# On Local Housing Supply Elasticity

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**Abstract**

Housing markets have been established as fundamental to understanding business cycles, financial market stability, labor mobility, household wealth, individual portfolio allocation, and urban dynamics. What determines local housing supply elasticities and prices? In this paper I give empirical content to the concept of land availability by processing satellite-generated data on elevation and presence of water bodies to precisely estimate the amount of developable land in each metro area. I demonstrate that development is effectively curtailed by the presence of slopes above 15% and that most areas that are widely regarded as supply-inelastic are, in fact, severely land-constrained by their topography. Furthermore, the extent of topographical constraints correlates positively and strongly with regulatory barriers to development. Immigration, high taxes, politics, and "communitarian" social capital are also predictive of more restrictive residential land regulations. I estimate a system of equations where housing prices, construction, and regulations are all determined endogenously. Housing supply elasticities can be well-characterized as functions of both physical and regulatory constraints, which in turn are endogenous to prices and past growth. The results provide operational estimates of local supply elasticities in all major US metropolitan areas.

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# 1 Introduction

Housing supply is a key element for understanding the evolution of housing prices and urban development. Housing supply mediates the impact of demand shocks in different cities, jointly determining the pricing of housing assets across markets (Glaeser, Gyourko, and Saks, 2006). While one can buy cars, computers, and other durable goods at very similar prices across markets, housing supply conditions differ substantially across locales.

It is well understood that housing supply is a composite of the supply of its two intermediary inputs: land and housing structures. Albeit international and domestic macroeconomic conditions affect the prices of basic construction inputs, relative local housing conditions do not have a strong impact on local construction costs. As demonstrated in Gyourko and Saiz (2006), the local supply of housing structures is extremely elastic, with the bulk of the variance in construction costs across cities explained by factors other than the quantity of homes being built in the city. It therefore corresponds to land markets to explain the wide divergence in housing supply elasticities and, ultimately, home values across metropolitan areas

One of the main sources of relative land scarcity for residential development is the existence of regulatory barriers. Zoning explicitly limits the availability of land for specific uses within a municipality, and the implementation of zoning or other land-related regulatory policies and growth controls can add significant costs, delays, and barriers to new projects.

Recent research has explored the impact of regulatory barriers on the evolution of housing prices in different areas of the United States and other countries.[1] While this

[1] Fischel (1985) outlines many of the major conceptual issues, and Quigley (2007) provides a recent overview. Empirical research about the impact of local land development regulations and house prices or new construction include Noam (1983), Katz & Rosen (1987), Pollakowski & Wachter (2000), Malpezzi (1996), Malpezzi, Chun, Green (2006), Levine (1996), Mayer & Somerville (2000), Glaeser & Gyourko (2003), Quigley & Raphael (2004a,b), Glaeser, Gyourko & Saks (2005a,b), Quigley & Rosenthal (2005), Glaeser, Scheutz & Ward (2006), Hwang & Quigley (2004), and Saks (2006).

empirical research is consistent with a link between restrictive development regulations and higher housing prices, there is not a consensus about the causal impact of regulation on the housing market equilibrium.

The major shortcoming in this empirical literature is the failure to take into account the endogeneity of regulations themselves. Clearly, existing and future home values are taken into account by voters and politicians when choosing the extent of permissible residential development. And declining places hardly need to impose growth controls. While old and new theoretical literature has explored the endogeneity of regulatory development constraints to current and future housing values, this has not been an important consideration in empirical research.[2]

Remarkably, the literature has been relatively silent about the importance of topography on housing supply elasticities and on regulatory growth constraints themselves. A relative scarcity of developable land can indeed be caused by topographic factors. Coastal cities can hardly expand toward the sea. Major coastal land reclamation projects in areas with an extremely constrained supply of land are very costly and rare. Other geographic constraints to development include abundance of other water bodies such as lakes and rivers (as in New Orleans), heavy slopes and mountainous areas (as in Los Angeles), and wetlands (as in the Miami's Everglades).

This paper tries to give empirical content to the concept of land scarcity and abundance. While land abundance is typically credited for lower home values in some areas, the concept has not been made operational so far. Previous work has produced estimates of the approximate share of a circle's arc around some of the largest cities that corresponds to the ocean or Great Lakes (Rose, 1982, Malpezzi, 1996). Using GIS techniques, I precisely estimate the quantity of area that is forgone to the sea at 50 and

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[2] Examples of the theoretical literature are Fischel, 1986, Epple, Romer, and Filimon, 1988, Brueckner, 1995, Helsley and Strange, 1995; Ortalo-Magné and Prat, 2006. The exception with respect to empirical work is Hilber and Robert-Nicoud, (2006).

10 kilometer radiuses from the center of each city in all metropolitan areas of the United States. I also use satellite-based geographic data on land use provided by the United States Geographic Service (USGS) to calculate the area that is lost to other water bodies and wetlands. Using the USGS Digital Elevation Model (DEM) at 90 square meter grids, I also create slope maps for rings around metropolitan central cities, which allow me to calculate how much of the area in each circle exhibits slopes above 15%. Merging digital maps of about 6,500 census-defined block groups within 50 km of LA city's geographic center and the slope maps, I show that high-slope areas, as defined earlier, drastically constrain residential development in a city where the incentives to develop anywhere are very strong.

Combining all the information above, the paper provides the first measure of exogenously "undevelopable" land in radiuses of 50 and 10 km around each central city of most metropolitan areas in the United States. For instance 77% of the area within a 50 Km ring of central Miami is rendered undevelopable due to physical constraints, but only 4.5% of Atlanta's is.

Notably, I find that most areas that are widely regarded as supply-inelastic are, in fact, severely land-constrained by their topography. Rose (1989) showed a positive correlation between water-originated constrains and housing prices in a limited sample of 45 cities, but the characteristics of coastal cities are quite different in their *levels*. Here, I show that a restrictive topography was a very strong predictor of housing price *growth* for all metro areas during the 1970-2000 period, even controlling for regional effects. This correlation was not solely driven by coastal areas, as the association between the share of a city's undevelopable area and housing price growth is present even *within* coastal markets. Of course, the correlations do not take into account demand shocks and the general equilibrium feedback between prices and regulations.

Therefore, the second substantive contribution of the paper consists in endogeneizing housing supply, specifically its regulatory component. To do so, the paper studies the origins of regulation differences across metropolitan areas. As such, I deploy the Wharton Residential Urban Land Regulation Index (WRLURI) recently created by Gyourko, Saiz, and Summers (20007). The index is meant to capture the stringency of residential growth controls (zoning constraints, the political process of permit approval, local exactions on developers, and administrative hurdles).

I posit and estimate an empirical model of metropolitan housing markets with endogenous regulations. I estimate a system of equations with supply, demand, and policy response parameters, and find that housing supply elasticities can be well-characterized as functions of both physical and regulatory constraints, which in turn show themselves to be endogenous to prices and past growth. The results provide operational estimates of local supply elasticities in all major US cities.

The rest of the paper is structured as follows. In section 2 I describe the data sources and the process of geographic and regulatory data generation. I also show correlations that suggest a very important role for topography in housing supply. Section 3 is devoted to the empirical analysis of regulations. I test several hypotheses about the origins of residential land use regulations, and show that regulations are, in fact, endogenous to other supply and demand factors that independently affect equilibrium housing prices. In section 4 I estimate a system of equations in which housing prices and regulatory constraints are simultaneously determined. Section 5 concludes.

# 2 Topography and Politics of Housing Supply: Data

### 2.1. Data Construction

Not enough is currently known about the economics of topographic constraints in metropolitan housing supply. Previous research has included proxies for the arc of circle lost to the sea in a limited number of cities and examined their correlation with housing prices (Rose, 1989, Malpezzi, 1996, Malpezzi, Chung, Green, 1996) but the measures proved somewhat limited and have not had a widespread impact.

Here, I develop a comprehensive measure of the area that is unavailable for residential or commercial real estate development for all metropolitan areas of the United States with a defined central city (I use 1999 MSA, PMSA, and NECMA definitions). The first step consists in identifying the extent of steep-sloped terrain. Typically, architectural guidelines deem areas with slopes above 15% as severely constrained for residential construction. Initial data on elevation was obtained from the USGS Digital Elevation Model (DEM) at its 90m resolution. The DEM models satellite information obtained at higher resolutions into cells 90 meters wide by 90 meters long. Using GIS software, the maximum slope of each point in the grid with respect to the adjacent quadrants is calculated. In order to reduce the computational requirements of the database, contour maps of all areas in the United States with slopes under and above 15% were created. An example of an elevation map for Los Angeles city and environs can be in Figure 1.A. Figure 1.B displays the corresponding slope maps.

The next step consists in drawing 10 and 50 km buffers around the geographic centroid of all central cities. I define land scarcity in terms of distance to central city location. Most metropolitan areas developed historically from the expansion and suburbanization of older established large population centers. Of course, city boundaries do not remain constant. Evidence from City Data Books in 1972 and 2002 shows that the median central city in our sample increased its area by 36% between 1970 and 2000. This is a relatively small number compared to the 50km radius that we are considering.[3] Moreover, city expansions usually involve the annexation of political jurisdictions that were already developed. On the contrary, metropolitan area definitions change often. Such definitions may follow the path of expansion of the metropolitan areas into previously undeveloped areas.

[3] Assuming a circular city, this implies a change in radius from 4.7 to 5.8 kilometers.

Within each of the 314 radiuses of all metropolitan areas with well-defined central cities in the continental US,[4] GIS software was used to calculate the exact share of the area that corresponds to the Ocean, Great Lakes, other water bodies, and to land with slopes above 15%. Figure 1.C shows the division of land in LA and environs into two groups: areas with "steep slopes" (in red color) and areas with slopes below 15% (in green). Finally figure 1.d portrays how the final slope data is embedded into a 50 Km radius around the Los Angeles central city centroid. As can be seen, a large area within the circle is occupied by the Pacific Ocean, and by terrains with steep slopes.

Residential development is severely constrained by areas with steep slopes. To demonstrate this I focus on Los Angeles. This city provides an interesting case study, because it is the second biggest metropolitan area in the US, and it is quite supply-constrained due to its adjacency to the Pacific Ocean and surrounding mountain ranges. Furthermore, median housing values there are amongst the highest in the US.[5] In a high-price area the incentives to develop on steep-sloped terrain are stronger. Therefore focusing on LA will generally understate the general deterrent effect of steep slopes on residential development. The upper panel in Figure 2 displays the areas with slopes above 15% within the city's 50km radius. The lower panel shows population density gradient, where darker colors signify higher densities. It is quite clear that development mostly happens in the flatter areas.

In order estimate the numerical magnitude of the deterrent effect of high slopes I use GIS software to delimit the intersection between steep-slope zones and some 6,500 block groups (as defined by the census in 2000) that lie within the 50km radius of the LA city centroid. I then calculate the share of the area of a block group that has a slope above 15%. Hence I define "steep-slope block groups" as those with a share of steep-

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[4] The metropolitan areas without central cities are typically extensions of other major metropolitan areas already included in the sample, such as Bergen-Passaic, Nassau-Suffolk, or Ocean-Monmouth in New Jersey.

[5] The median housing value in the 2000 Census was 221,200, ranking 8$^{th}$ out of the 95 metropolitan areas with population above 500,000.

sloped terrain above 50%. "Steep-slope block groups" encompass 47.62% of the land area within 50km of LA's geographic center. However only 3.65% of the population within the 50km ring lives in them. Since it is likely that development occurs in the flatter areas of the "steep-slope block groups," these magnitudes clearly illustrate the deterrent effect of mountains on housing development.

The next step in our creation of a physical land-availability measure involves estimating the area within the 50 km radiuses that corresponds to wetlands, lakes, rivers, and other water bodies. The 1992 USGS National Land Cover Dataset is a satellite-based GIS source that contains information about land use for all cells in a 30 by 30 meter grid that encompasses the continental USA. The data was processed by the Wharton GIS lab to produce land use areas by Census tract. For all census tracts, as defined in the 2000 census, we have information on total area and the area apportioned to each of the land uses delimited by the USGS (see data appendix for details). Next, the distance from each central city centroid to the centroid of all census tracts was calculated. Census tracts that were 50km or closer to a central city were used to calculate the share of the 50 km radius area that corresponded to water bodies.

The final measure combines the area lost to oceans, lakes, steep slopes, wetlands, and other water features. To the best of my knowledge, this is the first comprehensive measure of truly undevelopable area in the literature. The fact that a radius from the city centroid is used contributes to make it a measure of true original constraints, as opposed to one based on ex-post ease of development (e.g. density).

In Table 1, I present the measure of undevelopable area for all metropolitan areas with population over 500,000 in the 2000 Census. Of these large metro areas, Ventura (CA) is the most constrained, with 80% of the area within a 50km radius rendered undevelopable by the Pacific Ocean and mountains. Miami, Fort Lauderdale, New Orleans, San Francisco, Sarasota, Salt Lake City, West Palm Beach, San Diego, and San Jose complete the list of the top 10 more physically-constrained major metro areas in the US. Many large cities in the South and Midwest (such as Atlanta, San Antonio, and Columbus) are largely unconstrained.

The other major dataset used in the paper is obtained from the Wharton Regulation Survey. Gyourko, Saiz, and Summers (2007) use the survey to produce a number of indexes that capture the intensity of municipal growth control policies in a number of dimensions. A factor analysis of the different dimensions yielded a composite index: the Wharton Residential Land Urban Land Regulation Index (WRLURI henceforth). Lower values of the index, which is standardized across all municipalities in the original sample, can be thought of as indicating a more laissez-faire regulatory environment. The measure corresponds to the political and legal environment circa 2005.[6]

I process the original municipal-based data in Gyourko, Saiz, and Summers (2007) to create average regulation indexes by metropolitan area. Since the probability of response to the survey was not random I use the probability sample weights developed by Gyourko, Saiz, and Summers (2007). The weighting scheme tries to reproduce the average regulation level of a group of municipalities in each metro area that mimic the socio-demographic characteristics the US average metropolitan locality.

One caveat with the metropolitan index is that it is sometimes based on a small number of municipalities. Some metropolitan areas are not included due to missing responses, and 40% of the metro areas have 2 or 1 observations. Nonetheless the index contains valuable information even in metro areas with a few observations. On the one hand, the index is a composite of the answers to more than 50 different questions, some of which involve the State level. More importantly, there are strong correlations in the index levels within metropolitan areas. To demonstrate this, I conducted the following bootstrap experiment: I randomly drew one observation from all metro areas with more than one. Then I correlated the index values in this "one-observation sample" to the

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[6] The indexes are: Local Political Pressure Index, State Political Involvement Index, State Court Involvement Index, Local Zoning Approval Index, Local Project Approval Index, Local Assembly Index, Supply Restrictions Index, Density Restrictions Index, Open Space Index, Exactions Index, and Approval Delay Index (details about them can be found in Gyourko, Saiz, Summers, 2007).

weighted-average index calculated with the rest of observations. I repeated the process 1,000 times with different random draws that were independent across metropolitan areas. The average correlation between the "one-observation" sample and the "rest-of-observations" sample obtained across the 1,000 repetitions was a substantive 0.6. Figure 3 shows the kernel density estimate of a similar procedure where I limit the sample to metro areas with more than 5 municipalities. It can be easily seen that even a one-observation sample is likely to convey a lot of information, because regulation levels are strongly correlated within metropolitan areas.

Therefore, the final sample keeps all available observations providing the most extensive regulation index. I deal with heteroskedascity by using Feasible Generalized Least Squares (FGLS) to obtain optimally-weighted estimates. In fact, the results in the paper are very robust to all reasonable weighting schemes or the omission of metro areas with smaller number of observations.

Table 1 displays the average WRLURI values for all metropolitan areas with population greater than 500,000 and for which data is available. One clear pattern arises when comparing the regulation index with the land availability measure. Physical land scarcity is associated with stricter regulatory constraints to development. 14 out of the top 20 most land-constrained areas have positive values of the regulation index (which is normalized to a mean of zero). Conversely, 16 out of the 20 less land-constrained metropolitan areas have negative regulation index values.

There are 21 other data sources that are used throughout the paper: the interested reader is referred to the Data Appendix for the meaning and provenance of the rest of variables. The Appendix also offers summary statistics.

### 2.2. Topography and Housing Prices

The topographic variables that I calculate are strongly associated with the evolution of housing prices in the last decades. To show that, figure 4 displays the land topographic unavailability measure on the horizontal axis and the change in the log of median prices by metro area between 1970 and 2000. I exclude from the graph the cities that were not declining during the 1940-1970 period, because I do not suspect topographic constraints to be binding in shrinking metropolitan areas.

It is clear that topographic constraints are very strongly associated with recent price growth. In fact, this association robustly survives a regression (unreported) that controls for region fixed-effects and a dummy that takes value one if the metro area is within 50 miles of the ocean or Great Lakes. The association between topographic constraints and the evolution of housing prices is present within coastal areas.

