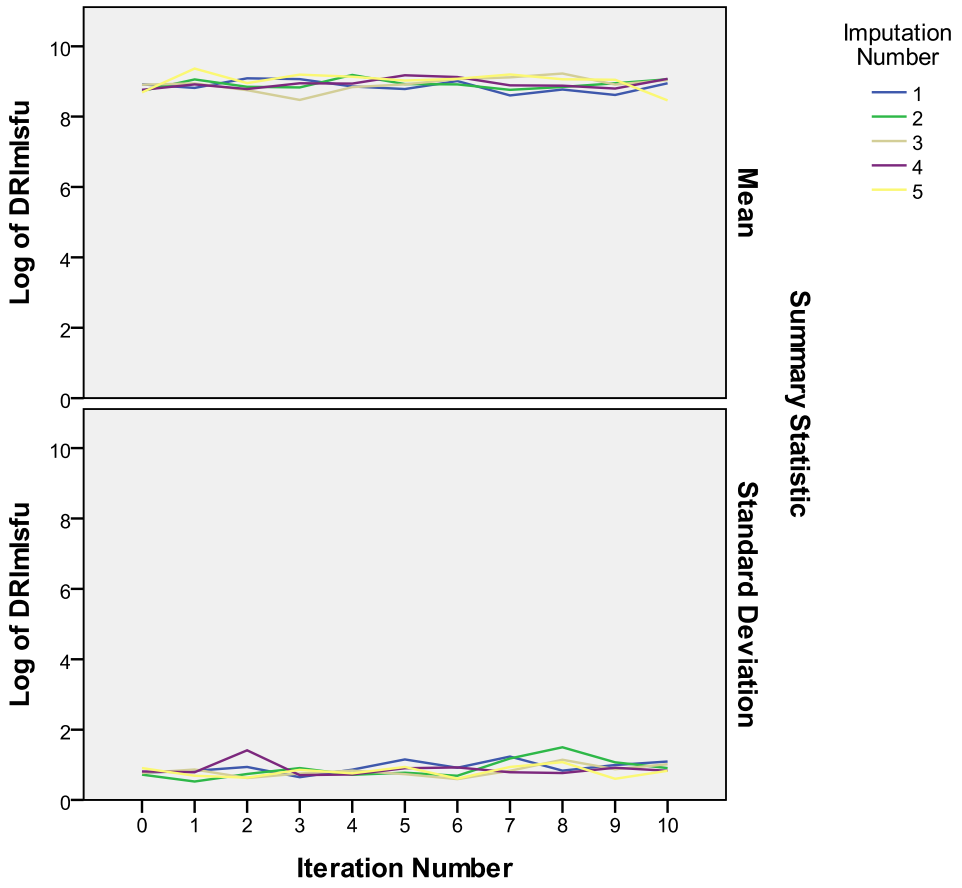
Imputation and missing data results

DRImlsfuetj							
Data	Imputation		N	Mean	Std. Deviation	Minimum	Maximum
Original Data	dimension1		68	4612.72	5617.980	2500.00	43560.00
Imputed Values	dimension1	1	23	4338.25	10165.878	-18026.16	27774.91
		2	23	1915.83	7513.196	-15425.05	13662.59
		3	23	3298.55	11210.138	-25697.07	20463.00
		4	23	2984.29	14086.704	-13129.20	40469.13
		5	23	3088.22	7631.631	-16437.90	14855.12
Complete Data After Imputation	dimension1	1	91	4543.35	6983.727	-18026.16	43560.00
		2	91	3931.09	6219.589	-15425.05	43560.00
		3	91	4280.57	7385.417	-25697.07	43560.00
		4	91	4201.14	8515.205	-13129.20	43560.00
		5	91	4227.41	6178.724	-16437.90	43560.00

