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Owners of Developed Land Versus Owners of Undeveloped Land: Why Land Use is More Constrained in the Bay Area than in Pittsburgh

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Abstract

We model residential land use constraints as the outcome of a political economy game between owners of developed and owners of undeveloped land. Land use constraints are interpreted as shadow taxes that increase the land rent of already developed plots and reduce the amount of new housing developments. In general equilibrium, locations with nicer amenities are more developed and, as a consequence, more regulated. We test our model predictions by geographically matching amenity, land use, and historical Census data to metropolitan area level survey data on regulatory restrictiveness. Following the predictions of the model, we use amenities as instrumental variables and demonstrate that metropolitan areas with better amenities are more developed and more tightly regulated than other areas. Consistent with theory, metropolitan areas that are more regulated also grow more slowly.

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1. Introduction

The question what the causes of land use regulation are and why some locations are more tightly regulated than others is an economically important one. According to the conservative estimates by Glaeser, Gyuorko and Saks (2005a), the ‘regulatory (shadow) tax’ on land use is probably the most important tax levied in ‘desirable’ locations after the income tax.[1] For example, the regulatory tax is estimated to explain more than 50 percent of house prices in Manhattan or San Francisco, two of the arguably most desirable cities in the United States. Interestingly, San Francisco and New York City are not only among the most tightly regulated cities in the United States, they were also the first metro areas to introduce rudimentary and later comprehensive zoning laws.[2] More generally, larger – and arguably more ‘desirable’ cities – were more likely to be zoned in the early days of land use regulation. In 1930, about 88 percent of cities with a population over 100,000 were zoned but only about 26 percent of cities with less than 25,000 inhabitants had some form of land use constraint (McKenzie 1933, p. 300).

In this paper we provide a novel explanation for why ‘more desirable’ places have introduced more restrictive land use controls. We postulate that land use constraints are the outcome of a political economy game between owners of developed land – who have an interest in tight regulation – and owners of undeveloped land – who prefer flexible zoning laws and lax regulations.[3] Importantly, there are no externalities in our model beyond congestion costs.[4] In our parsimonious model local planning boards impose a local ‘regulatory tax’, which does not generate any tax revenue; rather, it is a shadow tax that is due to regulations applying to the

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[1] In the terminology used in this paper a location is desirable if it is well endowed with natural amenities, such as hours of sunshine or access to coast line, and/or economic amenities, such as good urban transportation infrastructure.

[2] The first zoning ordinance is attributed to the city of San Francisco, which passed a zoning law in the 1880s to ban laundries – and implicitly the Chinese population – from certain neighborhoods. By many accounts New York City’s 1916 ordinance is considered the first comprehensive law, in that it divided the entire area of the city into zones. See Fischel (2004) for a survey on the ‘economic history’ of land use regulation.

[3] Owners of developed land (property owners) can be either ‘homeowners’ who rent the property to themselves or ‘landlords’ who rent the property to ‘tenants’. Owners of undeveloped land can be thought of as land developers or farmers.

[4] In many metro areas environmentalists fight further developments in cities by arguing that such developments cause negative externalities. In reality, it is difficult to distinguish between a genuine pre-occupation for the environment from a pretext building on an entirely different motivation. In the empirical analysis below we find strong support for our proposition that planning decisions are the outcome of a political economy game between owners of developed and owners of undeveloped land. However, we find no evidence for the proposition that the planning boards’ decisions are the consequence of negative externalities imposed by high population density in urbanized areas.

conversion of undeveloped land into developed land, in a way similar to those unveiled in the empirical study by Glaeser, Gyourko and Saks (2005a). In general equilibrium, we show that a planning board – which maximizes aggregated land rents – will choose a high regulatory tax if the location is already highly developed (i.e., owners of developed land are relatively more influential) but will choose a low tax if the location is little developed (i.e., if owners of undeveloped land have a greater influence on planning decisions).[5] The not-so-implicit assumption here is that regulatory taxes that apply to new developments are fully or almost fully capitalized into house and land prices of existing ones; Oates (1969) and numerous follow-up studies (e.g., Rosen 1982 and Palmon and Smith 1998) provide empirical evidence that support the full capitalization hypothesis for urbanized areas.

Our stylized model generates several empirically testable predictions. To start with, *locations with better amenities should be more developed* and, *as a consequence*, *be more tightly regulated*. Moreover, if one interprets proximity to the Central Business District (CBD) as a positive amenity, our model also predicts that the *restrictiveness should decrease with increasing distance to the CBD*.

Interestingly, these predictions are perfectly consistent with the empirical evidence provided by Glaeser, Gyourko and Saks (2005a) who estimate the cost of land use regulation for various locations and property markets in the United States. That is, the authors find the highest 'regulatory taxes' in the arguable most desirable locations in the United States, namely, Manhattan, the Bay Area (San Francisco, San Jose and Oakland) and Los Angeles. At the same time, they find no evidence for a regulatory tax in places such as Pittsburgh or Detroit. Moreover, while Glaeser, Gyourko and Saks (2005a) find a very high 'regulatory tax' (exceeding construction costs since 2001) for Manhattan condominiums, the estimated tax is much lower for the entire New York metropolitan area (12.2% of house values). The authors conjecture that the 'regulatory tax' may be lower in suburban areas outside Manhattan. Consistent with this conjecture is the observation by Fischel (2004) that the origins of land use regulation are within larger cities but that zoning then spreads quickly to the suburbs and towns surrounding the cities. The most direct piece of evidence that the timing and