While suggesting, these associations are far from establishing a causal link. To do so I need to estimate a fully-fledged demand and supply model that also takes into account man-made restrictions to land availability. But first, in the next section, I show that such regulatory restrictions are actually endogenous to topography and a host of variables that impact the demand of housing.

# 3 The Origins of Regulation: Hypothesis and Testing

This section investigates the origins of regulation, and relates them to specific pre-determined attributes of a city. Our regulation measure appears in all regressions as the left-hand-side variable. Concretely, I examine four commonly held hypotheses about what determines the level of regulatory constraints to development. I start by studying each set of hypotheses independently, and then investigate if the partial correlations are robust to a more complete model.

The first set of theories has to do with optimal land management. Regulation is necessary to enhance the architectural and historic value of a city, and to provide public goods, enhance positive externalities, mitigate negative ones, and enforce standards in an environment with asymmetric information and coordination gains. I do not believe that aesthetic standards or optimal levels of regulation, *ceteris paribus*, are very different across the United States, especially after controlling for regional differences. However, it is possible that cities that were developed earlier have a more nuanced history and well-defined structure or "character" that consumers value and is worthwhile to preserve. Similarly, more dense metropolitan areas are more complex and externalities may be more important. Of course, metropolitan density is endogenous to the level of regulation, so I use historical density.

Column 1, in table 3 tests if our version of the "optimal regulation" hypothesis holds. The OLS model includes regional fixed effects, the log average distance to a historical place, and the log of density in 1950 as explanatory variables. Interestingly, the south and Midwest appear to be much less regulated than the Northeast (the omitted regional dummy), and the West may be slightly more regulated. These patterns are consistent throughout all specifications in the paper. Historically more dense cities are not significantly more regulated. Nonetheless high average distance to a historic place is a predictor of lower regulation. Historic areas seem to be more regulated, which is consistent with a desire to maintain their valuable "character" intact.

The second set of theories that attempt to explain land use constraints are based on the idea of hysteresis in the elasticity of land supply. Zoning and growth controls have long been regarded as devices to maintain prices high in areas with valuable land. Recent theoretical work (Fischel, 2004, Hilber and Robert-Nicoud, 2006, Ortalo-Magné and Prat, 2007) emphasizes hysteresis via the political economy process of zoning. Hilber and Robert-Nicoud, 2006 show a number of variables, interpreted as city amenities, to be associated with regulations. The authors argue for a demand-side link from amenities, via increased demand and higher prices, to more restrictive growth controls.

Focusing on the supply side, areas that were initially supply-constrained are bound to be, on average, more expensive and more regulated. Demand-side shocks, such as increased valuation of amenities, national income growth, and monetary inflation, cannot have much of an impact on prices if housing supply was very elastic originally. Therefore, a natural test for the hysteresis hypothesis relies on using a measure of supply elasticity that precedes, and is therefore exogenous to, zoning regulations.

Fortunately I produced precisely that measure. Concretely, I will answer the question: do natural topographic constraints beget regulatory constraints? In column 2 the explanatory variable is our measure of undevelopable area within a 50km radius. Indeed, physical natural constraints were strongly associated with regulatory constraints in 2005.

A further pattern readily emerges after examining the complete list of the most topographically-constrained cities. Physically-constrained areas that have been declining or stagnating for a long time do not display strong anti-growth policies. Consider the case of Charleston, West Virginia. 71% of its 50km radius area is undevelopable according to our measure, yet the WRLURI measure is –1.1. Similar examples are New Orleans (LA), Asheville (NC), Chattanooga (TN), Elmira (NY), Erie (PA), and Wheeling (WV). In order to capture the fact that physical constraints may be not be binding in declining areas, I calculate the growth rates of all metropolitan areas during the 1950s and 1960s (1950-1970). I do not know what level of potential city decline makes growth control regulations non-binding. I therefore divide the sample in four quartiles by historic growth and use the Akaike criterion to select a breakpoint. The preferred specification corresponds to the model where I interact the physical constraints variable by the bottom growth quartile dummy, allowing a differential impact of natural constraints for this group (column 3 in table 3). Lagged growth rates in a period that is, on average, 45 years in the past, are unlikely to be caused by the regulation environment in 2005. But they are likely to be good predictors of future growth, because of the permanence of factors that drove growth during the second half of the 20$^{th}$ century, such as reliance on manufacturing, mining, or relative scarcity of institutions of higher education. The results suggest that the hysteresis hypothesis has strong support in non-declining cities. In declining cities regulations are insensitive to previous factors that made housing supply inelastic. Growth control measures are not in demand in places that couldn't be expected to grow regardless. More generally, there is also some support for the idea that declining places are less regulated overall. Since land unavailability does not matter in declining areas I will only include the interacted variable henceforth.

The next set of hypotheses on land use regulation pertain to racial and income heterogeneity. Land controls may stem from a demand for maintaining racial or income homogeneity, especially in suburban areas. Minimum lot sizes, density restrictions, and growth constraints might be used to deter the poor or minorities from moving to some municipalities (snob zoning). I examine here importance of these issues to explain cross-metropolitan regulation differences.

If the "snob zoning" theories are important to explain cross-MSA variance in regulations, then citizens in very heterogeneous cities should be more likely to enact growth control policies. In column 4 I include the share African-American, immigrant share, and share of individuals with bachelor's degrees as baseline controls. All variables take their pre-determined 1970 values. Highly educated cities tend to be more regulated, and so are immigrant cities. There is no evidence for cities with large historical black population shares to be more regulated (whites are a majority in 1970 in all metropolitan areas). In columns 5 and 6 I include measurements of income inequality: the coefficient of variation of income across municipalities within the MSA in 1970 (column 5), and across census tracts (column 6). None of these variables are significant. In column 7 I also include the coefficients of racial dissimilarity (white-black, and white-Hispanic) across school districts in 1968-1971. Their correlation with regulation is actually negative, but the coefficients are not significant. In sum, "snob-zoning" does not seem to explain differences across metropolitan areas except, perhaps, for the view that metropolitan areas with growing number of immigrants (immigrant levels in 1970 and subsequent inflows are very strongly correlated) became relatively "anti-growth."

The last set of theories on local land regulations relies on political or cultural explanations. People with different cultural backgrounds and political orientation may regard the desirability of public regulation differently (Kahn, 2007a,b). Alternatively, the origins of local laws (Djankov et al. 2003) and jurisprudence can be different across locales within the US. The explanatory variables that I use in column 8 are: the percentage of Christians in the Catholic Church, in 1971, the percentage voting for the Democratic Candidate in the 1980 presidential election (Carter), the log of non-profit organization density in 1980, the percentage of eligible voters voting for any candidate in the 1980 presidential election, Census mail response rates in 1990 (the last three variables are measures for social capital), and the log of local tax revenues per person as a share of income per capita in the MSA (a proxy for the taste for public goods).

The results in column 8 show that more democratic, catholic, high-tax metropolitan areas with higher levels of "communitarian" social capital, as measured by census response rates, tend to constrain new development more. However, in column 9 I show that once I control for the share of immigrants in 1970 the catholic variable becomes insignificant. In columns 10 and 11 I also control for the unionization rate and, separately, for a city political corruption measure recently developed by Saiz and Simonsohn (2007) for a subset of cities in our sample. None of these variables are significant.

Table 4 includes all explanatory variables significant at the 10 percent level in table 3. The model now includes a large and comprehensive number of variables from independently-estimated equations, reducing spurious partial correlations that could have arisen earlier.

The specifications in Table 4 deal with the issue of heteroskedasticity by implementing Feasible Generalized Least Squares estimation, where the residuals of the complete OLS model are used to fit an estimate of the variance of the residual with respect to the number of municipalities in the metropolitan-area sample. Then I use those estimates to weight optimally the observations. The results are, in fact, always very similar to simple OLS ones.

In column 1, the variables that are more robust to explain local regulations are the share of topographically unavailable area, a dummy for metropolitan areas that were stagnating during the 1950-70 period, the share foreign-born in 1970, census response rates in 1990, and the regional fixed-effects. Overall the results seem to favor the hysteresis hypothesis: voters in non-declining, supply-constrained areas are more inclined to pass anti-growth policies. "Anti-snob" zoning motivations may also be stronger in areas where demographic heterogeneity is increasing quickly due to immigration. High local taxes, Democratic Party shares, and a more "communitarian" culture are also associated with higher preferences for local growth management.

Table 4, column 2, conducts a median regression to ensure that the results are not driven by outliers. All parameters are very similar to the earlier results, with the only difference being that democratic vote is now quantitatively more important. Columns 3 and 4 exclude from the sample, respectively, metropolitan areas in New England and California. Issues related to land regulation appear very often in descriptions about local housing markets in these areas. The results do not change much with these exclusions. Column 5 conducts a further robustness check. Rather than contemplating a radius of 50 km around the city center, our topographical variable is now defined over a 10 km radius, with no discernible impact on the estimates.

Column 6 pushes the data further by including state fixed effects. There are 50 states and only 266 observations, so this reduces significantly the amount of variance in the data. The variables robust to state fixed effects are those related to the "hysteresis" hypothesis and local taxation.

Finally, columns 7 and 8 repeat the regressions, separating this time the areas that were stagnating in the 50s and 60s (column 7) from those that were not (column 8). This amounts to running a fully-interacted model with the decline dummy. Interestingly, most of the variables in the model are now significant when examining the dynamics of cities that were not in decline in the 50s and 60s. Conversely no variable (except regional effects and historical character) seems to matter much in declining cities. This is consistent with the idea that cities that could expect decline did not require growth controls regardless of pre-determined characteristics.

# 4 Topography, Regulations, and Housing Prices

Both topography and regulations could be important determinants of housing price differences across metropolitan areas. However, previous research has failed to assess their relative importance in a general equilibrium context. The previous section demonstrated that anti-growth policies are associated to several variables that have impacts on housing demand and supply independently. Critically, the hysteresis hypothesis posits that regulations are stronger in high-price metropolitan areas. In order to learn about the impacts of regulation, therefore, one has to take into account the feedback from prices into the regulatory process. To do that I posit a simultaneous system of equations where housing supply, demand, and regulations are determined jointly. In each city, demand shocks have an impact on prices via the local elasticity of supply, which is assumed to be a function of both physical and regulatory constraints. The initial impact of demand shocks on prices then feedbacks into the supply elasticity via regulations: higher home values beget more regulatory constraints. The final equilibrium involves market-clearing prices and residential growth that are consistent with the final regulation level.

The intuition of the approach can be seen in Figure 5.a. In this example, demand shifts initially from $D_1$ to $D_2$. Moving initially along the short-run supply curve ($S_1$) prices experience upward pressure. That, in turn, has an impact on regulations and, therefore, on the elasticity of supply of the marginal units that are being built. The final equilibrium is such that regulation intensity, and therefore the elasticity of the equilibrium supply schedule ($S_2$), is compatible with market clearing prices ($S_2$=$D_2$). Figure 5.b portrays the situation where construction costs are also changing, thus shifting the initial supply curve upward. In both scenarios, the adjustment from initial to final equilibria can be understood as a tattonement process with endogenous regulations. With slow adjustment and positive demand shocks, construction surges initially, but later permit levels may fall below capital depreciation. Alternatively, agents may anticipate their response to future demand shocks.

Consider first the supply equation. I estimate the system in the differences of prices (median census value at the metropolitan area level)[7] and housing quantities (the number of homes in the census). By first-differencing values and quantities I difference-out variables that account for different initial scale differences across cities (Mayer and Somerville, 2000). I use long differences between 1970 and 2000 and hence focus on long-run housing dynamics (as opposed to high-frequency volatility).[8]

The price of a housing unit in city $i$ at time $t$ can be expressed as the cost of the physical structure ($CC_{it}$) plus the price of the land on where it sits: $P_{it} = CC_{it} + PL_{it}$

Taking logarithms, differentiating, taking a first-order Taylor approximation, and considering the initial shares of land and construction costs we can express changes in housing prices as: $\Delta \ln P_{it} = \alpha_{it\text{-}1} \dfrac{\Delta CC_{it}}{CC_{it-1}} + \dfrac{\Delta PL_{it}}{P_{it-1}}$, where $\alpha_{it-1}$ is the initial housing structure share (one minus the land share). I will model changes in land values as a function of changes in housing quantity. For now, I assume changes in local construction costs to be exogenous to local changes in housing demand. This is a good assumption, because the price of capital and materials (timber, cement, copper, and so on) are determined at the national or international level, and construction is an extremely competitive industry with a relatively elastic labor supply. The assumption is consistent with previous research, which has showed extremely large supply elasticities of construction costs (Gyourko and Saiz, 2006). I will relax the assumption later. Land supply is inelastic

[7] Bucks and Pence (2006) demonstrate that the census reported housing prices are good estimates of actual prices. The correlation between the *change* in log median census values and *change* in the log of the Freddie Mac repeat sales index between 1980 and 2000 is 0.9 across the 147 cities for which the measures were available. The repeat sales index, obtained from Freddie Mac, is unavailable in 1970, and the coverage in our application is limited to the 147 aforementioned cities. Therefore, in this context, it is better to use the census measure.

[8] Short-run housing adjustments involve considerable dynamic aspects, such as lagged construction responses and serial correlation of high-frequency prices changes (Glaeser and Gyourko, 2006). Here I focus on the cointegrating (long-run) relationship between demand, prices, and quantities over the 3-decade period under consideration.

with $\frac{\Delta PL_{it}}{P_{it-1}} = \beta \cdot \Delta \ln Q_{it} + R_i + \varepsilon_{it}$. $R_i$ are regional effects and $\varepsilon_{it}$ an error term. Therefore:

$$(1) \qquad \Delta \ln P_{it} = \alpha_{it\text{-}1} \frac{\Delta CC_{it}}{CC_{it-1}} + \beta^S \cdot \Delta \ln Q_{it} + R_i + \varepsilon_{it}$$

The city-specific parameters $\alpha_{it-1}$ (one minus land shares by metropolitan area in 1970) are calculated by the author using the estimates in Davis and Heathcote (2007) and Davis and Palumbo (2008), and data on construction costs and housing prices (see data appendix for details). Combined with existing detailed information about the growth of construction costs in each city from published sources, the city-specific intercept $\alpha_{it\text{-}1} \cdot \frac{\Delta CC_{it}}{CC_{it-1}}$ is therefore known and calibrated into the model.[9]

Demand is modeled as a function of local economic success (the growth in income in the metropolitan area between 1970 and 2000) and a number of initial city conditions in 1970 that have proved to be good predictors of urban population in the literature. While I do not believe that these 1970 variables will have a permanent impact on future growth, it is clear that productivity and amenity shocks have affected different types of cities very differently. For instance, I include the 1970 share of individuals with a bachelor's degree, because technology-biased productivity change has favored skilled cities (Moretti, 2004, Glaeser and Saiz, 2004). Similarly increasing incomes have meant that consumers value more local amenities such as a pleasant weather and proximity to coastal areas (Kahn and Cragg, 1997). Previous research (Saiz, 2003, 2007, Ottaviano and Peri, 2007) has shown international migration to be one of the strongest determinants of the growth in housing demand and prices in a number of major American cities and I also include "immigration shocks" (change in the immigrant

[9] Note that the model contemplates capitalization of construction costs into land values via demand and the supply elasticities. If land supply is inelastic, then increases in construction costs will shift up the supply curve and decrease demand, so that in equilibrium land values change without much change in the number of housing units.

population divided by initial population) as demand shifters.[10] The demand function is therefore:

$$(2) \qquad \Delta \ln Q_{it} = \beta^D \cdot \Delta \ln P_{it} + \alpha_1 \cdot \Delta \ln Inc_{it} + \alpha_2 \cdot \frac{\Delta \operatorname{Im} mi_{it}}{Pop_{it-1}} + X'_{t\text{-}1}\mathrm{A} + R_i + \xi_{it}$$

Finally, the model allows for the endogeneity of regulations. Regulations (as measured circa 2005) are modeled as functions of housing price levels in 2000, housing stock growth during the 1970-2000 (citizens in declining areas are less likely to constrain development) and other variables in Table 4. Since the model accounts explicitly for the hysteresis hypothesis via current price *levels* and contemporaneous growth I now drop the physical availability variable and lagged-decline exogenous proxies that I used earlier.

$$(3) \qquad WRLURI_{it} = \lambda_1 \cdot \ln P_{it} + \lambda_2 \cdot \Delta \ln Q_{it} + Z'_{t-1}\mathrm{P} + R_i + u_{it}$$

The system of 3 equations [(1), (2), and (3)] is estimated simultaneously via GMM, where the relevant moments are zero expectations for the perturbation terms and for the covariance of these and the instruments. $P_{it}, \Delta \ln P_{it}$, $\Delta \ln Q_{it}$, and $WRLURI$ (the regulation index) are endogenously determined. All predetermined variables (including the initial price level, $P_{1970}$) and the rest of explanatory variables are used as instruments for all the endogenous variables. Note that the set of predetermined variables includes the land availability variable and local changes in construction costs. All equations include region fixed effects. I use the "optimal weighting matrix" (Wooldridge, 2002), derived from the 2SLS-estimated variance-covariance matrix.