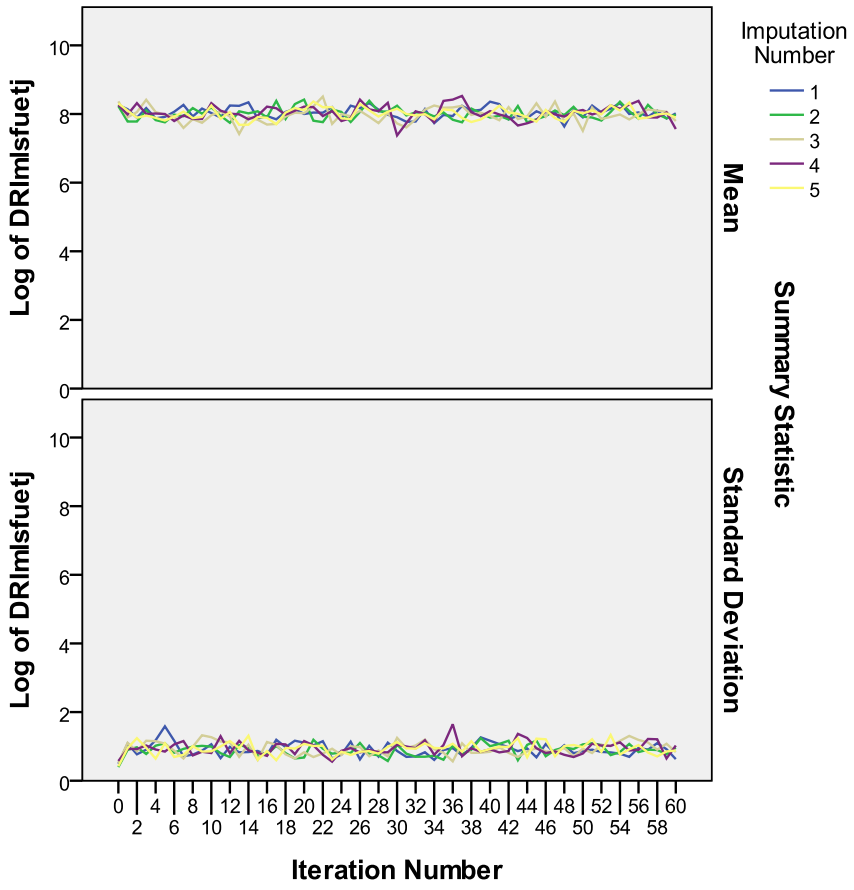
DRImfasfu							
Data	Imputation		N	Mean	Std. Deviation	Minimum	Maximum
Original Data	dimension1		77	921.04	245.655	800.00	1800.00
Imputed Values	dimension1	1	14	989.49	425.355	202.38	1647.22
		2	14	983.03	374.718	296.07	1687.38
		3	14	981.80	247.108	552.06	1415.73
		4	14	983.59	401.865	222.45	1760.41
		5	14	933.91	257.992	518.21	1329.64
Complete Data After Imputation	dimension1	1	91	931.57	278.765	202.38	1800.00
		2	91	930.58	267.856	296.07	1800.00
		3	91	930.39	245.490	552.06	1800.00
		4	91	930.66	273.498	222.45	1800.00
		5	91	923.02	246.161	518.21	1800.00

DRImsrw							
Data	Imputation		N	Mean	Std. Deviation	Minimum	Maximum
Original Data	dimension1		76	53.03	10.585	.00	80.00
Imputed Values	dimension1	1	15	56.66	10.402	36.61	78.27
		2	15	51.64	12.939	28.46	77.71
		3	15	57.77	20.025	28.51	87.77
		4	15	46.79	20.139	-4.37	77.53
		5	15	55.48	13.082	34.44	73.56
Complete Data After Imputation	dimension1	1	91	53.62	10.585	.00	80.00
		2	91	52.80	10.940	.00	80.00
		3	91	53.81	12.605	.00	87.77
		4	91	52.00	12.723	-4.37	80.00
		5	91	53.43	10.992	.00	80.00

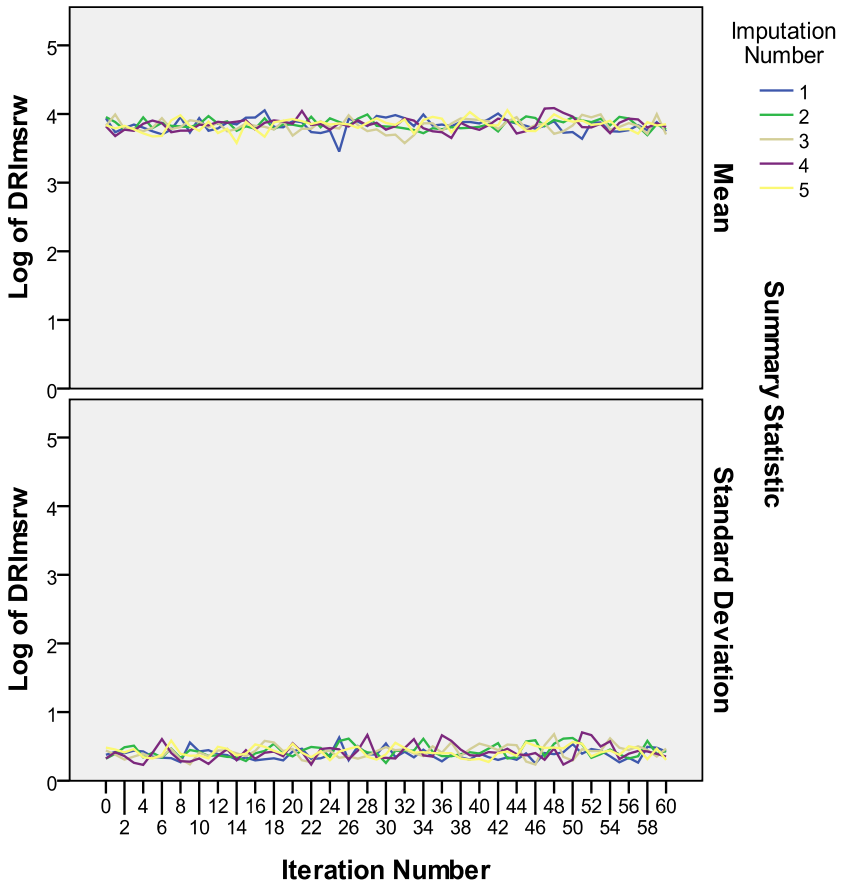
InDRImsrw							
Data	Imputation		N	Mean	Std. Deviation	Minimum	Maximum
Original Data	dimension1		75	3.96	.239	2.30	4.38
Imputed Values	dimension1	1	16	3.75	.425	2.85	4.50
		2	16	3.77	.434	2.96	4.42
		3	16	3.70	.470	2.66	4.53
		4	16	3.81	.351	3.00	4.33
		5	16	3.85	.303	3.17	4.35
Complete Data After Imputation	dimension1	1	91	3.93	.290	2.30	4.50
		2	91	3.93	.289	2.30	4.42
		3	91	3.92	.307	2.30	4.53
		4	91	3.94	.266	2.30	4.38
		5	91	3.94	.253	2.30	4.38