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[5] The objective function of the planning board is consistent with a 'menu auction' lobbying model à la Grossman and Helpman (1994), as we explain later. In Appendix B, we generalize the objective function to take into account the wishes of the different categories of agents. This objective function can be micro-founded by a combination of a probabilistic voting model and a menu auction lobbying model.

restrictiveness of zoning is tied to the distance from the central city comes from Rudel (1989, p. 135) who shows – using disaggregated municipal level data for Connecticut – that the municipalities adopted land-use laws later if they lived at a greater distance to New York City. Moreover, controlling for distance, the greater the share of farmland in those municipalities the later they adopted land use laws. Finally, in a separate regression Rudel investigates the relationship between changes in land use laws and changes in the farming population. He finds "that increases in the degree of restriction occurred in those communities which experienced large declines in the number of farmers during the 1960s". All three observations are perfectly consistent with our theoretical framework.

When trying to explain the causes of land use regulation, one popular hypothesis is the so-called 'homevoter hypothesis' (Fischel 2001 and 2003). The homevoter hypothesis suggests that homeowners have an incentive to protect their house values and that they therefore vote for restrictive zoning measures. There is plenty of anecdotic evidence that suggests that homeowners indeed support land use restrictions. Paradoxically, however, MSA homeownership rates are strongly negatively related to regulatory restrictiveness. We offer a simple explanation for this phenomenon that is articulated around the heterogeneity of tenancy durations among the different classes of agents and Olson's (1971) view that small groups of agents with high stakes benefit most from collective action.

Usually, landlords are a small fraction of the population and some of them own a large number of properties. This suggests that this small group with high stakes should find it very much beneficial to overcome the organizational costs and seek to influence the planning boards to impose high regulatory taxes by other means than voting (Olson 1971). The group of homeowners is much larger; in addition, their incentives to support more restrictive regulations are weaker than those of landlords. The intuition for this result runs as follows: the key difference between landlords and homeowners is that the latter have a double, schizophrenic identity: homeowners are simultaneously landlords (as such they favor more regulation) and tenants (as such they oppose more regulation). Since, on average, they expect to sell their house in their lifetime, they favor more regulation on balance but less so than landlords. Finally, similar to the group of owners of undeveloped land, the group of tenants prefers a low regulatory tax. However, tenants are numerous, tend to be weakly organized and their duration in the property tends to be relatively short, hence their opposition against land use regulation measures is weak.[6]

Overall, these considerations have a subtle implication: while homeowners favor land use restrictions, the homeownership *rate* should have a *negative* impact on land use restrictions, as in Brueckner and Lai (1996). This is because a larger fraction of homeowners is matched with a smaller fraction of landlords (and tenants). We make this point formally in Appendix B. To keep the core of the analysis simple and short, we do not incorporate the role of the homeownership rate in the core theory section of the paper.

It is important to note that the 'homevoter hypothesis' is not per se inconsistent with our results but our theoretical framework suggests it is incomplete insofar as it ignores that buildings occupied by tenants are also owned by somebody—landlords. Actually, the data strongly suggest that this 'landlord effect' dominates the 'homevoter effect'. To get a foretaste of this result, turn to Table 1 on page 42. This table reports the 'regulatory tax' measure by Glaeser, Gyourko and Saks (2005a) for 21 metropolitan areas and the corresponding homeownership rates for these locations. The correlation between the 'regulatory tax' measure and the metropolitan area-level homeownership rate is very strongly negative, with -0.55. The rank correlation is even more strongly negative, with -0.63.[7] The metro areas with the highest 'regulatory taxes' (Manhattan, San Francisco, San Jose, Los Angeles and Oakland) have among the lowest homeownership rates in the United States (see again Table 1 for precise numbers) and while we do not have direct estimates of the magnitude of regulatory taxes in suburbs, we suspect that the correlation between the regulatory tax and the homeownership rate is similarly negative *within* metro areas.[8] Obviously, these stylized facts imply that the 'homevoter' effect alone cannot explain why places such as Manhattan or Los Angeles are so tightly regulated and why regulatory constraints are highest in the central cities of metro areas.

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[6] If tenants are very numerous they can succeed in imposing rent control measures via a voting mechanism. Rent control measures typically imply lower rents and a longer expected duration in the property. One side effect of rent control is that it reduces the amount of available properties on the local market and thereby increases property values of surrounding properties. The effect is similar to that of a regulatory tax although the mechanism is a different one.

[7] The correlation coefficients are similar when we use an alternative measure of regulatory restrictiveness, the regulatory index developed by Saks (2005) – described in more detail in Section 4.1. The correlation is -0.69, while the rank correlation is -0.52.

[8] Homeownership rates are generally lower in central cities compared to its suburbs. This is mainly because central locations have a greater share of multiunit buildings with greater landlord production efficiency (Linneman 1985) and because their neighborhoods tend to be more risky (Hilber 2005).

Table 1 also reports the percentage of developed land in the 21 metro areas. The 'percentage developed land' is defined as developed (residential plus industrial) land in percent of all developable land.[9] Interestingly, here the correlations between the two reported measures of regulatory restrictiveness, on the one hand, and the percentage developed land in the metro areas, on the other one, are quite positive (+0.48 and +0.33, with the rank correlations being: +0.34 and +0.36).[10] The core of the paper focuses on this positive link between the extent of land development and the tightness of regulatory constraints. That is, it provides an explanation for why land scarcity and regulatory restrictiveness are so strongly positively related.