I start by focusing on the parameter estimates of the supply functions in Table 5. These are consistent with their expected sign. Intuitively, identification here is coming

[10] Immigration inflows have been shown to be largely unrelated to other city-wide shocks, and very strongly associated with the previous settlement patterns of immigrant communities. I later relax the assumption of exogenous immigration, but note that the model allows outmigration response by natives via supply elasticity and higher prices.

from the demand shifters (income shocks, immigration, temperature, and so on). Higher demand pushes prices up. The implicit average elasticity of housing supply across all American cities is quite high, around 2.

In column 2 I posit the inverse-elasticity of supply as a function of regulatory and physical constraints. I first-order approximate the inverse-elasticity parameter as a linear function of regulation and topographical land unavailability: $\beta^S = \beta^S_{REG} \cdot WRLURI_{it} + \beta^S_{TOPO} \cdot TOPO_i$. Therefore the supply equation becomes:

$$(4)\quad \Delta \ln P_{it} = \alpha_{it\text{-}1} \cdot \frac{\Delta CC_{it}}{CC_{it}} + \beta^S_{REG} \cdot WRLURI_{it} \cdot \Delta \ln Q_{it} + \beta^S_{TOPO} \cdot TOPO_i \cdot \Delta \ln Q_{it} + R_i + \tilde{\varepsilon}_{it}$$

Given the results in column 1, supply elasticities should be positive, and so I add 2 to the WRLURI index, which is now always positive while retaining a standard deviation equal to one. In order to generate instruments for the interacted terms ($WRLURI_{it} \cdot \Delta \ln Q_{it}, TOPO_i \cdot \Delta \ln Q_{it}$), I regress $\Delta \ln Q_{it}$, and $WRLURI$ on the exogenous variables and use the interacted predictions to generate additional exclusion restrictions. Column 2 estimates the supply equations. It is apparent that the elasticity of supply depends critically on both regulations and physical constraints. However, standard errors on the land unavailability parameter are larger.

This can be explained easily by heterogeneity in how binding physical constraints are. While regulatory constraints bind regardless of the existing level of construction, physical constraints may not be important until the level of development is large enough to make them binding. After all, if development is sparse one can always build in the existing flat and dry areas, regardless of the presence of mountains and bodies of water. The most parsimonious way to capture that effect is to model the impact of physical constraints on elasticities as an interacted linear function of predetermined initial log population levels. In this specification: $\beta^S = \beta^S_{REG} \cdot WRLURI_{it} + \beta^S_{TOPO} \cdot TOPO_i \cdot \log POP_{it} + \psi \cdot \log POP_{it-1}$. And therefore the supply equation becomes:

$$
(5)\quad \begin{aligned} \Delta \ln P_{it} &= \alpha_{it\text{-}1}\frac{\Delta CC_{it}}{CC_{it}} + \beta^{S}_{REG}\cdot WRLURI_{it}\cdot \Delta \ln Q_{it} + \beta^{S}_{TOPO}\cdot TOPO_{i}\cdot \ln Pop_{it}\cdot \Delta \ln Q_{it} + \\ &+\psi \cdot \ln Pop_{it}\cdot \Delta \ln Q_{it} + R_{i} + \tilde{\tilde{\varepsilon}}_{it} \end{aligned}
$$

The results in column 3 strongly suggest that physical constraints matter more in larger metropolitan areas, consistent with the "binding constraints" hypothesis. Figure 6 depicts the difference in the inverse of beta (the supply elasticity) across the interquartile range of land availability as a function of initial population levels. The graphs assume the median level of regulation for all city sizes. At the lowest population levels supply elasticity is mostly determined by regulations: the difference between the 75% and $25^{th}$ percentile cities (in terms of physical land constraints) is not large. Nonetheless, physical constraints become binding and have a strong impact on prices as metropolitan population becomes larger. In metropolitan areas above 500,000 inhabitants, moving from the $25^{TH}$ to the $75^{th}$ percentile of land unavailability implies elasticities that are around 0.8 smaller.

Columns 4 and 5 show the estimates of the demand and regulation equations. None of the results change much with the different specifications of the supply equation, so I present results with supply as specified in column 3. Intuitively, identification here comes from excluding land unavailability and shocks to construction costs as a share of initial prices. The parameters in the demand equation all have the expected signs. The estimated price elasticity of demand is around -1, whereas the elasticity with respect to income is 1.54. Higher temperatures and the coastal dummies are strong predictors of growing demand for housing in a metro area during this period. Higher taxation and a high initial share of African American population are associated with decreasing demand. There is some mild evidence of mean reversion in population. As in previous research, "immigration shocks" are the strongest predictors of housing demand growth (t-statistic slightly above 11), even after controlling for the evolution of income.

The regulation equation (column 5) demonstrates that, as posited by the "hysteresis hypothesis," higher housing prices and contemporaneous growth beget more restrictive regulations. This is consistent with the idea that those homeowners with considerable equity investments in land values are more likely to curtail new development. Similarly, higher demand or the problems associated with growth are also spurs to the demand for more restrictive development regulations. Interestingly, all the other variables in the regulation equation take values that are not too dissimilar to those in previous specifications except for the Democratic Party variable, which is now insignificant. This variable was earlier capturing the fact that areas that lean democratic tend to have higher housing values.

In Table 5.b I relax the assumption of exogeneity of changes in immigration and income. I allow changes in log income and the immigration shock to be endogenous to the system's equilibrium (and therefore instrumented by the other predetermined and exogenous variables). None of the results of interest change much, albeit, of course, the coefficients on income and immigration become more imprecisely estimated.

Table 6 allows for endogenous construction costs. The models is exactly as defined by (2), (3), and (5), but I now add an extra equation in which construction costs are endogenously determined.

(6) $$\frac{\Delta CC_{it}}{CC_{it}} = \kappa_1 + \beta_{CC}^{S} \cdot \Delta \ln Q_{it} + \kappa_2 \cdot \Delta \ln Inc_{it} + \kappa_3 \cdot UNIONC_i + R_i + \tau_{it}$$

Construction costs are assumed here to be endogenous to the change in the housing stock. $\tau_{it}$ is an i.i.d. shock and other controls, which enter as instruments for construction costs in equation (5), include the unionization rate in the construction sector (CPS average over the 1985-2000 period) and the change in local income. Unionization rates in the construction sector have been demonstrated to be the strongest predictor of growth in construction costs (Gyourko and Saiz, 2007), above and beyond unionization rates in other sectors (such as durable goods) and as such are good instruments in this context. To dispel any concern about their endogeneity with respect to changes in construction demand (i.e. highly unionized cities grew more slowly during this period), I now include average unionization rates by metropolitan area as explanatory variables in the demand equation (3).

The results suggest an extremely elastic construction supply schedule, as in Gyourko and Saiz (2007). In fact, there is no evidence that constructions costs respond at all to differences in building activity across metropolitan areas. Therefore, importantly for our exercise, the actual implied supply elasticities in Table 5 do not change.

The short-run elasticities derived exclusively from equation (5) do not take into account the feedback of demand shocks into higher prices and tightening regulations. They are therefore based on linear combinations of the available data on physical and regulatory constraints. These estimates are interesting because they can be used as short to medium-run elasticities in future research and because they allow us to compare cities contemporaneously without regard to the future impact of demand shocks on regulatory conditions. The results for metropolitan areas with population over 500,000 in 2000 can be found in Table 7. Estimated elasticities using only our topographical, regulatory, and initial population variables agree with perceptions about supply-constrained areas. Los Angeles, Miami, San Francisco-Oakland, Boston, and San Diego top the list of most inelastic cities.

The estimated elasticities also correlate very strongly with housing price levels in 2000 and changes over the 1970-2000 period. Figure 7 presents plots relating housing prices (Panel 1) or changes (Panel 2) on the vertical axis and the inverse of the estimated supply elasticity by metropolitan area on the horizontal axis. It is clear that a simple linear combination of physical and regulatory constraints goes very far explaining the evolution of prices, even without taking into account the differential demand shocks that each city experienced.

Of course, the parameters used to calculate elasticities have been chosen to maximize the fit with respect to housing supply in the 1970-2000 period. As an out-of-sample test, Figure 8 plots changes in the Freddie-Mac Repeat Sales Index between the first quarters of 2000 and 2005. I use a subsample of 112 cities for which both the estimated elasticities and repeat sales data are available.

A simple model where all city-level demand shocks are identical in the 2000-2005 periods, perhaps driven by national changes in interest rates (Himmelberg, Mayer, Sinai, 2005) does remarkably well explaining much of the variation in recent price changes. The correlation between the inverse of the supply elasticity estimated from fundamentals and recent changes in prices is 0.65. The relationship between the two variables can be appreciated in Figure 8. Of course, differential local shocks are apparent Nevertheless, a simple model with our supply parameters based on fundamentals and a common demand shifter explains quite well the big picture of the evolution of housing prices during the 2000-2005 period, further validating our estimates.

# 5 Conclusions

I started by providing empirical content to the concept of land availability in metropolitan areas. Using satellite-generated elevation data I produced slope maps for all areas within 10 and 50 kilometers of metropolitan center cities, and identified areas with slopes above 15%. I showed that residential development is drastically hampered by high-sloping terrain. I hence combined the share of steep-sloped areas with the share of the 50 km radius around cities that corresponds to water. To do that I used GIS data on ocean and Lakes boundaries, combined with land use data processed at the census tract level. The paper provides the first measure of land unavailable for real estate development in the metropolitan US. For instance, 72% of the area around a 50km ring of downtown San Francisco is rendered undevelopable by water and mountains. This topographic measure can be used in future work exploring topics as diverse as housing, labor mobility, urban density, transportation, and urban environmental issues.

Most areas that are widely regarded as supply-inelastic were found, in fact, to be severely land-constrained by their topography. Deploying a new comprehensive survey on residential land use regulations, I also found that highly-regulated areas tend to also be topographically constrained. This is an important fact for future work. One needs to control for geographic effects when studying the impact of land use regulation on housing prices and labor mobility. Other variables --immigration, high taxes, politics, and "communitarian" social capital-- were also found to be predictive of more restrictive residential land regulations.

The results in the paper are consistent with the "hysteresis hypothesis" of housing supply: voters in areas with initially high land values were more likely to support restrictive growth control regulations that kept intact or increased housing prices. More generally, the results point to the endogeneity of land use controls with respect to the housing market equilibrium. Hence I next estimated a model where regulations are both causes and consequences of housing supply inelasticity.

In our system of equations, housing demand, construction, and regulations are all determined endogenously. Housing supply elasticities were found to be well-characterized as functions of both physical and regulatory constraints, which in turn are endogenous to prices and past growth. The results provided operational estimates of local supply elasticities in all major US metropolitan areas. These estimates, based on fundamental primitives about land availability, should prove useful in calibrating general equilibrium models of inter-regional labor mobility and to predict the response of housing markets to future demand shocks. As an initial step in that direction, I showed the estimated elasticities to be very strong predictors of the evolution of housing prices by metropolitan area during the 2000-2005 period, which is out-of-sample in the original estimation.

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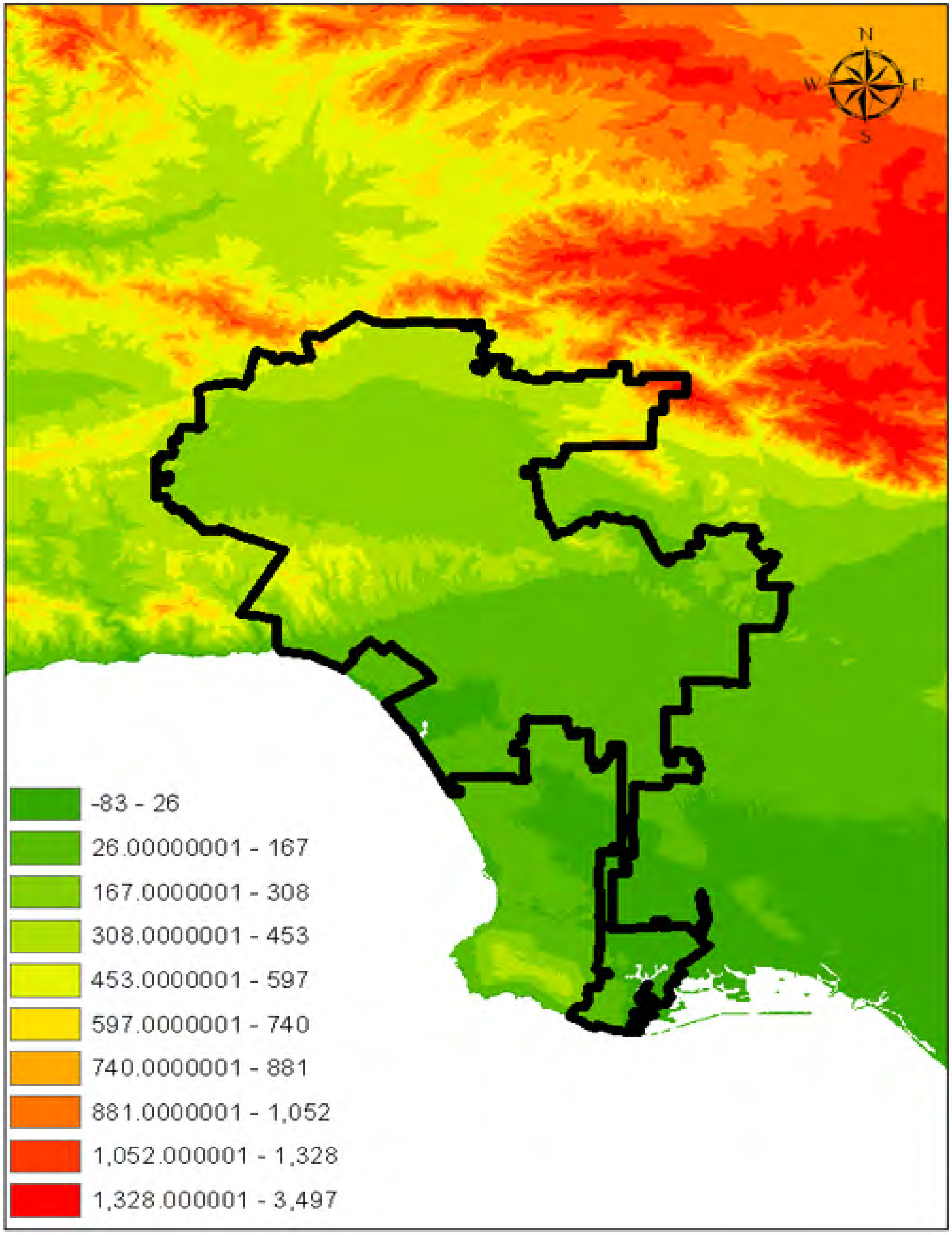
[85] Van Niewerburgh, S. and P. Weill (2006). “Why Has Housing price Dispersion Gone up?” NBER Working Paper No. 12538

[86] Wooldridge, J. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, Mass.: MIT Press.