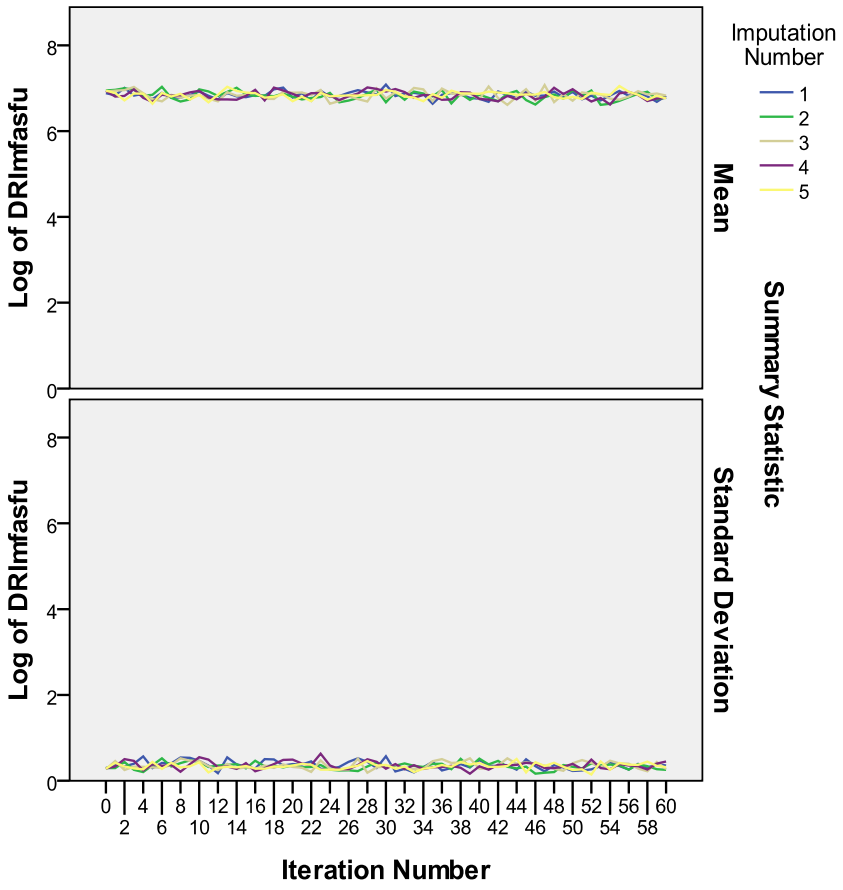
Plots of the iteration data to assess convergence of the MI MCMC method 10 iterations



Plots of the iteration data to assess convergence of the MI MCMC method 60 iterations



Plots of the iteration data to assess convergence of the MI MCMC method 60 iterations



Plots of the iteration data to assess convergence of the MI MCMC method 60 iterations

VITA

Name: Luis Estevez Jimenez

Address: EPS # I-5852. PO BOX 025488. Miami, FL 33102-5488

E-mail address: estevez_luis@yahoo.com

Education: B.A. Architecture. National Autonomous University of Mexico, 1994

M.U. Urbanism. National Autonomous University of Mexico, 2002

M.U.P. Texas A&M University, 2007

Ph.D. Texas A&M University, 2012