Before we proceed, let us stress that the main claim in our paper is that percentage developed land is causal to the regulatory tax. We also want to control for the homeownership rate because a strict interpretation of the 'homevoter hypothesis' suggests that MSAs with a higher homeownership rate should be more regulated. Actually, our regressions reject this hypothesis: in all specifications in which the homeownership rate is treated as an exogenous variable, it is negative and significant at the five percent level. We also report specifications in which we have instrumented the homeownership rate; the effect remains strongly negative and statistically highly significant. The effect is remarkably robust to alterations in the specification. To summarize, our hypothesis that more desirable and, consequently, more developed locations (with a greater share of owners of developed land and a smaller share of owners of undeveloped land) are more tightly regulated receives much stronger support in the data than the alternative explanation usually put forward.

The rest of our paper is structured as follows. In Section 2 we review the related theoretical and empirical literatures. In Section 3 we develop a simple stylized model that captures the main aspects in which we are interested. The model is static in nature, but we rely on a dynamic heuristic to provide intuition. In Section 4 we test the various predictions of the model by combining various data sources and by geographically matching the data to the Metropolitan Statistical Area (MSA)-level. Specifically, we demonstrate that local amenities indeed affect the degree of land development and, in turn, the degree of regulatory constraints.

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[9] Developable land is defined as all land except water, ice, barren, wetland and shrubland.

[10] If one were also to consider 'forested upland – evergreen' as 'non-developable', then these positive correlations are even stronger.

We also provide evidence for a number of additional – more subtle – predictions derived from theory. Finally we conclude in Section 5 with a discussion of results and policy implications.

2. Related Literature

Both the theoretical and the empirical sections of this paper stand on the shoulders of a well developed literature. Here, we select a subset of the papers most closely related to ours; the reader should refer to Duranton (1997), Fischel (1985, 2001), Lecat (2006) and Pogodzinski and Sass (1991) for more exhaustive surveys. On the theoretical side, we postulate that land use constraints are determined through a local political economy game and that the regulatory (shadow) tax that is the outcome of this game is being capitalized into land prices (Fischel 1990b). Specifically, we do not touch upon the issue of the desirability of land use constraints and we take the Public Choice view that land use restrictions do not maximize social welfare but, rather, are the outcome of a political game between rational, selfish agents (e.g. Bailey 1959, Brueckner 1990, Fischel 1990a, Mills 1989, Pogodzinski and Sass 1994). Also, as in Brueckner (1995, 1998) or Helsey and Strange (1995), local jurisdictions interact strategically.

In the wake of this literature, Glaeser, Gyourko and Saks (2005b) develop a political economy model of zoning determination in which the political game is a struggle between homeowners and developers. Interestingly, many aspects of their model are like a reduced form of ours. A key difference between their theoretical setting and ours is that the homeownership rate and the organizational skills of homeowners play an opposite role in our model; indeed, the extension of our model in the appendix identifies a new effect of homeownership that, empirically, seems to overwhelm the Glaeser et al. (2005b) effect; see also Brueckner and Lai (1996). Rather, in our model the equilibrium regulatory tax and the percentage of developed land balances the interests of the owners of developed land (who demand more regulation) with those of the owners of undeveloped land (who demand less of it). The more desirable is a locale, the more numerous is its potential population and, as a result, the more regulated is its land use.

Brueckner and Lai (1996) focus on the distinction between absentee landowners and resident landowners. Our theoretical approach is consistent with their view and is supported by the data. In addition, in the wake of Brueckner and Joo (1991), our model features some agents (tenants in our model) who are imperfectly mobile and this plays some role in the political economy game; this imperfect mobility is caused by heterogeneous preferences on local amenities, as in Brueckner, Thisse and Zenou (1999).

Our model is static but our heuristic is dynamic; Epple, Romer and Filimon (1988) develop a dynamic (two-period) model in which early arrivals control policy and, as a result, newcomers pay a disproportionate share of publicly provided local services and infrastructure (see also Fischel 1990a and 2000). The focus of their model is the boundaries of local communities (which are thus endogenous in their model); by contrast, we treat such boundaries as exogenous. We feel at ease with this simplifying assumption because, in practice, the boundaries of local jurisdictions in the US change very rarely (by contrast, gerrymandering frequently re-shapes the boundaries of the districts for the House of Representative).

Our model is also consistent with Fischel's (2000) view that suburbanization is a phenomenon that is anterior to zoning restrictions; in our model, there is even a causal relationship from the former phenomenon to the latter. Also, Fischel (1992) stresses that land use restrictions are the local jurisdictions' policy instrument *par excellence* in the sense that zoning is perhaps the 'least limitable' of all government powers.

Our empirical work is also rooted in a well-established tradition; see e.g. Fischel (1990b) and Pogodzinski and Sass (1991) for surveys. Cheshire and Sheppard (2002), Cheshire and Hilber (2006) and Glaeser, Gyourko and Saks (2005b) estimate the cost of regulation in various urban locales, each working on a small but extremely detailed sample (respectively Reading, UK, London, UK, and Manhattan, US); in all cases, the 'shadow tax' on new development is very large. Accordingly, we model land use constraints as a shadow tax (namely, a tax that generates no revenue but has the usual distributive effects of taxes). Gyourko, Mayer and Sinai (2006) attribute the rising trend in house prices in desirable cities like San Francisco jointly to the rise in demand (increasingly, people at the top end of income and wealth distributions move to such locations and, as is well known, the income distribution in the US has become ever more unequal in a ‘fractal’ manner) and to highly restrictive land use constraints (strikingly, despite the surge in demand the *number* of residential units has not increased in downtown San Francisco). Consistent with such evidence, an implication of our model is that when population grows (which is equivalent to a growth in incomes if housing is a normal good) desirable communities become more regulated than average *and* their population rises more slowly than average. We specifically test this additional implication of the model and our data do not reject it.