## Figure 1.A: Elevation Map of LA and Environs



## Figure 1.B: Slope Map of LA and Environs

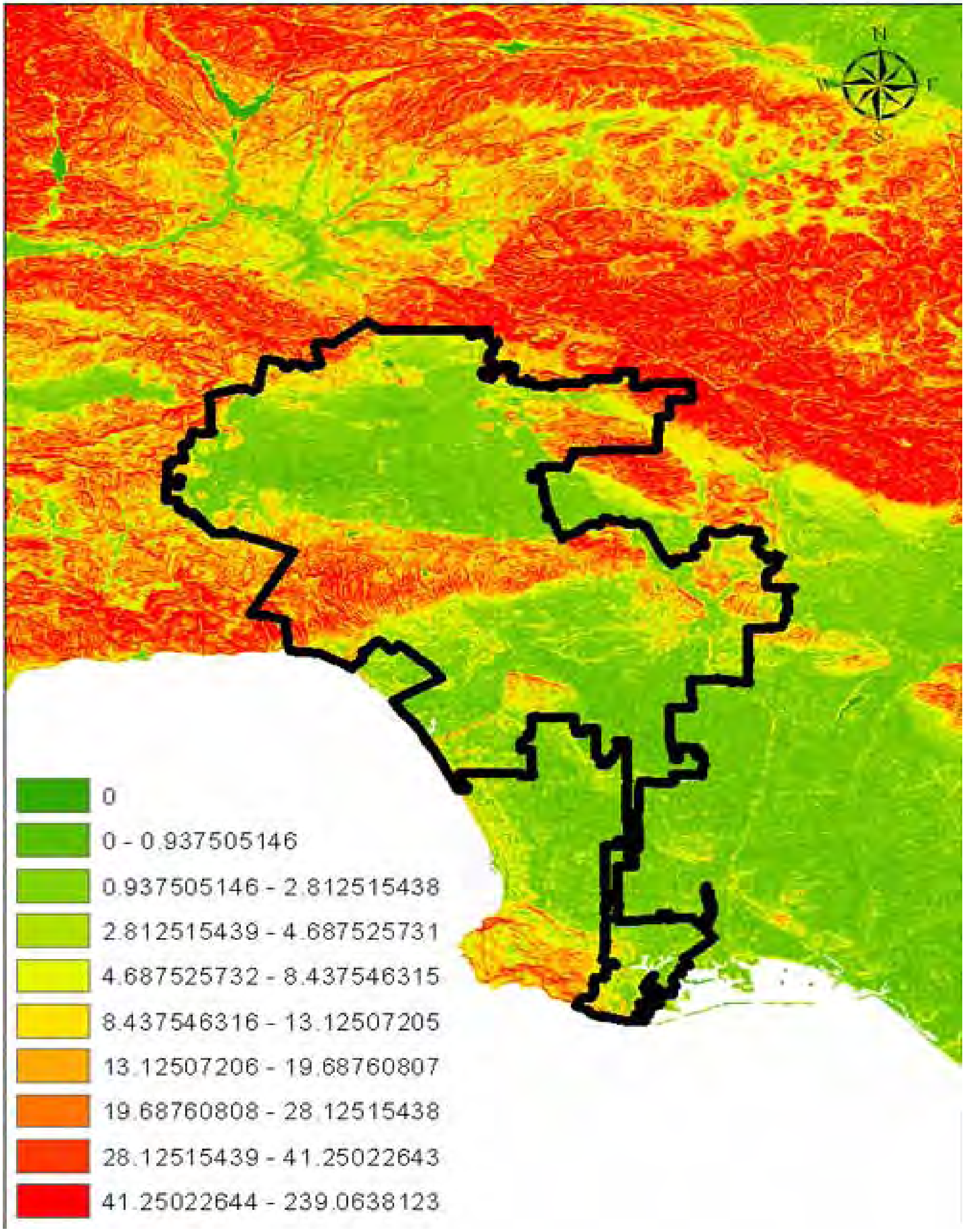


**Figure 1.C: “Steep Slope Areas” in LA and Environs**

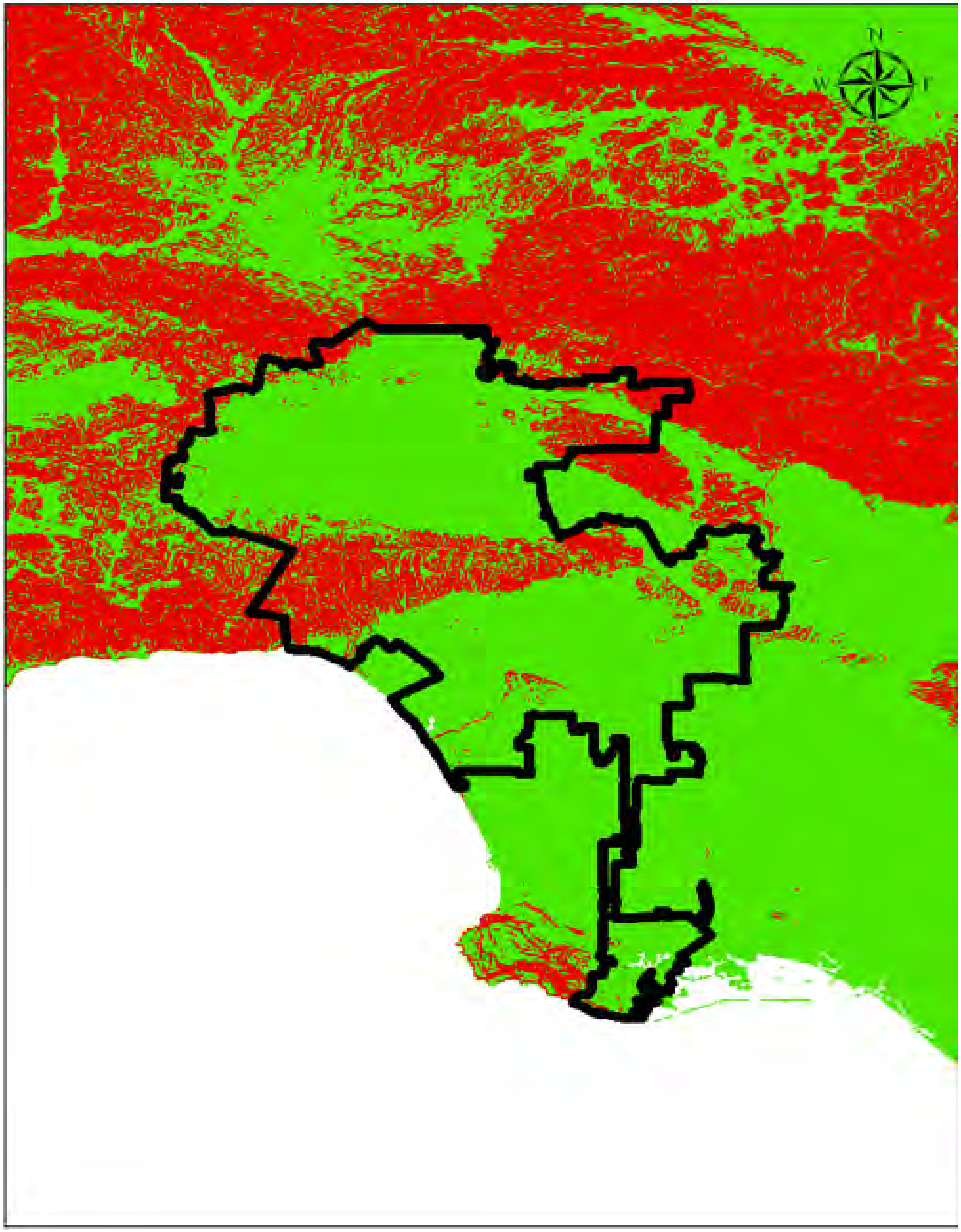
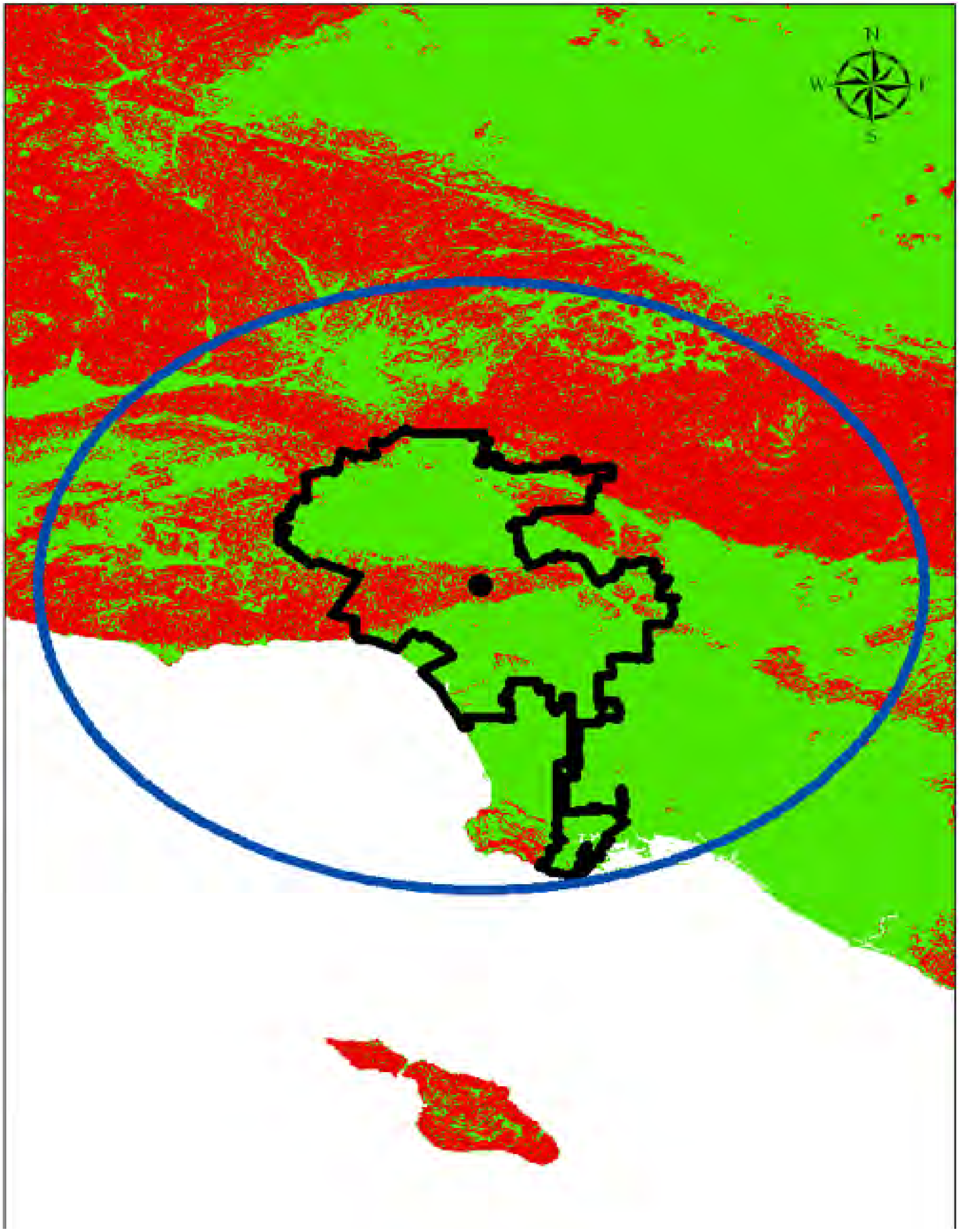
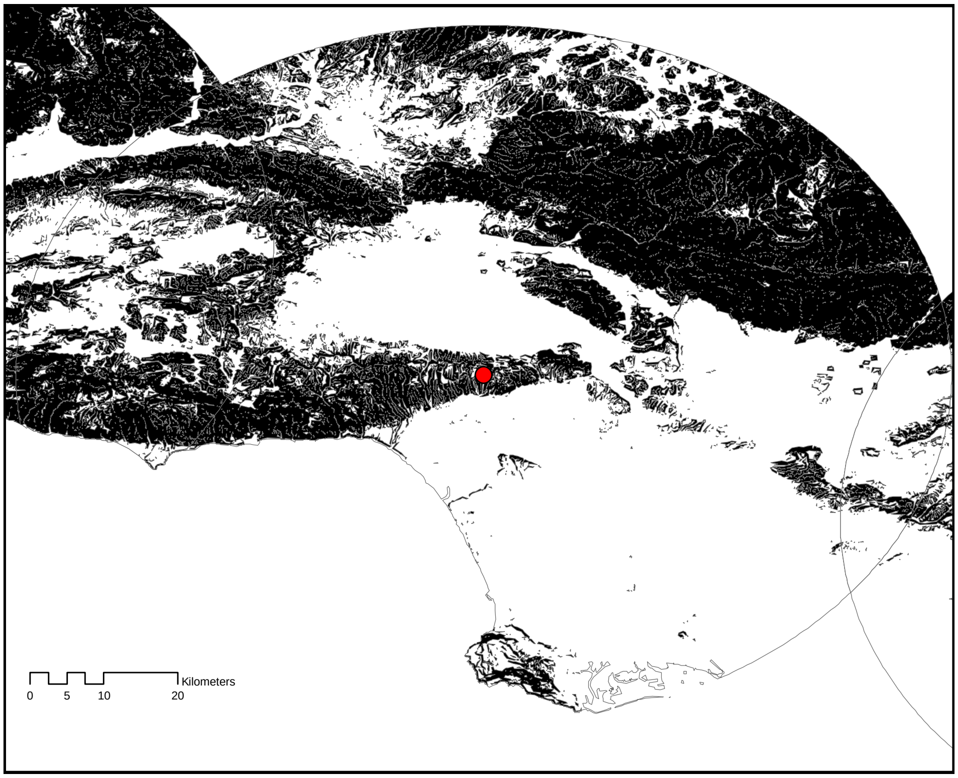


**Figure 1.D: Embedding LA Data into 50km Radius**

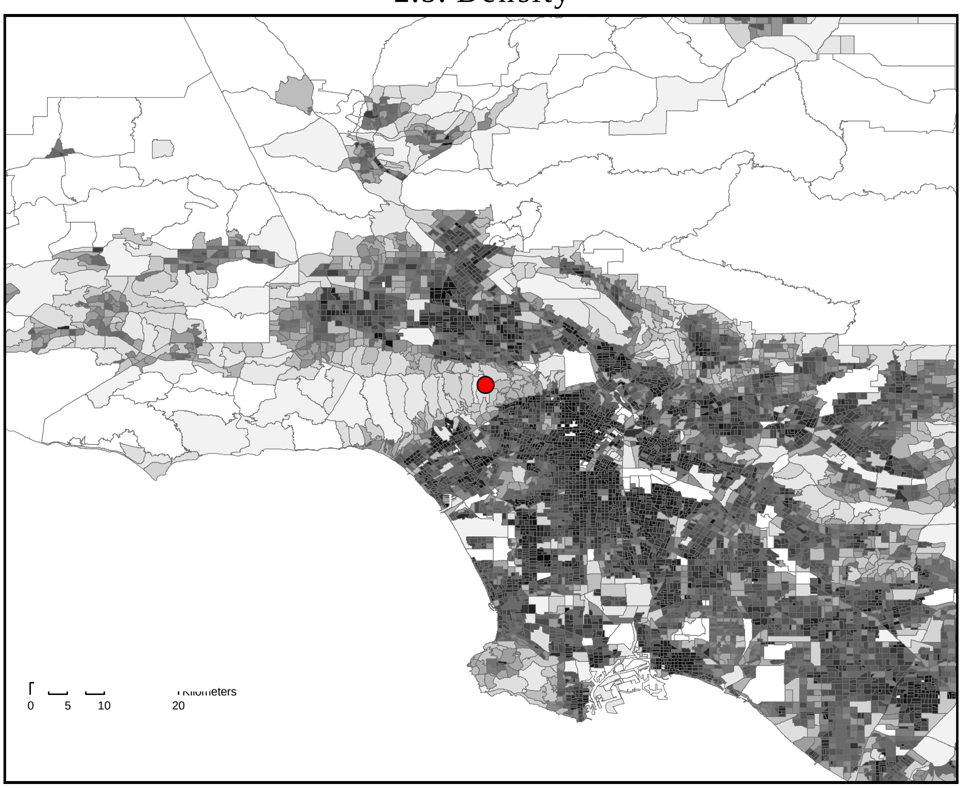


# Figure 2: Steep slopes and Density in LA

2.a: Slopes Above 15%

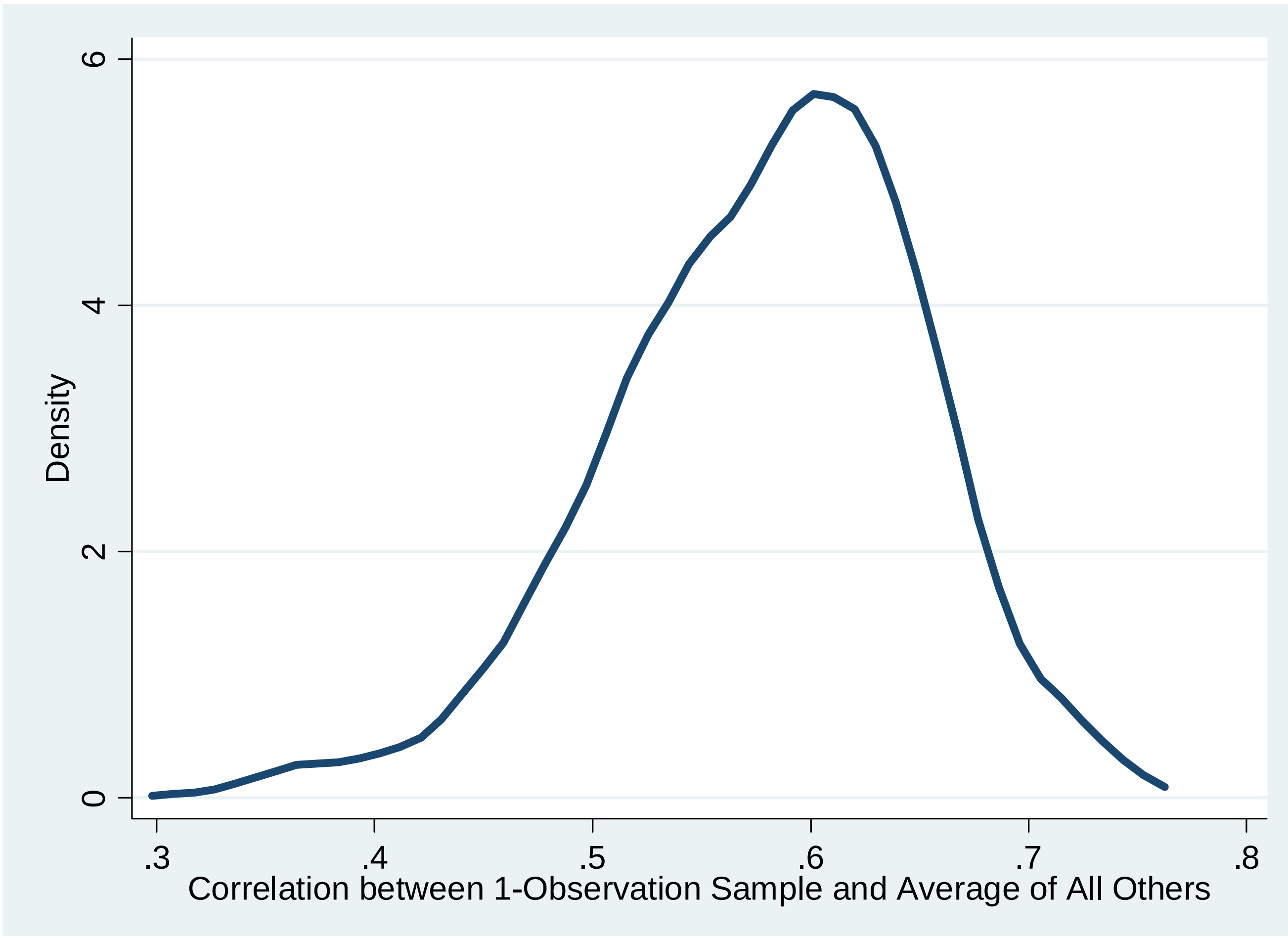



2.b: Density



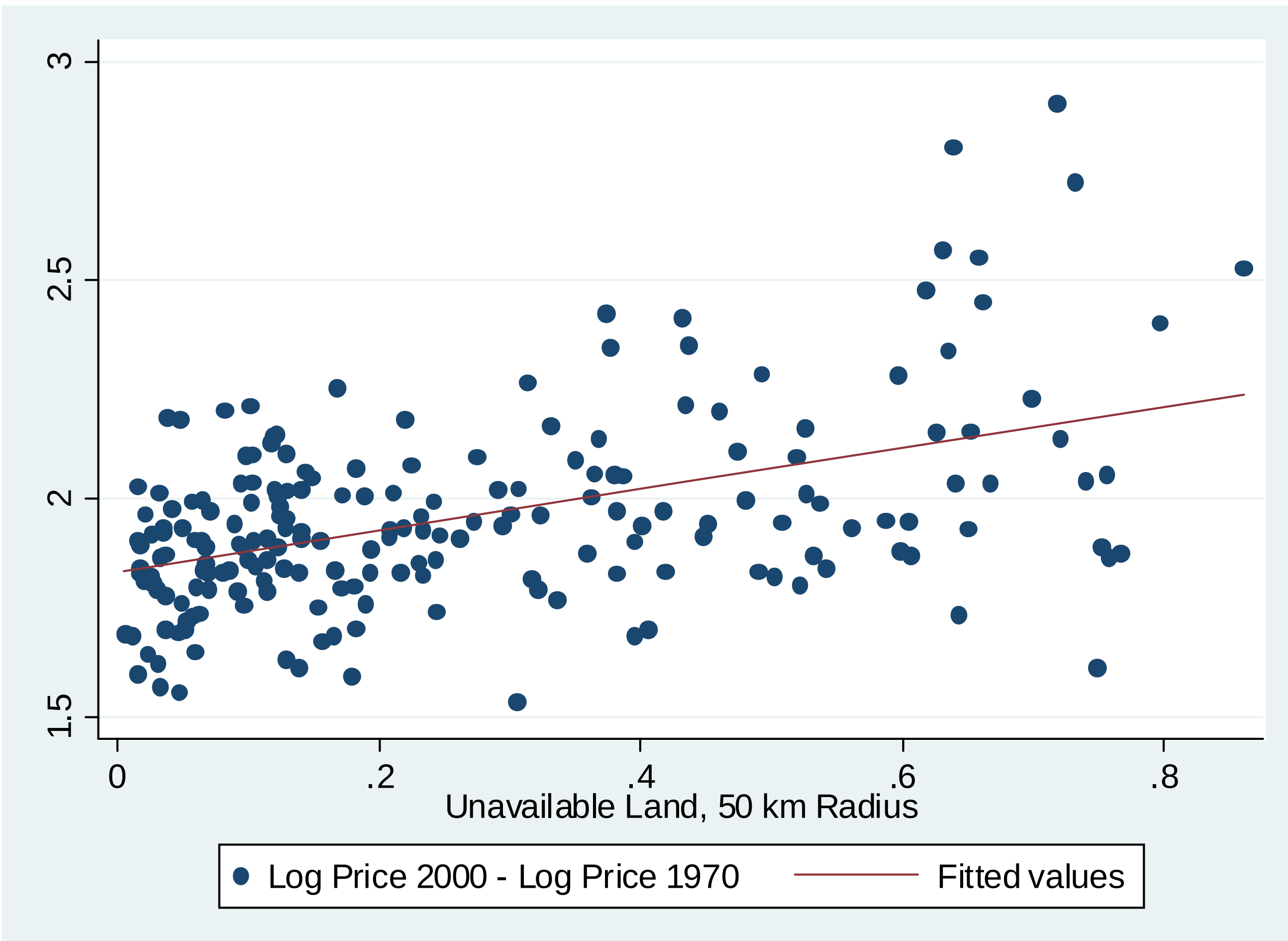
## **Figure 3**

One-observation WRLURI samples



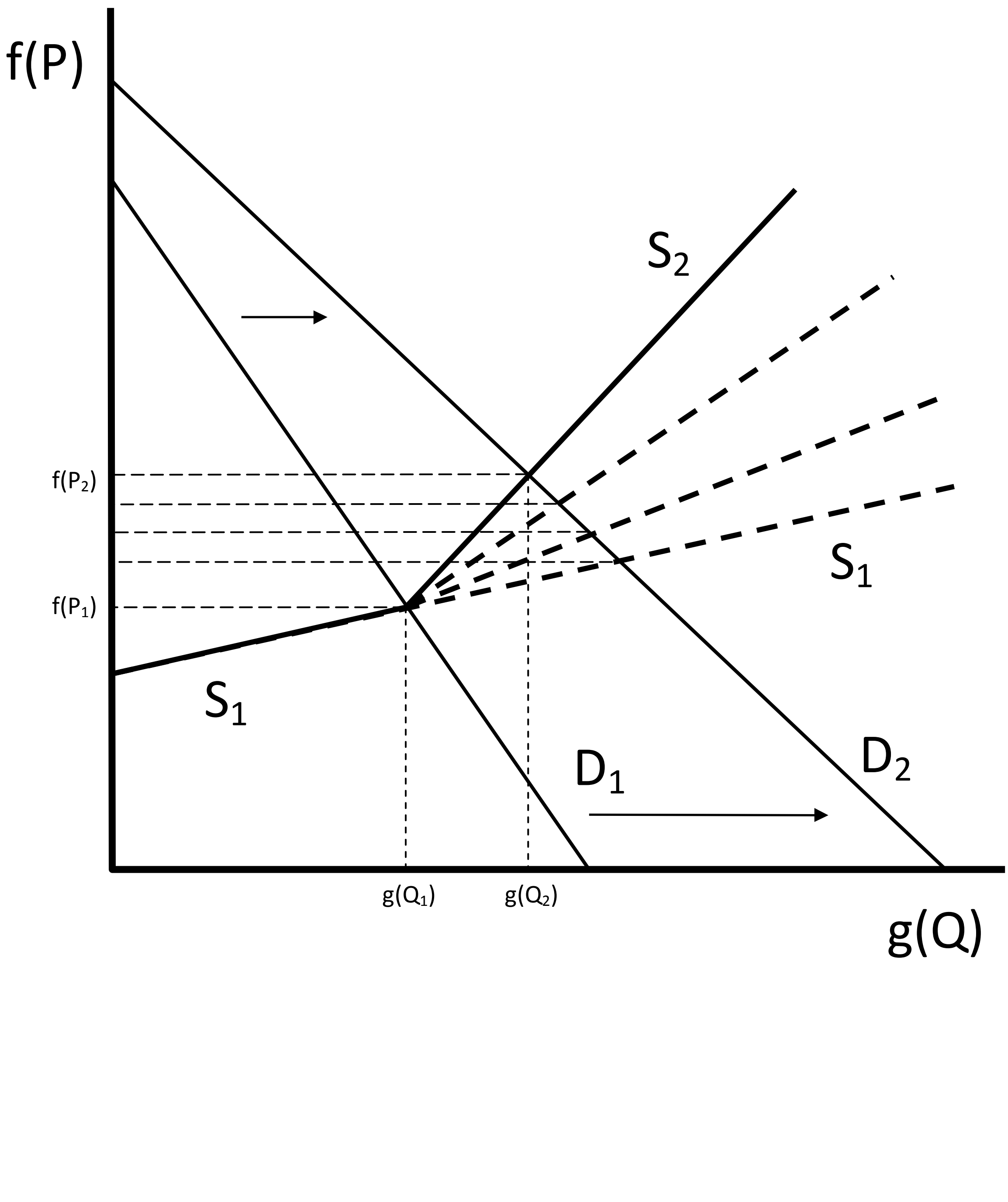
# Figure 4

Correlation Between land availability and Price Growth (non-declining cities)