Another important paper for ours is the piece due to Burchfield, Overman, Puga and Turner (2006). There, using a fine grid of high altitude photographs from 1976 and satellite pictures from 1992 (we merge the latter in our empirical section with a couple of other original databases), they show that residential development in 1992 was no more scattered than in 1976, namely, urban sprawl has not increased over this time period. In other words, expanding local communities built new developments that did not leapfrog previously open space: “the new city is just like an enlarged version of the old city”. The version of the monocentric city model that we introduce in our theoretical section is consistent with this stylized fact. Also, they find that cities with better natural amenities sprawl more than others – likely because of minimum lot size restrictions that reduce the capital-to-land ratio. In the model, we attribute this phenomenon to endogenous land use constraints; remarkably, our empirical results are consistent with this theoretical prediction: we find that locations with better amenities are more regulated.

Finally, our political economy model postulates that locations with little available land for future development are more tightly regulated implying – in a dynamic setting – a lower elasticity of new housing supply and a greater extent of land/house price capitalization. Consistent with this view, Hilber and Mayer (2004) provide evidence that local jurisdictions in Massachusetts with less developable land indeed have more inelastic supply of new housing and a greater extent of house price capitalization. Similarly, Hilber (2006) finds that homeowners’ investments in neighborhood specific social capital are much greater in places with little open land for further development, plausibly because social capital investments are less diluted in more built-up and more tightly regulated places with inelastic supply of new housing. All these findings are consistent with the view held in our paper that local land scarcity is tied to land use restrictiveness.

3. Model

In this section we develop a parsimonious model that, despite the simplicity of its structure, captures all the aspects we are interested in; specifically, we explicitly model only two locations and one period. The stylized facts that are intrinsically dynamic are matched in the model by a standard comparative statics exercise; since our empirical work is cross-sectional anyway, we feel entitled not to complicate the model unduly by adding a specific dynamic dimension to it.

3.1 Assumptions and basic structure

There are two jurisdictions, indexed by j=1,2. We give two distinct interpretations of the 'jurisdictions': at the largest spatial scale, the jurisdictions will be *metropolitan areas*; alternatively, the spatial units can be interpreted as *local municipalities*.[11] For the sake of clarity, in this theoretical section we are mostly using the former interpretation and we stress in footnotes how to change the model to give it the alternative interpretation.

We start with a brief overview of the game, describing the timing and the set of players. There are two jurisdictions j=1,2. The timing is as follows:

1. Jurisdictions set their land use regulatory tax T_j simultaneously and non-cooperatively. These taxes apply to new developments but not to existing ones.
2. Households choose between jurisdictions j=1,2.
3. Households choose a specific plot h and pay a rent to the plot's landowner.

The game will be solved backwards; we now introduce each set of players and their action sets in turn.

Each jurisdiction is similar to a 'monocentric city' in the sense that each jurisdiction has a center (a CBD in the case of metropolitan areas or, for example, a train station in the case of local jurisdictions) that minimizes commuting cost. Each jurisdiction has a population of

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[11] In the United States, planning decisions are mainly made at the local municipality level. Despite this fact, surveys on the restrictiveness of land use regulations are typically conducted at the metropolitan area level, arguably because the tightness of regulation is strongly positively correlated within metro areas. We interpret the metropolitan area level measures of restrictiveness (from empirical surveys) as the weighted average tightness of local land use regulations.

tenants N_j to be determined in subsection 0 (we abuse notation and use N_j to denote both the number (mass) and the set of people living in j).

To simplify our analysis we assume that land is owned by absentee landlords. However, it is important to note that our static analysis below is qualitatively—and much of it also quantitatively—unaltered as long as the fraction of the occupiers that actually own the house in which they live is lower than unity. We set it to zero for convenience. In the dynamic extension of the model we propose in the appendix, the homeownership rate *does* matter.

People commute to work at the CBD; each household is made of one person and consumes one unit of housing; each housing unit in turn requires one unit of land; the (marginal) cost of converting undeveloped land into a housing unit does not play any role in our analysis and hence it is normalized to zero. Each jurisdiction is embodied with a three-dimensional set of variables denoted by $\{w_j,\tau_j,T_j\}$; we refer to the subset $\{w_j,\tau_j\}$ as 'economic amenities' (these variables are exogenous in the model): w_j parameterizes the *location-specific* component of the yearly wage households earn at the CBD, τ_j parameterizes the per unit distance annual commuting cost to the CBD; with these definitions, a jurisdiction with a high w_j and/or a low τ_j is said to be embodied with favorable economic amenities (for instance, locations with large population densities pay higher wages, suggestive of agglomeration economies).[12] Finally, T_j is a 'regulatory tax' chosen by the executive branch of the jurisdiction.