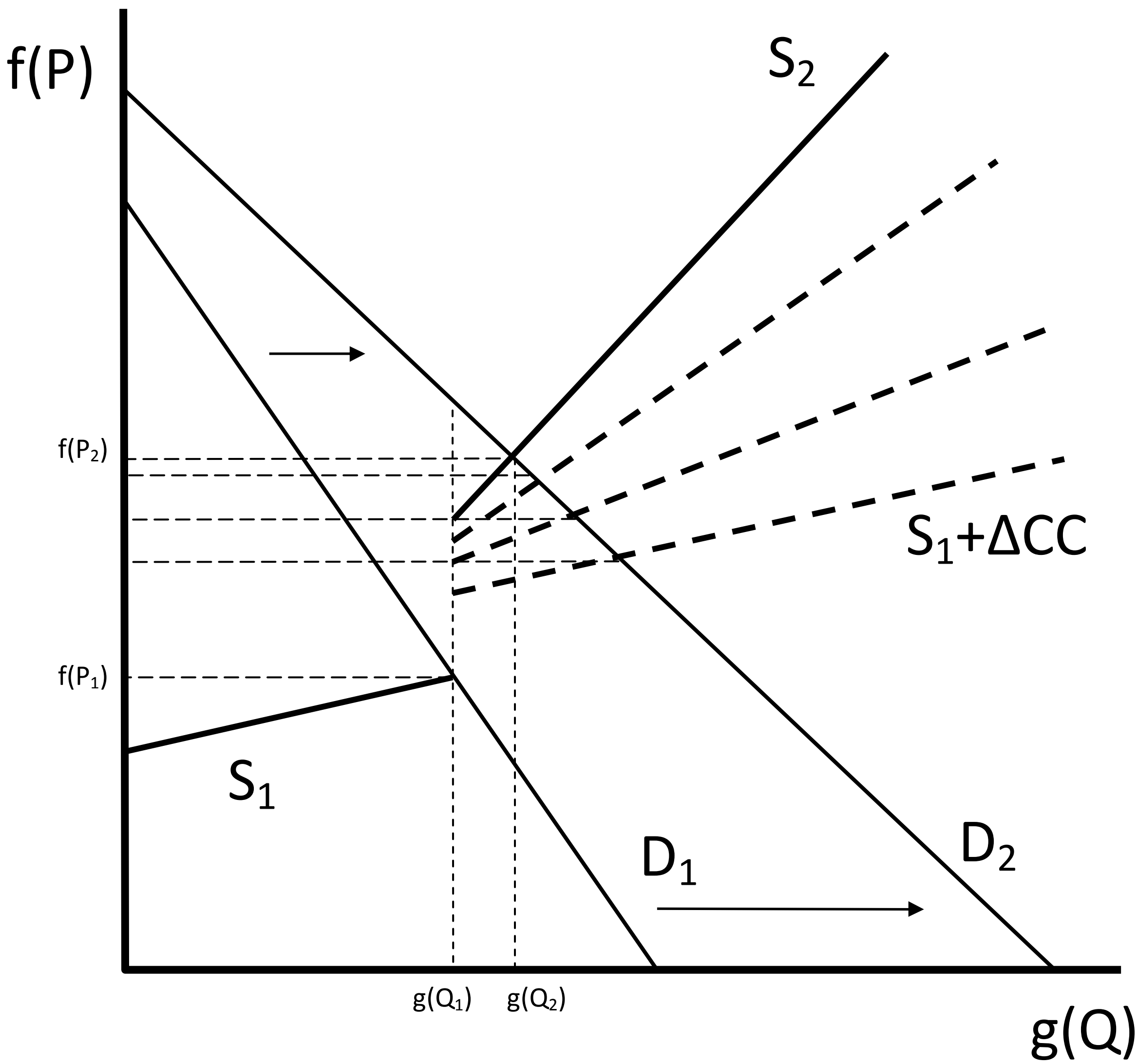
# Figure 5.a

Endogenous Supply Elasticity

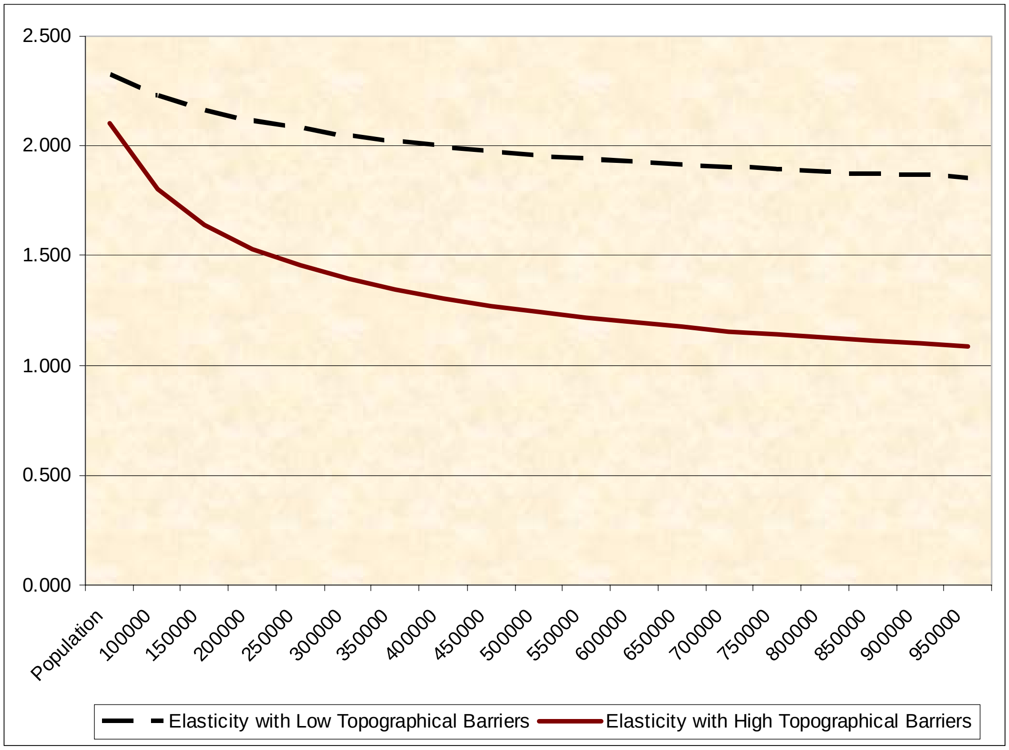


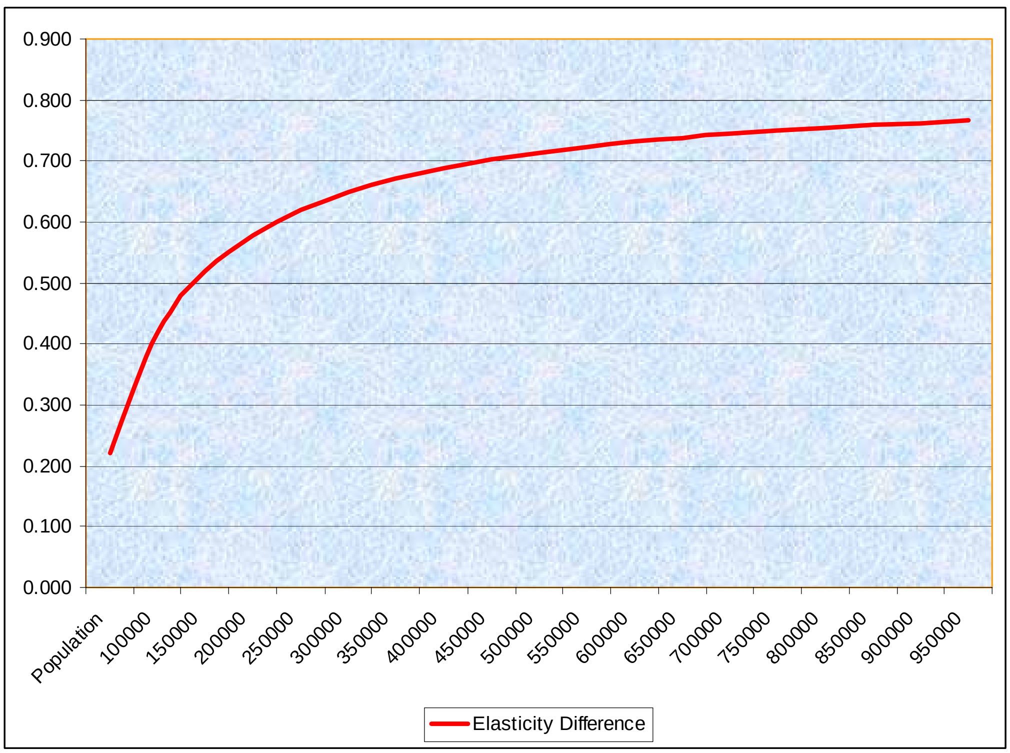
# Figure 5.b

Endogenous Supply Elasticity with Shift



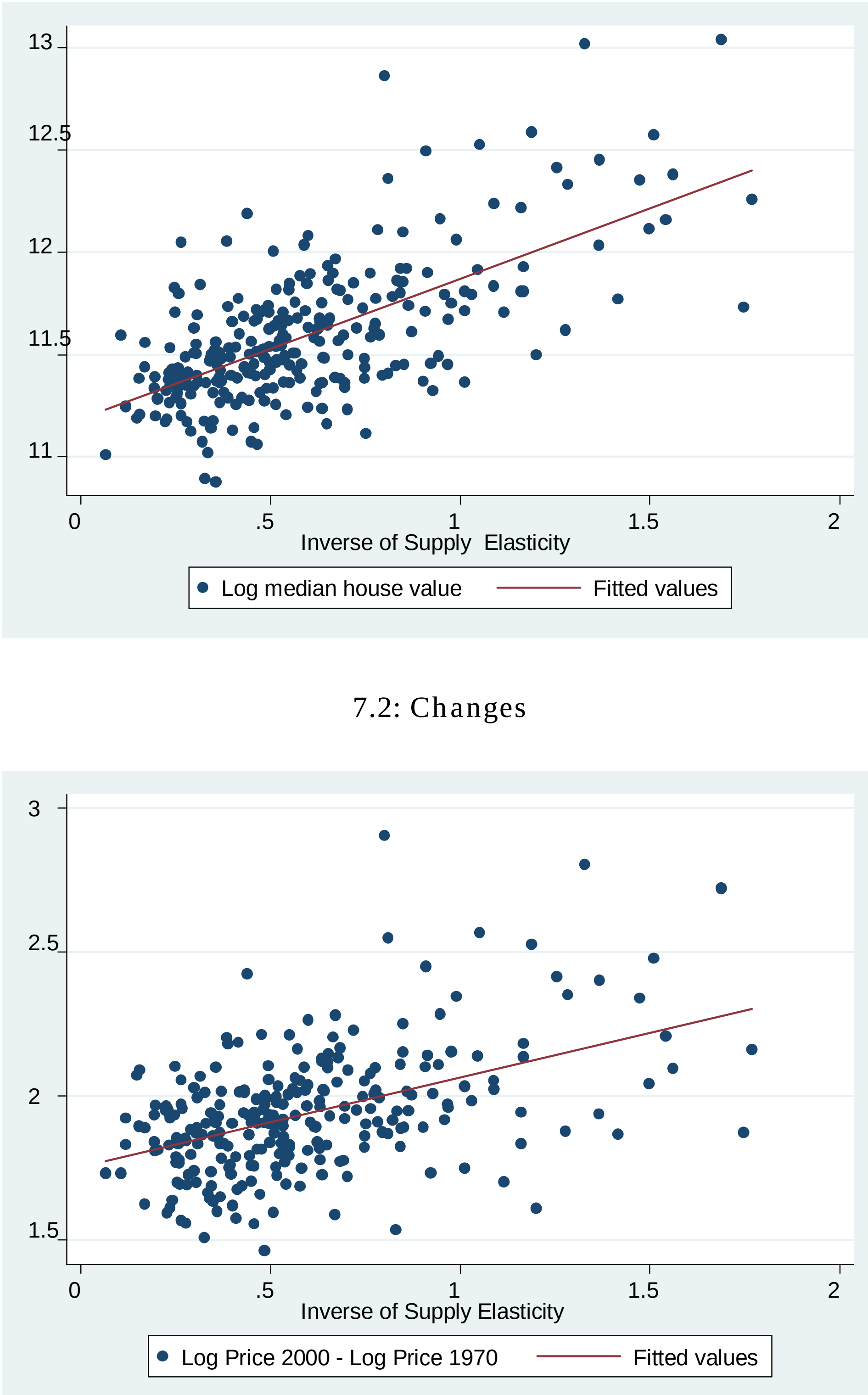
# Figure 6
# Impact of Topography on Elasticities by Population



# Figure 7: Estimated Elasticities and Home Values (2000)

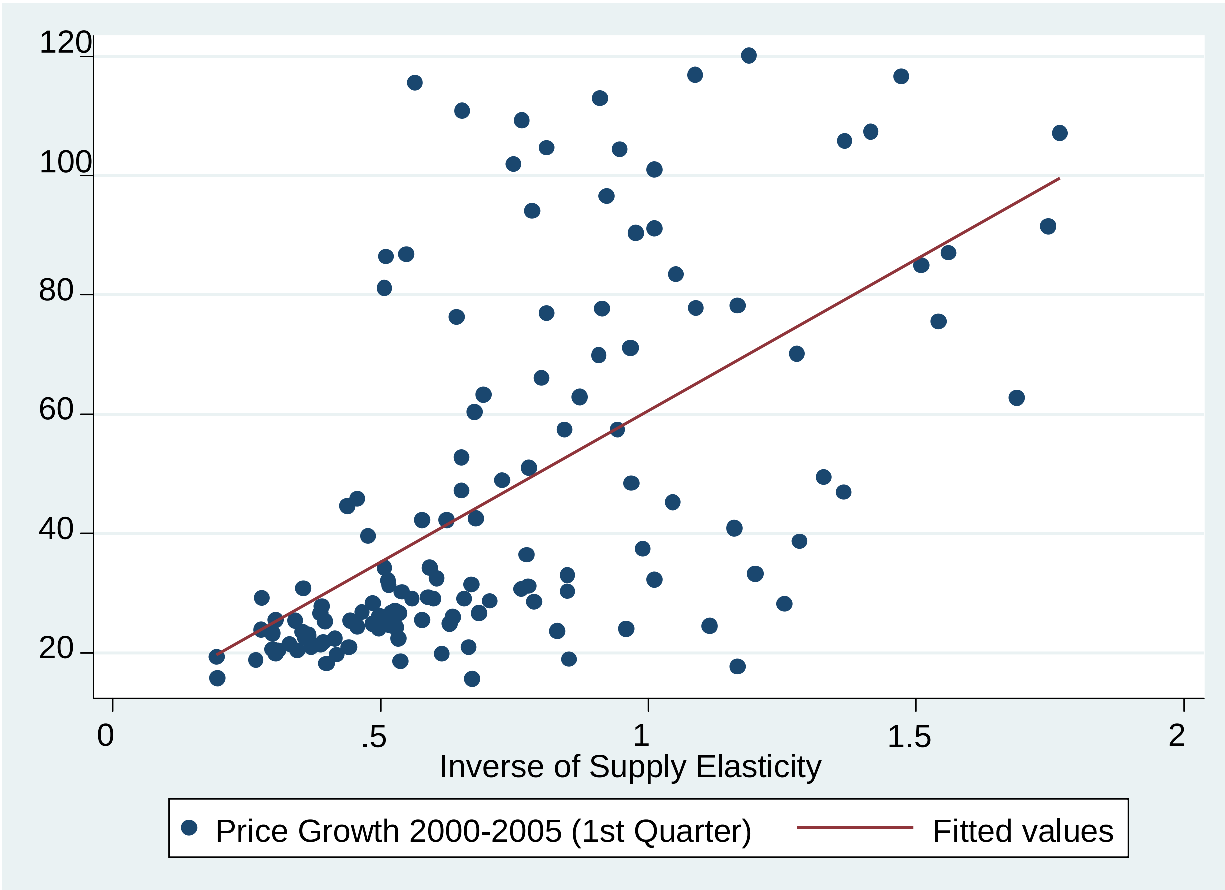
7.1: Levels




7.2: Changes

**Figure 8**

**Using Supply Elasticities to Predict Out-of-sample**



# TABLE 1

Physical and Regulatory Development Constraints (Metro Areas with Pop>500,000)

| Rank | MSA Code | MSA/NECMA Name | Undevelopable Area | WRLURI | Rank | MSA Code | MSA/NECMA Name | Undevelopable Area | WRLURI |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 8735 | Ventura, CA | 80.10% | 1.22 | **49** | 5120 | Minneapolis-St. Paul, MN-WI | 19.32% | 0.38 |
| **2** | 5000 | Miami, FL | 76.91% | 0.94 | **50** | 1280 | Buffalo-Niagara Falls, NY | 19.25% | -0.28 |
| **3** | 2680 | Fort Lauderdale, FL | 76.05% | 0.70 | **51** | 8400 | Toledo, OH | 19.11% | -0.57 |
| **4** | 5560 | New Orleans, LA | 75.01% | -1.25 | **52** | 8160 | Syracuse, NY | 17.17% | -0.70 |
| **5** | 7360 | San Francisco, CA | 72.39% | 0.78 | **53** | 2080 | Denver, CO | 16.56% | 0.81 |
| **6** | 7510 | Sarasota-Bradenton, FL | 66.81% | 0.89 | **54** | 1760 | Columbia, SC | 15.80% | -0.76 |
| **7** | 7160 | Salt Lake City-Ogden, UT | 65.36% | -0.03 | **55** | 6200 | Phoenix-Mesa, AZ | 15.23% | 0.60 |
| **8** | 8960 | West Palm Beach-Boca Raton, FL | 64.11% | 0.30 | **56** | 1000 | Birmingham, AL | 14.76% | -0.24 |
| **9** | 7320 | San Diego, CA | 63.63% | 0.44 | **57** | 9160 | Wilmington-Newark, DE-MD | 14.69% | 0.46 |
| **10** | 7400 | San Jose, CA | 62.71% | 0.21 | **58** | 8840 | Washington, DC-MD-VA-WV | 14.50% | 0.21 |
| **11** | 1440 | Charleston-North Charleston, SC | 60.72% | -0.81 | **59** | 6483 | Providence-Warwick-Pawtucket, RI | 14.23% | 2.07 |
| **12** | 5775 | Oakland, CA | 60.10% | 0.63 | **60** | 4400 | Little Rock-North Little Rock, AR | 13.64% | -0.88 |
| **13** | 5720 | Norfolk-Virginia Beach, VA-NC | 60.04% | 0.12 | **61** | 200 | Albuquerque, NM | 13.63% | 0.36 |
| **14** | 4480 | Los Angeles-Long Beach, CA | 53.43% | 0.50 | **62** | 2840 | Fresno, CA | 13.56% | 0.90 |
| **15** | 3600 | Jacksonville, FL | 47.75% | -0.03 | **63** | 2320 | El Paso, TX | 12.85% | 0.71 |
| **16** | 8720 | Vallejo-Fairfield-Napa, CA | 47.49% | 0.98 | **64** | 3160 | Greenville-Spartanburg-Anderson, SC | 12.81% | -0.94 |
| **17** | 5483 | New Haven-Bridgeport-Stamford, CT | 44.56% | 0.19 | **65** | 5360 | Nashville, TN | 12.61% | -0.46 |
| **18** | 7600 | Seattle-Bellevue-Everett, WA | 42.88% | 0.93 | **66** | 4520 | Louisville, KY-IN | 12.56% | -0.46 |
| **19** | 8280 | Tampa-St. Petersburg-Clearwater, FL | 42.19% | -0.24 | **67** | 4920 | Memphis, TN-AR-MS | 12.33% | 1.16 |
| **20** | 5080 | Milwaukee-Waukesha, WI | 41.98% | 0.45 | **68** | 8120 | Stockton-Lodi, CA | 11.93% | 0.59 |
| **21** | 1680 | Cleveland-Lorain-Elyria, OH | 40.54% | -0.18 | **69** | 7040 | St. Louis, MO-IL | 11.22% | -0.73 |
| **22** | 5600 | New York, NY | 40.51% | 0.67 | **70** | 9320 | Youngstown-Warren, OH | 10.68% | -0.39 |
| **23** | 1600 | Chicago, IL | 40.28% | 0.01 | **71** | 6160 | Philadelphia, PA-NJ | 10.50% | 1.13 |
| **24** | 6780 | Riverside-San Bernardino, CA | 38.73% | 0.57 | **72** | 1640 | Cincinnati, OH-KY-IN | 10.23% | -0.58 |
| **25** | 3840 | Knoxville, TN | 37.40% | -0.38 | **73** | 440 | Ann Arbor, MI | 9.83% | 0.32 |
| **26** | 5960 | Orlando, FL | 36.66% | 0.31 | **74** | 3000 | Grand Rapids-Muskegon-Holland, MI | 9.48% | -0.14 |
| **27** | 6440 | Portland-Vancouver, OR-WA | 36.46% | 0.26 | **75** | 1920 | Dallas, TX | 9.23% | -0.27 |
| **28** | 4120 | Las Vegas, NV-AZ | 36.27% | -0.68 | **76** | 6760 | Richmond-Petersburg, VA | 9.06% | -0.38 |
| **29** | 8200 | Tacoma, WA | 36.01% | 1.34 | **77** | 3360 | Houston, TX | 8.93% | -0.30 |
| **30** | 1123 | Boston-Worcester-Lawrence, MA-NH | 34.06% | 1.67 | **78** | 6640 | Raleigh-Durham-Chapel Hill, NC | 8.45% | 0.62 |
| **31** | 760 | Baton Rouge, LA | 33.73% | -0.83 | **79** | 80 | Akron, OH | 6.53% | 0.00 |
| **32** | 3640 | Jersey City, NJ | 33.66% | 0.29 | **80** | 8560 | Tulsa, OK | 6.41% | -0.75 |
| **33** | 2960 | Gary, IN | 31.63% | -0.69 | **81** | 3760 | Kansas City, MO-KS | 6.08% | -0.80 |
| **34** | 6840 | Rochester, NY | 30.55% | 0.04 | **82** | 1520 | Charlotte-Gastonia-Rock Hill, NC-SC | 5.19% | -0.53 |
| **35** | 6280 | Pittsburgh, PA | 30.52% | 0.08 | **83** | 2800 | Fort Worth-Arlington, TX | 5.04% | -0.28 |
| **36** | 5640 | Newark, NJ | 30.21% | 0.73 | **84** | 640 | Austin-San Marcos, TX | 4.42% | -0.27 |
| **37** | 5160 | Mobile, AL | 29.43% | -0.94 | **85** | 520 | Atlanta, GA | 4.30% | 0.03 |
| **38** | 680 | Bakersfield, CA | 29.38% | 0.39 | **86** | 7240 | San Antonio, TX | 3.94% | -0.26 |
| **39** | 7560 | Scranton-Wilkes-Barre-Hazleton, PA | 27.93% | 0.00 | **87** | 5920 | Omaha, NE-IA | 3.51% | -0.56 |
| **40** | 8003 | Springfield, MA | 25.52% | 0.71 | **88** | 3120 | Greensboro-Winston-Salem, NC | 3.41% | -0.29 |
| **41** | 2160 | Detroit, MI | 24.58% | 0.07 | **89** | 4880 | McAllen-Edinburg-Mission, TX | 3.17% | -0.46 |
| **42** | 8520 | Tucson, AZ | 24.52% | 1.55 | **90** | 2760 | Fort Wayne, IN | 2.65% | -1.22 |
| **43** | 3240 | Harrisburg-Lebanon-Carlisle, PA | 23.53% | 0.55 | **91** | 1840 | Columbus, OH | 2.63% | 0.25 |
| **44** | 160 | Albany-Schenectady-Troy, NY | 22.62% | -0.01 | **92** | 5880 | Oklahoma City, OK | 2.57% | -0.38 |
| **45** | 1720 | Colorado Springs, CO | 22.40% | 0.85 | **93** | 9040 | Wichita, KS | 1.73% | -1.20 |
| **46** | 3283 | Hartford, CT | 22.28% | 0.51 | **94** | 3480 | Indianapolis, IN | 1.50% | -0.74 |
| **47** | 720 | Baltimore, MD | 22.25% | 1.65 | **95** | 2000 | Dayton-Springfield, OH | 1.08% | -0.50 |
| **48** | 240 | Allentown-Bethlehem-Easton, PA | 20.92% | 0.02 | | | | | |