Households are indexed by H and have a set of attributes $H=\{h,\nu\}$ where h is the distance from H's home to the local CBD (to be determined at equilibrium); as a result of its location choices, household H incurs an annual monetary cost of commuting towards the CBD that is equal to $\tau_j h$,; the attribute ν, which will be introduced shortly, is orthogonal to h and not observable by the researcher; therefore, each household can be uniquely identified by its attribute h (we sometimes explicitly add the component ν to avoid confusions). Thus, for implicity we use h to denote both the household itself and its location. Figure 1 (left panel) on page 37 illustrates this case.[13]

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[12] A widespread view that we share is that the main economic reason for cities to exist is that denser or more populated areas generate positive externalities (Ciccone and Hall 1996), namely, $\partial w_j/\partial N_j \geq 0$). However, we assume that w_j is independent of N_j to get more streamlined results; allowing for such externalities would reinforce some of our results while leaving others unaffected.

[13] We can also interpret jurisdictions as local municipalities in which households reside only. Figure 1 (right panel) illustrates this case. People earn a wage w, determined at the MSA level; commute from the jurisdiction's

In the current context, it is useful to think of households as tenants; as usual in the monocentric city model, (absentee) landowners allocate each unit of land to the highest bidder; each landowner is atomistic, hence landowners are perfectly competitive. Under these assumptions, household h enjoys the following 'economic' wellbeing $u_j(h)$:

(1) $$u_j(h) = w_j - T_j - \tau_j h - R_j(h), \qquad j = 1,2$$

where T_j is a per capita tax to be determined later on and $R_j(h)$ is the rent paid by the individual tenant living at distance h from location j's CBD.

3.2 Within-Jurisdiction Equilibrium (WJE)

Once households have chosen a jurisdiction to live in, they need to be allocated within the jurisdiction. At this stage of the game, the players (landowners and households) take N_j and T_j as given. We introduce the following definition:

> **Definition 1: <u>Within-Jurisdiction Equilibrium (WJE)</u>. In a WJE, land is allocated to the highest bidder and no household has any incentive to move to another location in the jurisdiction.**

This structure yields the well known outcome:

> **Proposition 1: (Within-Jurisdiction Equilibrium). At the WJE equilibrium, the length of the monocentric jurisdiction is N_j (any plot of land located between any two developed plots of land is also developed). Furthermore, household h pays annual rent $R_j(h) = \tau_j(h - N_j)$, $\forall h \le N_j$. Finally, all households residing in j enjoy the same level of economic wellbeing:**

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boundaries or local subway station to the MSA's CBD, which is located at a distance δj away; incur a annual monetary cost of doing so of δjτ (where τ is the per unit distance commuting cost); 'commute' to j's local public good (a school, park or subway station) at a cost τjh. Defining wj as w-δjτ, then the expressions in the text also apply to this alternative interpretation of the model.

(2) WJE: $\forall h \in N_j: \quad u_j(h) = w_j - T_j - \tau_j N_j \equiv u_j(N_j, T_j)$

Proof. To be indifferent, households h^0 and h' must enjoy the same economic wellbeing, i.e. $u_j(h^0)=u_j(h')=u_j$, all $h^0, h' \in N_j$. This implies $R_j(h^0)+\tau_j h^0= R_j(h')+\tau_j h'$, thus land units closest to the CBD generate the highest rents: households trade off lower commuting costs for higher rents. Landowners being perfectly competitive, it must be that (1) there is no unoccupied piece of land in the midst of developed land units (formally, it is straightforward to show that if some unit h' is allocated to a household, then all h<h' are allocated, too), thus the horizontal size of city/jurisdiction j is equal to N_j. (2) It must be the case that at the city fringe the rent is zero (the alternative use of land is normalized to zero), thus $R(N_j)=0$. Together, the two expressions derived in the text imply $R_j(h)+\tau_j h= \tau_j N_j$; substituting into (1) yields the results. *QED.*

The result in (2) implies that residents of cities that generate larger wages and impose lower taxes are better off than residents living outside such cities, ceteris paribus. In addition, smaller jurisdictions are better places to live in, all things being equal, because larger cities generate longer average commuting distances that all residents pay for in the form of higher land rents. Of course, owners of developed land benefit from this latter outcome.

3.3 Across-Jurisdiction Equilibrium (AJE)

We now describe how households sort themselves between the possible jurisdictions, that is, we determine N_j as a the result of individuals' choices, knowing T_1 and T_2 and foreseeing u_1 and u_2 from (2). Formally, there is a total population of size N to be allocated between jurisdictions j=1,2. Each jurisdiction has its specific amenities and people's preferences vary over these amenities. To fix ideas, imagine that jurisdiction j=1 is the San Francisco Bay area, with a mild climate, access to the sea and mountains at the back whereas location j=2 is the Boulder, Colorado area with nicer mountains but no access to the sea. For the sake of the argument, assume also that the materialistic utility households might enjoy in either place is the same, i.e. $u_1=u_2$ (in general this will not be the case at equilibrium). Some people strongly prefer the former location, others mildly prefer the bay over the Rockies, another category is pretty much indifferent, and yet other people would leave Boulder under virtually no possible circumstances. To capture this heterogeneity, each household's total utility $V_j(h,\nu)$ is made of two components: economic wellbeing u_j (which is jurisdiction-specific at the WJE) and the household-specific amenity-based utility, ν(h):

(3) $$V_j(h,\nu(h)) = \begin{cases} u_j + \dfrac{\nu(h)}{2}, & j=1 \\ u_j - \dfrac{\nu(h)}{2}, & j=2 \end{cases}$$

That is to say, household h enjoys an 'amenity premium' equivalent to ν(h) monetary units by living in j=1 instead of living in j=2. A large and positive ν(h) means that this household is very fond of the Bay area; a large but negative ν(h) corresponds to a household which is very keen on the Rockies. To get closed-form solutions, we impose the following functional form:

(4) $$\nu \sim \text{iid}\, U[-\sigma+\varepsilon, \sigma+\varepsilon] \;\Rightarrow\; \mathrm{E}[\nu]=\varepsilon, \quad \mathrm{Var}[\nu]=3\sigma^2$$

where ε captures an average preference for location 1 (in the whole population). Without loss of generality, we assume that ε>0 so that, on average, people prefer location 1 over location 2; using a somewhat colloquial terminology, San Francisco is a more 'desirable' location than Boulder.[14] Also, the cumulative density function associated with (4) can be written as F(ν)=(ν+σ-ε)/(2σ). We can now introduce our second equilibrium concept:

> **Definition 2: <u>Across-Jurisdiction Equilibrium (AJE)</u>. At the AJE, the conditions of a WJE equilibrium hold; in addition, no household wants to switch jurisdictions.**

This structure gives rise to an equilibrium outcome that has the following properties: Jurisdiction 1 ends up with a larger fraction of population than jurisdiction 2 if it has better natural amenities, more favorable economic amenities and lower taxes; formally:

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[14] For the sake of political correctness towards Coloradoan people, let us emphasize that one of the authors of this paper has a positive ν while the other one has a negative one.

Proposition 2: (Across-Jurisdiction Equilibrium). At the AJE, the following fraction of the total population resides in j=1:

$$\textbf{(5)} \qquad \text{AJE: } \frac{N_1}{N} = \frac{1}{2} + \frac{\varepsilon + (w_1 - w_2) - \frac{N}{2}(\tau_1 - \tau_2) - (T_1 - T_2)}{2\sigma + (\tau_1 + \tau_2)N}$$

and N_1/N is equal to 0 or 1 in an obvious manner if the expression on the right-hand side of (5) does not belong to the unit interval. In addition, this equilibrium exists and is unique.

Proof. On the demand side, given u_1 and u_2, the fraction of households who wish to reside in j=1 is given by $1 - F[u_2 - u_1] = (\sigma + \varepsilon + u_1 - u_2)/(2\sigma)$. In particular, the fraction of households wising to live in j=1 is increasing in the gap between the economic wellbeing in the two jurisdictions (u_1- u_2), which is decreasing in N_1 and increasing in N_2 by (2), ceteris paribus. At equilibrium, the actual fraction of people living in jurisdiction 1, N_1/N, must be equal to $1 - F[u_2 - u_1]$; substituting for the values of u_1 and u_2 from (2) and rearranging gives the result in (5). Note that N_1/N is trivially increasing in N_1. This, together with the fact that 1-F[.] is decreasing in N_1, warrants that the equilibrium, exists and is unique—this is true regardless of the functional form of F(.). *QED*

It will often prove quite useful to deal with differences between the variables pertaining to the two jurisdictions, thus let us define:

$$\textbf{(6)} \qquad \Delta N \equiv (N_1 - N_2), \quad \Delta T \equiv (T_1 - T_2), \quad \Delta w \equiv (w_1 - w_2), \quad \Delta \tau \equiv (\tau_1 - \tau_2)$$

Using this and then identity $N_2 \equiv N - N_1$, we can thus rewrite (5) as

$$\textbf{(7)} \qquad \text{AJE: } \frac{\Delta N}{N} = \frac{\varepsilon + \Delta w - \frac{N}{2}\Delta\tau - \Delta T}{\sigma + (\tau_1 + \tau_2)N/2}$$

The economic interpretation of the AJE expression for N_1/N is quite intuitive. First, N_1 is increasing in jurisdiction 1's economic amenities ($\partial N_1/\partial w_1>0$ and $\partial N_1/\partial \tau_1<0$) and decreasing in its level of regulation/taxation ($\partial N_1/\partial T_1<0$). Symmetrically, N_1 is decreasing in the economic amenities of the jurisdiction 2 and increasing in its tax rate. Third, N_1 is increasing in the quality of its natural amenities, as perceived be the average household, namely $\partial N_1/\partial\varepsilon>0$. Finally, the gap between the population sizes of the two jurisdictions is decreasing in the heterogeneity of the households' tastes for either of the two locations; at one extreme, some households care exclusively about natural amenities (in which case σ is arbitrarily large) and, since F(.) is symmetric, $N_j\rightarrow½$. Conversely, households are homogeneous and they share the same preferences ($\sigma=0$), in which case the whole population resides in the jurisdiction with the best aggregate amenities (natural and economic). This fact will turn out to be quite important at the tax/regulation setting stage: if σ is large, many households care little about the differences between the tax rates, and thus the regulatory authorities will be little constrained by household mobility.

To understand this result in a graphical way, see Figure 2 on page 37.

The horizontal segment is of length N and the size of jurisdiction 1 reads from left to right (the size of jurisdiction 2 reads from right to left); the vertical axis on the left measures u_1 and the vertical axis on the right measures $u_2-\varepsilon$. The decreasing schedule going through point A and B represents u_1 as a function of N_1, meaning that the economic wellbeing enjoyed by jurisdiction 1's residents is decreasing in N_1 (with slope $-\tau_1$): the maximum wellbeing residents in 1 can enjoy (when the population is arbitrarily small) is w_1-T_1; as more people move into j=1, demand for housing increases and land rents increase as a result (because in larger jurisdictions people incur longer commuting distances). Likewise, the utility of 2's residents increases as more people move into jurisdiction 1, as can be seen along the schedule going through points C and D (with slope τ_2). As a benchmark, consider the case in which individuals are homogenous, that is, the case where F(.) is degenerate so that $V_1(.)-V_2(.)=\varepsilon$ for all h; then the equilibrium would be at the intersection of the two schedules (point H for 'homogenous').