## Table 2
*Descriptive Statistics*

| | Mean | Standard Dev. |
|---|---|---|
| Log Density in 1950 | 4.713 | 1.125 |
| Log Average Distance to Historic Place | 0.874 | 0.458 |
| Unavailable Land, 50 km Radius | 0.262 | 0.210 |
| African-American Share in 1970 | 0.097 | 0.100 |
| Share with Bachelors Degree in 1970 | 0.111 | 0.042 |
| Share foreign born in 1970 | 0.033 | 0.032 |
| Log Coefficient of Variation of Income: Places | -1.864 | 0.599 |
| Log Coefficient of Variation of Income: Tracts | -1.182 | 0.340 |
| 68-71 MSA Dissimilarity White/Black | 74.723 | 13.282 |
| 68-71 MSA School Dissimilarity White/Hispanic | 65.791 | 15.959 |
| Percentage Catholic, 1971 | 0.361 | 0.238 |
| % Voting for Democratic Candidate, 1980 (Carter) | 0.439 | 0.108 |
| Log non-Profit Organization Density | -7.368 | 0.679 |
| Vote for President in 1988/Total Elegible Population | 49.767 | 7.639 |
| Census Mail Response Rates 1990 | 67.030 | 6.879 |
| Log (Local Tax Revenues/Income Capita) in 1982 | -3.325 | 0.385 |
| Construction Unionization Rate 1986-2000 | 0.204 | 0.142 |
| Midwest | 0.264 | 0.442 |
| South | 0.383 | 0.487 |
| West | 0.201 | 0.401 |

# TABLE 3

## *Accounting for Differences in Residential Land Regulation Across Metropolitan Areas*

| | *Wharton Residential Land Use Index (Metropolitan Area)* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Welfare* | *Path Dependence* | | *Racial and Income Heterogeneity* | | | | *Politics* | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| Midwest | -0.76 | -0.76 | -0.97 | -0.71 | -0.62 | -0.6 | -0.76 | -0.77 | -0.73 | -0.8 | -0.71 |
| | (0.141)*** | (0.142)*** | (0.140)*** | (0.139)*** | (0.130)*** | (0.130)*** | (0.148)*** | (0.149)*** | (0.146)*** | (0.156)*** | (0.205)*** |
| South | -0.54 | -0.75 | -0.94 | -0.61 | -0.51 | -0.49 | -0.63 | -0.22 | -0.19 | -0.25 | -0.13 |
| | (0.147)*** | (0.129)*** | (0.126)*** | (0.150)*** | (0.140)*** | (0.142)*** | (0.152)*** | (0.184) | (0.180) | (0.205) | (0.248) |
| West | 0.33 | 0.03 | -0.3 | 0.04 | 0.14 | 0.15 | -0.05 | 0.38 | 0.34 | 0.45 | 0.54 |
| | (0.167)** | (0.145) | (0.149)** | (0.144) | (0.135) | (0.135) | (0.172) | (0.154)** | (0.152)** | (0.166)*** | (0.218)** |
| Log Density in 1950 | 0.05 | - | - | - | - | - | - | - | - | - | - |
| | (0.051) | - | - | - | - | - | - | - | - | - | - |
| Log Average Distance to Historic Place | -0.3 | - | - | - | - | - | - | - | - | - | - |
| | (0.124)** | - | - | - | - | - | - | - | - | - | - |
| Unavailable Land, 50 km Radius | | 0.73 | - | - | - | - | - | - | - | - | - |
| | | (0.224)*** | - | - | - | - | - | - | - | - | - |
| Unavailable Land in Stagnating Cities (1950-1970) | | | -0.14 | - | - | - | - | - | - | - | - |
| | | | (0.489) | - | - | - | - | - | - | - | - |
| Unavailable Land in Non-Stagnating Cities (1950-1970) | | | 0.9 | - | - | - | - | - | - | - | - |
| | | | (0.230)*** | - | - | - | - | - | - | - | - |
| Stagnating City in 1950-1970 | | | -0.27 | - | - | - | - | - | - | - | - |
| | | | (0.160)* | - | - | - | - | - | - | - | - |
| Share foreign born in 1970 | | | | 6.87 | 6.18 | 7.17 | 5.87 | - | 7.82 | - | - |
| | | | | (1.430)*** | (1.384)*** | (1.370)*** | (1.481)*** | - | (2.349)*** | - | - |
| African-American Share in 1970 | | | | 0.23 | -0.06 | 0.24 | 0.67 | - | - | - | - |
| | | | | (0.554) | (0.528) | (0.533) | (0.628) | - | - | - | - |
| Share with Bachelors Degree in 1970 | | | | 2.81 | 2.37 | 2.64 | 2.13 | - | - | - | - |
| | | | | (1.015)*** | (0.945)** | (0.970)*** | (1.102)* | - | - | - | - |
| Log Coefficient of Variation of Income: Places | | | | | 0.1 | - | - | - | - | - | - |
| | | | | | (0.068) | - | - | - | - | - | - |
| Log Coefficient of Variation of Income: Tracts | | | | | | -0.16 | - | - | - | - | - |
| | | | | | | (0.127) | - | - | - | - | - |
| 68-71 MSA Dissimilarity White/Black | | | | | | | 0 | - | - | - | - |
| | | | | | | | (0.004) | - | - | - | - |
| 68-71 MSA School Dissimilarity White Hispanic | | | | | | | -0.01 | - | - | - | - |
| | | | | | | | (0.004) | - | - | - | - |
| Percentage Catholic, 1971 | | | | | | | | 0.46 | -0.19 | 0.33 | 0.12 |
| | | | | | | | | (0.249)* | (0.314) | (0.256) | (0.311) |
| % Voting for Democratic Candidate, 1980 (Carter) | | | | | | | | 1.05 | 0.92 | 1.12 | 1.72 |
| | | | | | | | | (0.431)** | (0.425)** | (0.465)** | (0.554)*** |
| Log non-Profit Organization Density | | | | | | | | -0.07 | -0.03 | -0.08 | 0.06 |
| | | | | | | | | (0.074) | (0.074) | (0.082) | (0.106) |
| Vote for President in 1988/Total Elegible Population | | | | | | | | 0 | 0.01 | 0 | -0.01 |
| | | | | | | | | (0.007) | (0.008) | (0.008) | (0.010) |
| Census Mail Response Rates 1990 | | | | | | | | 0.03 | 0.03 | 0.03 | 0.03 |
| | | | | | | | | (0.009)*** | (0.009)*** | (0.010)*** | (0.013)** |
| Log (Local Tax Revenues/Income Capita) in 1982 | | | | | | | | 0.31 | 0.24 | 0.36 | 0.77 |
| | | | | | | | | (0.138)** | (0.137)* | (0.152)** | (0.251)*** |
| Unionization Rate 1986-2000 | | | | | | | | | | -0.61 | - |
| | | | | | | | | | | (0.874) | - |
| Saiz-Simonsohn Corruption Index | | | | | | | | | | | -0.03 |
| | | | | | | | | | | | (0.057) |
| Observations | 269 | 269 | 269 | 269 | 265 | 265 | 247 | 265 | 265 | 213 | 120 |
| R-squared | 0.3 | 0.29 | 0.37 | 0.34 | 0.37 | 0.37 | 0.36 | 0.33 | 0.36 | 0.38 | 0.46 |

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

# TABLE 4
*Origins of Land Regulation: Full Model*

| | FGLS | Median Regression | Excludes NE | Excludes CA | 10 Km Radius | State FE | Non-Stagnating Cities | Stagnating Cities |
|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| Log Average Distance to Historic Place | -0.167 | 0.042 | -0.055 | -0.216 | -0.165 | -0.191 | -0.024 | -0.495 |
| | (0.104) | (0.106) | (0.097) | (0.113)* | (0.105) | (0.113)* | (0.125) | (0.211)** |
| Unavailable Land in Non-Stagnating Cities | 0.551 | 0.491 | 0.413 | 0.732 | 0.565 | 0.389 | 0.592 | -0.032 |
| | (0.228)** | (0.240)** | (0.212)* | (0.254)*** | (0.273)** | (0.217)* | (0.240)** | (0.546) |
| Stagnating City in 1950-1970 | -0.245 | -0.197 | -0.353 | -0.186 | -0.285 | -0.196 | - | - |
| | (0.113)** | (0.119)* | (0.105)*** | (0.119) | (0.109)*** | (0.098)** | - | - |
| Share with Bachelors Degree in 1970 | 0.824 | 1.230 | 0.431 | 1.549 | 0.701 | 1.230 | 0.796 | 3.464 |
| | (1.069) | (1.065) | (0.974) | (1.132) | (1.070) | (0.938) | (1.097) | (4.375) |
| Share foreign born in 1970 | 4.256 | 4.293 | 4.661 | 4.901 | 4.716 | 1.735 | 3.259 | 3.753 |
| | (1.414)*** | (1.431)*** | (1.297)*** | (1.531)*** | (1.380)*** | (1.287) | (1.791)* | (2.620) |
| Log (Local Tax Revenues/Income Capita) in 1982 | 0.225 | 0.186 | 0.214 | 0.207 | 0.229 | 0.435 | 0.379 | -0.228 |
| | (0.120)* | (0.107)* | (0.109)* | (0.123)* | (0.120)* | (0.137)*** | (0.137)*** | (0.259) |
| % Voting for Democratic Candidate, 1980 (Carter) | 0.606 | 1.101 | 0.602 | 0.816 | 0.665 | -0.145 | 0.999 | -0.807 |
| | (0.397) | (0.416)*** | (0.363)* | (0.422)* | (0.396)* | (0.431) | (0.462)** | (0.924) |
| Census Mail Response Rates 1990 | 0.018 | 0.025 | 0.029 | 0.021 | 0.019 | 0.013 | 0.029 | -0.009 |
| | (0.008)** | (0.009)*** | (0.008)*** | (0.009)** | (0.008)** | (0.009) | (0.010)*** | (0.017) |
| Midwest | -0.794 | -0.780 | -0.681 | -0.741 | -0.802 | | -0.939 | -0.591 |
| | (0.137)*** | (0.147)*** | (0.130)*** | (0.140)*** | (0.137)*** | | (0.178)*** | (0.244)** |
| South | -0.403 | -0.320 | -0.191 | -0.317 | -0.374 | | -0.416 | -0.626 |
| | (0.158)** | (0.167)* | (0.153) | (0.164)* | (0.158)** | | (0.190)** | (0.339)* |
| West | 0.049 | 0.183 | 0.243 | 0.104 | 0.114 | | -0.008 | 0.089 |
| | (0.160) | (0.170) | (0.155) | (0.184) | (0.156) | | (0.185) | (0.550) |
| Constant | -0.606 | -1.739 | -1.586 | -1.099 | -0.678 | 0.492 | -1.017 | 0.189 |
| | (0.683) | (0.704)** | (0.648)** | (0.731) | (0.687) | (0.787) | (0.819) | (1.575) |
| Observations | 266 | 266 | 255 | 244 | 266 | 266 | 198 | 68 |
| R-squared | 0.45 | na | 0.47 | 0.43 | 0.45 | 0.72 | 0.45 | 0.45 |

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

**TABLE 5**

*Topography, Regulation, Prices, and Development: System Estimation*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Δlog(P) (SUPPLY) | | | Δlog(Q) (DEMAND) | WRLURI |
| Δlog(Q) | 0.481 | - | - | - | - |
| | (0.066)*** | - | - | - | - |
| WRLURI*Δlog(Q) | | 0.149 | 0.225 | - | - |
| | | (0.035)*** | (0.035)*** | - | - |
| Unavailable Land*Δlog(Q) | | 0.249 | -5.651 | - | - |
| | | (0.105)** | (1.195)*** | - | - |
| Log(1970 Population)*Unavailable Land*Δlog(Q) | | | 0.501 | - | - |
| | | | (0.099)*** | - | - |
| Δlog(P) | | | | -0.952 | - |
| | | | | (0.232)*** | - |
| Δlog(Per Capita Income) | | | | 1.485 | - |
| | | | | (0.277)*** | - |
| Log January Monthly Hours of Sun (Average 1941-1970) | | | | 0.094 | - |
| | | | | (0.061) | - |
| Coastal Metro Area | | | | 0.111 | - |
| | | | | (0.046)** | - |
| Share with Bachelors degree 1970 | | | | 0.309 | -0.112 |
| | | | | (0.453) | (0.793) |
| Immigration Shock | | | | 1.435 | - |
| | | | | (0.121)*** | - |
| Log Local Tax Revenues/Income per Capita 1982 | | | | -0.060 | 0.194 |
| | | | | (0.037) | (0.081)** |
| Share workers in manufacturing 1970 | | | | 0.025 | - |
| | | | | (0.188) | - |
| African-American Share 1970 | | | | -0.618 | - |
| | | | | (0.197)*** | - |
| Log(Population in 1970) | | | | -0.026 | - |
| | | | | (0.013)* | - |
| Log(P) 2000 | | | | | 1.017 |
| | | | | | (0.177)*** |
| Δlog(Q) | | | | | 0.379 |
| | | | | | (0.176)** |
| Log Average Distance to Historic Place | | | | | -0.142 |
| | | | | | (0.108) |
| Share foreign born 1970 | | | | | 5.201 |
| | | | | | (0.882)*** |
| % voting for Democratic candidate (1980: Carter) | | | | | -0.175 |
| | | | | | (0.383) |
| Census Mail Response Rates 1990 | | | | | 0.019 |
| | | | | | (0.007)** |
| Midwest | -0.056 | 0.016 | 0.068 | 0.029 | -0.676 |
| | (0.041) | (0.038) | (0.035) | 0.039 | (0.123) |
| South | -0.142 | -0.045 | -0.047 | 0.175 | -0.358 |
| | (0.048) | (0.039) | (0.036) | (0.048)*** | (0.144) |
| West | 0.078 | 0.081 | -0.034 | 0.466 | -0.145 |
| | (0.061) | (0.056) | (0.063) | (0.096)*** | (0.147) |
| Constant | 0.569 | 0.589 | 0.471 | -1.133 | -12.421 |
| | (0.043) | (0.043)*** | (0.045)*** | (0.475)** | (1.882)*** |
| Observations | 266 | 266 | 266 | 266 | 266 |

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

## TABLE 5.B

*System Estimation with endogenous Income and Immigration Shocks*

| | (2) | (4) | (5) |
|---|---|---|---|
| | Δlog(P) (SUPPLY) | Δlog(Q) (DEMAND) | WRLURI |
| WRLURI*Δlog(Q) | 0.178 | - | - |
| | (0.039)*** | - | - |
| Unavailable Land*Δlog(Q) | 0.223 | - | - |
| | (0.111)** | - | - |
| Log(1970 Population)*Unavailable Land*Δlog(Q) | | - | - |
| | | - | - |
| Δlog(P) | | -0.952 | - |
| | | (0.254)*** | - |
| Δlog(Per Capita Income) | | 2.371 | - |
| | | (0.444)*** | - |
| Log January Monthly Hours of Sun (Average 1941-1970) | | 0.129 | - |
| | | (0.063)** | - |
| Coastal Metro Area | | 0.142 | - |
| | | (0.049)*** | - |
| Share with Bachelors degree 1970 | | -0.620 | -0.351 |
| | | (0.657) | (0.935) |
| Immigration Shock | | 1.420 | - |
| | | (0.158)*** | - |
| Log Local Tax Revenues/Income per Capita 1982 | | -0.068 | 0.254 |
| | | (0.037)* | (0.078)** |
| Share workers in manufacturing 1970 | | 0.096 | - |
| | | (0.212) | - |
| African-American Share 1970 | | -0.892 | - |
| | | (0.230)*** | - |
| Log(Population in 1970) | | -0.029 | - |
| | | (0.015)* | - |
| Log(P) 2000 | | | 0.996 |
| | | | (0.21)*** |
| Δlog(Q) | | | 0.406 |
| | | | (0.237)* |
| Log Average Distance to Historic Place | | | -0.116 |
| | | | (0.115) |
| Share foreign born 1970 | | | 4.721 |
| | | | (0.952)*** |
| % voting for Democratic candidate (1980: Carter) | | | 0.024 |
| | | | (0.373) |
| Census Mail Response Rates 1990 | | | 0.022 |
| | | | (0.007)** |
| Midwest | 0.026 | 0.056 | -0.722 |
| | (0.039) | (0.040) | (0.119)*** |
| South | -0.039 | 0.152 | -0.350 |
| | (0.040) | (0.051)*** | (0.150)** |
| West | 0.059 | 0.534 | -0.210 |
| | (0.059) | (0.101)*** | (0.154) |
| Constant | 0.560 | -2.949 | -12.211 |
| | (0.047)*** | (0.711)*** | (2.243)*** |
| Observations | 266 | 266 | 266 |