Imagine now that households are heterogeneous, as in (4). In this case, they make a discrete choice regarding location (Anderson, Palma and Thisse 1992; Tabuchi and Thisse 2002; Murata 2003). For the sake of the illustration, assume that $w_1-T_1=w_2-T_2$; thus, the vertical difference in Figure 2 between points A and D is equal to ε. Also, given that the materialistic utility that one can enjoy in each jurisdiction is the same, the fraction of people wishing to live in jurisdiction 1 is equal to $\varepsilon+½$; graphically, this is the ratio O_1K/O_1O_2. In other terms, the household that is indifferent between the two jurisdictions at the margin when $u_1=u_2+\varepsilon$ is the one whose ν is equal to ε, the average in the population. Point H is the actual equilibrium only in a very specific parameter configuration that has measure zero (specifically, $\varepsilon=½(\tau_1-\tau_2)/(\tau_1+\tau_2)$). In general, this needs not be the case, so turn now to Figure 3 on page 38.

Both axes measure fractions of people living in 1. Along the 45°-line labeled OS in the figure, the actual fraction of households residing in 1, N_1/N, is equal to the proportion of people willing to live in j=1, 1-F(ν). At equilibrium, these must be the same. Now, given N_1, we can infer u_1 and u_2 from (2) and the identity $N_2 \equiv N- N_1$. Using these together with (3) and (4), we can infer the fraction of people who desire to live in jurisdiction 1, $1-F(u_2,u_1)$. Since a larger population in 1 means a lower economic wellbeing in 1 and a larger one in 2, the fraction of households who desire to live in 1 is a decreasing function of N_1; this relationship is represented by the locus labeled DD in the figure (a straight line under the assumption that ν is uniformly distributed). At equilibrium (point E), the segments OL (the actual fraction of people in j=1) and OM (the 'desired' fraction of people in j=1) have the same length. Mathematically, we have:

$$\textbf{(8)} \qquad \underbrace{\frac{\sigma+\varepsilon++\Delta w-\Delta T-\Delta \mathrm{T}}{2\sigma}}_{\overline{\mathrm{OM}}}=\underbrace{\frac{N_1}{N}}_{\overline{\mathrm{OL}}}, \quad \Delta \mathrm{T} \equiv (N_1\tau_1 - N_2\tau_2)$$

Using $N_2 \equiv N-N_1$ and solving for N_1 yields the result in (5).[15]

3.4 Political economy game and equilibrium spatial configuration

In the general equilibrium, the executive branch of community j—call this branch the 'planning board'—chooses T_j taking both the individuals' equilibrium decisions (which are functions of the T_j's from (5) and (2)) and the other planning board's regulatory tax as given. In other words, people make their location decisions once planning boards have chosen their

---

[15] This expression conveys a similar intuition as in (5). However, it emphasizes an additional feature of the model: as N grows arbitrarily large, the difference in the quality of local transportation infrastructure ($N_1\tau 1-N_2\tau_2$) becomes all that maters regarding location choices. This is an artifact of the functional form we have chosen for both the commuting technology and the preference for amenities. This result would be relaxed if we assumed that ν was distributed over the whole set of real numbers and if the distribution had 'thick' tails and/or if there were increasing returns to the population scale in the provision of transportation infrastructure, i.e. if $\partial\tau j<\partial Nj<0$.

taxes non-cooperatively (thus, the equilibrium concept for this stage of the game is the Nash equilibrium). For simplicity, we assume that planning boards cater to owners of (undeveloped and developed) land by maximizing aggregated local land rents as defined in

(9) $$\text{Rents}_j \equiv \int_0^{N_j} \tau_j(N_j - h)\,\mathrm{d}h + T_j N_j$$

This maximization function is consistent with a Menu-Auction lobbying game in which owners of both undeveloped and developed land lobby the local planning board (Bernheim and Winston 1986). That is, in the wake of Dixit, Grossman and Helpman (1997), we assume that the influence of the two groups on the planning board is proportional to the aggregated dollar amount that is at stake for them and that the outcome of this lobbying game is T_j.[16]

The regulatory tax increases the cost of developing land at the margin and thereby increases the land rent for each plot of already developed land by the same amount.[17] Hence, planning boards face a trade off: an increase in the regulatory tax increases the land rent of already developed land at the cost of less land development at the fringe. It is quite intuitive that in a highly developed jurisdiction the planning board has more to gain by imposing a high regulatory tax (and thereby cater to the interests of owners of developed land), while in little developed areas, planning boards have more to gain by imposing a low regulatory tax (and thereby cater to the interests of farmers and developers).

Note in this context that landowners are perfectly competitive when they set up $R_j(h)$ but that the planning boards are not; this is because of two things: there are a discrete and small number of planning boards and households have heterogeneous preferences over local natural amenities. Let $T_1^{nash} \equiv \arg\max_{T_1} \text{Rents}_1[T_1, N_1(T;\varepsilon,\sigma,w,\tau) | T_2 = T_2^{nash}]$, where T, w and τ are the defined as the vectors of taxes/regulations, wages and commuting costs with typical elements T_j, w_j and τ_j, respectively. Then the solution of this non cooperative game is the following

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[16] This is not as stringent an assumption as might happen in the first place: in any coalition proof equilibrium, it must be that the planer is locally the residual claimant of the rents her T_j generates; see Grossman and Helpman (1994) for details.