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

# TABLE 6

*Endogenous Construction Costs*

| | Δlog(P) (SUPPLY) | Δlog(Construction Cost) (SUPPLY) |
|---|---|---|
| Δlog(Q) | - | -0.001 |
| | - | (0.010) |
| WRLURI*Δlog(Q) | 0.237 | - |
| | (0.033)*** | - |
| Unavailable Land*Δlog(Q) | -5.603 | - |
| | (1.062)*** | - |
| Log(1970 Population)*Unavailable Land*Δlog(Q) | 0.495 | - |
| | (0.089)*** | - |
| Δlog(Per Capita Income) | | 0.064 |
| | | (0.018)*** |
| Construction Unionization Rate | | 0.100 |
| | | (0.046)** |
| Regional FE | Yes | Yes |
| Observations | 266 | 266 |

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

## TABLE 7

Short/Medium Run Supply Elasticity (Available Metro Areas with Pop>500,000)

| Rank | MSA Code | MSA/NECMA Name | Supply Elasticity | Rank | MSA Code | MSA/NECMA Name | Supply Elasticity |
|---|---|---|---|---|---|---|---|
| **1** | 4480 | Los Angeles-Long Beach, CA | 0.57 | **49** | 1440 | Charleston-North Charleston, SC | 1.38 |
| **2** | 5000 | Miami, FL | 0.57 | **50** | 3840 | Knoxville, TN | 1.42 |
| **3** | 7360 | San Francisco, CA | 0.59 | **51** | 2320 | El Paso, TX | 1.42 |
| **4** | 5600 | New York, NY | 0.64 | **52** | 160 | Albany-Schenectady-Troy, NY | 1.45 |
| **5** | 1123 | Boston-Worcester-Lawrence, MA-NH | 0.65 | **53** | 9160 | Wilmington-Newark, DE-MD | 1.48 |
| **6** | 5775 | Oakland, CA | 0.66 | **54** | 1280 | Buffalo-Niagara Falls, NY | 1.49 |
| **7** | 7320 | San Diego, CA | 0.68 | **55** | 6640 | Raleigh-Durham-Chapel Hill, NC | 1.50 |
| **8** | 2680 | Fort Lauderdale, FL | 0.71 | **56** | 8120 | Stockton-Lodi, CA | 1.53 |
| **9** | 8735 | Ventura, CA | 0.73 | **57** | 240 | Allentown-Bethlehem-Easton, PA | 1.54 |
| **10** | 1600 | Chicago, IL | 0.73 | **58** | 200 | Albuquerque, NM | 1.58 |
| **11** | 7400 | San Jose, CA | 0.75 | **59** | 2960 | Gary, IN | 1.59 |
| **12** | 7600 | Seattle-Bellevue-Everett, WA | 0.78 | **60** | 440 | Ann Arbor, MI | 1.70 |
| **13** | 5720 | Norfolk-Virginia Beach-Newport News, VA-NC | 0.78 | **61** | 1000 | Birmingham, AL | 1.79 |
| **14** | 5560 | New Orleans, LA | 0.83 | **62** | 4120 | Las Vegas, NV-AZ | 1.82 |
| **15** | 7160 | Salt Lake City-Ogden, UT | 0.86 | **63** | 760 | Baton Rouge, LA | 1.86 |
| **16** | 720 | Baltimore, MD | 0.86 | **64** | 1840 | Columbus, OH | 1.88 |
| **17** | 5483 | New Haven-Bridgprt-Stamfrd-Danbry-Wtrbry, CT | 0.86 | **65** | 1920 | Dallas, TX | 1.88 |
| **18** | 5080 | Milwaukee-Waukesha, WI | 0.86 | **66** | 80 | Akron, OH | 1.90 |
| **19** | 1680 | Cleveland-Lorain-Elyria, OH | 0.90 | **67** | 3000 | Grand Rapids-Muskegon-Holland, MI | 1.93 |
| **20** | 5640 | Newark, NJ | 0.92 | **68** | 8400 | Toledo, OH | 1.93 |
| **21** | 6780 | Riverside-San Bernardino, CA | 0.92 | **69** | 520 | Atlanta, GA | 1.94 |
| **22** | 8200 | Tacoma, WA | 0.96 | **70** | 8160 | Syracuse, NY | 1.97 |
| **23** | 6483 | Providence-Warwick-Pawtucket, RI | 0.97 | **71** | 3360 | Houston, TX | 2.01 |
| **24** | 8960 | West Palm Beach-Boca Raton, FL | 0.99 | **72** | 4520 | Louisville, KY-IN | 2.02 |
| **25** | 6280 | Pittsburgh, PA | 0.99 | **73** | 5360 | Nashville, TN | 2.03 |
| **26** | 7510 | Sarasota-Bradenton, FL | 0.99 | **74** | 7040 | St. Louis, MO-IL | 2.10 |
| **27** | 6440 | Portland-Vancouver, OR-WA | 1.01 | **75** | 9320 | Youngstown-Warren, OH | 2.12 |
| **28** | 8520 | Tucson, AZ | 1.03 | **76** | 1640 | Cincinnati, OH-KY-IN | 2.15 |
| **29** | 8280 | Tampa-St. Petersburg-Clearwater, FL | 1.03 | **77** | 5160 | Mobile, AL | 2.16 |
| **30** | 2160 | Detroit, MI | 1.04 | **78** | 6760 | Richmond-Petersburg, VA | 2.19 |
| **31** | 8720 | Vallejo-Fairfield-Napa, CA | 1.06 | **79** | 7240 | San Antonio, TX | 2.26 |
| **32** | 3600 | Jacksonville, FL | 1.06 | **80** | 2800 | Fort Worth-Arlington, TX | 2.27 |
| **33** | 6160 | Philadelphia, PA-NJ | 1.10 | **81** | 3120 | Greensboro-Winston-Salem-High Point, NC | 2.39 |
| **34** | 5960 | Orlando, FL | 1.15 | **82** | 640 | Austin-San Marcos, TX | 2.41 |
| **35** | 8003 | Springfield, MA | 1.16 | **83** | 1760 | Columbia, SC | 2.57 |
| **36** | 3640 | Jersey City, NJ | 1.16 | **84** | 5880 | Oklahoma City, OK | 2.58 |
| **37** | 4920 | Memphis, TN-AR-MS | 1.17 | **85** | 1520 | Charlotte-Gastonia-Rock Hill, NC-SC | 2.59 |
| **38** | 2080 | Denver, CO | 1.18 | **86** | 3160 | Greenville-Spartanburg-Anderson, SC | 2.70 |
| **39** | 5120 | Minneapolis-St. Paul, MN-WI | 1.18 | **87** | 4400 | Little Rock-North Little Rock, AR | 2.73 |
| **40** | 3283 | Hartford, CT | 1.19 | **88** | 4880 | McAllen-Edinburg-Mission, TX | 2.81 |
| **41** | 6840 | Rochester, NY | 1.20 | **89** | 3760 | Kansas City, MO-KS | 2.82 |
| **42** | 3240 | Harrisburg-Lebanon-Carlisle, PA | 1.27 | **90** | 5920 | Omaha, NE-IA | 2.83 |
| **43** | 8840 | Washington, DC-MD-VA-WV | 1.28 | **91** | 2000 | Dayton-Springfield, OH | 2.91 |
| **44** | 6200 | Phoenix-Mesa, AZ | 1.29 | **92** | 8560 | Tulsa, OK | 3.02 |
| **45** | 2840 | Fresno, CA | 1.31 | **93** | 3480 | Indianapolis, IN | 3.36 |
| **46** | 1720 | Colorado Springs, CO | 1.31 | **94** | 2760 | Fort Wayne, IN | 5.13 |
| **47** | 680 | Bakersfield, CA | 1.34 | **95** | 9040 | Wichita, KS | 5.16 |
| **48** | 7560 | Scranton-Wilkes-Barre-Hazleton, PA | 1.34 | | | | |

# Appendix Table 1

*Descriptive Statistics*

| | Mean | Standard Dev. |
|---|---|---|
| Log Density in 1950 | 4.713 | 1.125 |
| Log Average Distance to Historic Place | 0.874 | 0.458 |
| Unavailable Land, 50 km Radius | 0.262 | 0.210 |
| African-American Share in 1970 | 0.097 | 0.100 |
| Share with Bachelors Degree in 1970 | 0.111 | 0.042 |
| Share foreign born in 1970 | 0.033 | 0.032 |
| Log Coefficient of Variation of Income: Places | -1.864 | 0.599 |
| Log Coefficient of Variation of Income: Tracts | -1.182 | 0.340 |
| 68-71 MSA Dissimilarity White/Black | 74.723 | 13.282 |
| 68-71 MSA School Dissimilarity White/Hispanic | 65.791 | 15.959 |
| Percentage Catholic, 1971 | 0.361 | 0.238 |
| % Voting for Democratic Candidate, 1980 (Carter) | 0.439 | 0.108 |
| Log non-Profit Organization Density | -7.368 | 0.679 |
| Vote for President in 1988/Total Elegible Population | 49.767 | 7.639 |
| Census Mail Response Rates 1990 | 67.030 | 6.879 |
| Log (Local Tax Revenues/Income Capita) in 1982 | -3.325 | 0.385 |
| Construction Unionization Rate 1986-2000 | 0.204 | 0.142 |
| Midwest | 0.264 | 0.442 |
| South | 0.383 | 0.487 |
| West | 0.201 | 0.401 |

# Data Appendix

## 1. Data sources

| Variable | Source | Notes |
|---|---|---|
| Land Unavailability | Calculated by author from elevation and land use GIS data from USGS | See Data section in text |
| Regulation Index (WRLURI) | Gyourko, Saiz, Summers (2007) | See Data section in text |
| Average Distance to Historic Place | Calculated by author from National Register of Historic Places, National Park Service (NPS) | We first calculate the distance from each census block group centroid to the closest historic place using the coordinates and the haversine formula. We then average across block groups within the metropolitan area. |
| Declining Metro Area: 1950-1970 | Calculated by author from data in Historical Census Browser – University of Virginia | We calculate population growth rates for the metropolitan areas (as defined by the county MSA-NECMA definitions in 2000), and create a dummy that takes value 1 if growth is in the lowest quartile of the metro areas in our sample. |
| Log Density (1950) | Historical Census Browser – University of Virginia | Adds county data using 2000 MSA-NECMA definitions |
| MSA Area | HUD State of the Cities Database (originally from Census) | |
| Black Share (1970) | HUD State of the Cities Database (originally from Census) | |
| BA/BS share (1970) | HUD State of the Cities Database (originally from Census) | |
| Foreign-Born Share (1970) | HUD State of the Cities Database (originally from | |

| | | |
|---|---|---|
| | Census) | |
| Immigration Shock | HUD State of the Cities Database (originally from Census) | The variable is defined as the difference in the number of foreign-born individuals between 1970 and 2000, divided by metro area population in 1970 |
| Share workers in manufacturing 1970 | HUD State of the Cities Database (originally from Census) | |
| Median Housing price (1970,2000) | HUD State of the Cities Database (originally from Census) | |
| Number of Hosing Units (1970,2000) | HUD State of the Cities Database (originally from Census) | |
| Coefficient of Variation of Income (census tracts and places - 1970) | Calculated by author using Neighborhood Change Database (Geolytics Inc) – Originally from 1970 Census files | Calculated as the standard deviation of household income across areas divided by the mean income. |
| 68-71 Dissimilarity Indexes | American Communities Project - Brown university | |
| Percentage Catholic, 1971 | Churches and Church membership in the United States, 1971 – The Association of Religion data Archives | Calculated as the total number of Catholic Church adherents over total number of adherents to any Christian denomination |
| % Voting for Carter (1980) | County and City data Book 1983 | % of voters casting votes for Democratic presidential candidate (Carter in 1980) |
| Non-profit Organization Density | Rupasingha, Goetz, and Freshwater (2006) | Total number of charities, religious, civic, professional, and other non-profit organizations divided by population |
| Voter Participation Rate 1988 | Rupasingha, Goetz, and Freshwater (2006) | |
| Census Mail Response Rates | Rupasingha, Goetz, and Freshwater (2006) | |

| | | |
|---|---|---|
| Local Tax Revenues in 1982 | Census of Governments 1982 | Data were obtained aggregated at the county level (all local governments in each county). 2000 county-based metropolitan definitions were used to aggregate at the metro level. |
| Corruption at city Level | Saiz and Simonsohn (2007) | The measure is derived from the frequency of webpages containing the word "corruption" in textual proximity to the name of each city. Saiz and Simonsoh (2007) show this approach to work well to proxy for corruption at the World and US State level and for other demographic variables at the city level. |
| Unionization in the construction sector (1986-2000) | Saiz and Gyourko (2006), calculated from the Current Population Surveys (1986-2000) | Metropolitan samples of construction workers are typically small, so we add 15 years in order to obtain reliable averages over the period. Unionization rates calculated as workers in union divided by total number of workers. Data are matched to closest MSA definition (matches at the county level are not possible). |
| Unionization rates (1986-2000) | Saiz and Gyourko (2007), calculated from the Current Population Surveys (1986-2000) | Same as above |
| Coastal Metro Area Dummy | Rappaport and Saks (2003) | Rappaport and Saks provide data by county. We use the distance of the metropolitan county closest to the ocean, and create a dummy that takes value one if the minimum distance in a MSA is below 100 km. |
| January Monthly Hours of Sun (Average 1941-1970) | Natural Amenities Scale – USDA Economic Research Service | |
| Construction Costs (Single | Gyourko and Saiz (2006) – | |

| | | |
|---|---|---|
| Family, Average Quality) | Originally from Means and Co. | |
| Housing Price Repeat Sales Index | Freddie Mac purchase-only Conventional Mortgage Home Price Index | |
| Central City Areas 1970, 2000 | County and City Data Books 1972, 2002 | |

## 2. National Land Cover Dataset

The classification of land uses in the USGS NLCD is as follows.

1 Water
2 Perennial Ice Snow
3 Low Intensity Residential
4 High Intensity Residential
5 Commercial/Industrial/Transportation
6 Bare Rock/Sand
7 Quarries/ Mines
8 Transitional
9 Deciduous Forest
10 Evergreen Forest
11 Mixed Forest
12 Shrubland
13 Orchards/ Vineyard
14 Grasslands/Herbaceous
15 Pasture/Hay
16 Row Crops
17 Small Grains
18 Fallow
19 Urban/Recreational Grasses
20 Woody Wetlands
21 Emergent/Herbaceous Wetlands

We define the share of a 50/10 km radiuses "available" ex ante for development as one minus steep-slope (as calculated by the author) and water shares (numbers 1, 23, and 21 in the previous list) conditional of not being in an ocean, multiplied by the share of the radius outside an ocean/Great Lake. Note that the definition reasonably assumes that major bodies of water are not in areas with slopes above 15%.

## 3. Construction Cost and Land Shares

In order to obtain the initial structure's share we rely on the calculations of Davis and Heathcote (2006). These authors calculate the average share of land for residential real estate in the US to be 20%. Davis and Palumbo (2008) calculate the unweighted mean share of land *across metropolitan areas* to be 32% in 1984 (the first year for which their metropolitan data series is available), and a very similar number (36%) at the national level. We therefore adapt an unweighted average 20% land share *across metropolitan areas* in 1970, and therefore an 80% structure share. We then calculate differences in the structure cost/value ratio by dividing the average construction cost in 1970 for a 2,000 sq. ft. home (the average home size) by the median home value in each metro area. The final metropolitan-level estimate of structural shares in 1970 ($\alpha_{it-1}$) is proportional to the aforementioned ratio, and such that its unweighted mean across metro areas is 80%. Note that the estimates in Davis and Heathcote (2006) take into account the depreciation of structural capital.

Both construction costs and construction unionization rates are imputed using state metropolitan averages in the few cases where these variables are missing.