[17] Here we assume that the regulatory tax only affects the cost of developing a new housing unit (e.g., by imposing minimum lot size or height restrictions or by delaying or complicating the planning approval process). The regulatory tax should not be interpreted as a regulation that increases the cost of all housing units (e.g., more restrictive building codes that force existing and new property owners to improve their window isolations).

(these are in general interior solutions, for the second order condition for a local maximum always holds):

(10)
$$
\begin{aligned}
T_1^{nash} &= (\sigma + \frac{N}{2}\tau_2)(1 + \frac{\varepsilon + \Delta w}{3\sigma + N(\tau_1 + \tau_2)}) \quad \Leftrightarrow \\
\Delta T^{nash} \equiv T_1^{nash} - T_2^{nash} &= [1 + \frac{\sigma}{3\sigma + 2N(\tau_1 + \tau_2)}]\frac{\varepsilon + \Delta w}{2} - \frac{N(\tau_1 - \tau_2)}{2}
\end{aligned}
$$

Plugging (10) into (5), the equilibrium spatial configuration can be written as:

(11)
$$
\frac{N_1^{nash}}{N} = \frac{\sigma + \varepsilon + \Delta w - \Delta T^{nash} - \Delta \mathrm{T}^{nash}}{2\sigma} = \frac{1}{2}(1 + \frac{\varepsilon + \Delta w}{3\sigma + 2N(\tau_1 + \tau_2)})
$$

where $\Delta \mathrm{T}^{\mathrm{nash}} \equiv \mathrm{N}_1^{\mathrm{nash}}\tau_1 - \mathrm{N}_2^{\mathrm{nash}}\tau_2$ (capital 'τ' looks like a non-italic capital 't') and ΔT^{nash} is given by (10). In words, the jurisdiction with the best natural amenities, the best commuting infrastructure and a favorable wage gap manages to tax (regulate) the development of its land more than the other jurisdiction; nevertheless, it achieves to attract a greater population at equilibrium. Note that the equilibrium regulatory tax exactly compensates for the difference in the quality of infrastructures (a knife-edge result).

We also note that if the aggregate population is small enough, then the whole population chooses to locate in a single jurisdiction; without loss of generality, assume that $\varepsilon + \Delta w > 0$ holds (this ensures $\mathrm{N}_1^{\mathrm{nash}} > 0$); then everybody *might* live in jurisdiction 1; this happens if the aggregate population is small enough; formally:

(12)
$$
\frac{N_1^{nash}}{N} < 1 \quad \Leftrightarrow \quad N > \max\{0, \frac{\varepsilon + \Delta w - 3\sigma}{\tau_1 + \tau_2}\}
$$

We can summarize these results in:

> **Proposition 3: In the general equilibrium, as the population grows, the jurisdiction with the nicest amenities gets populated first. It also regulates in a restrictive way the development of its available land. When other jurisdictions get populated in turn, it is still the case that the former jurisdiction is more populated and that the use of its land is more regulated. Finally, qualitatively similar results are obtained if economic amenities (higher wages and/or lower commuting costs) replace the natural amenities.**

3.5 Discussion

One way of interpreting the 'economic amenities' (the wage gap and the commuting costs), which are exogenously given in our model, is as follows: a positive wage gap could capture the fact that a 'jurisdiction' (a metropolitan area or a local municipality) is well endowed in some resources and specializes in the production of goods and services that use this resource intensively. A negative commuting cost gap (that is, an exogenously given efficient commuting technology) might capture an area on which it is easy to build a city; counterexamples include steep slopes (even Boulder was built in the valley), the permafrost (after all, Fairbanks is sparsely populated), sandy grounds or easily flooded areas (New Orleans).

3.6 Extensions

Our model could be extended to capture other features of the data our empirical section below suggests are important; these extensions include the role of homeownership and spatial sorting according to individual incomes, as well as treating population density as an endogenous variable.[18] Arguably, a complete model should address all channels

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[18] Appendix B and Appendix C of the paper respectively address the issues of homeownership and spatial sorting according to income; a formal treatment of population density needs not be treated here for it is standard; see Brueckner (1987). We intend to solve the entire model with the material on homeownership in future versions of the paper; given that the other two extensions require to amend the model in a way that makes it intractable, a meta-model that incorporates all these elements at once would no longer yield explicit and closed form solutions and thus would lose much of its appeal. The reason our current model is tractable is because our assumptions together yield a linear bid rent curve and a linear trade-off between income and natural amenities. Relaxing one of these assumptions at a time is workable; hence this subsection.

simultaneously. However, we believe that an attractive feature of our model is it being parsimonious, so we have opted for not incorporating these extensions in the core of the paper because the focus of our paper is on the share of developed land. In this subsection, we mention these extensions in turn, explain how they would affect our endogenous variables and provide the economic intuition for these theoretical results. In our empirical work, we control for homeownership (we even instrument for it) and population density; we also treat average income in a way that is consistent with theory. As we will see, these theoretical extensions also find some support in the data.

Homeownership

The rate of homeownership is highly negatively correlated to the land use restrictions by any measure at our disposal; see Table 2 on page 43. One possible theoretical reason for the homeownership rate to have a *negative* impact on land use restrictions has been put forward in a static framework by Brueckner and Lai (1996). Homeowners pay rents to themselves, so the benefits conferred to them by the escalation of rents that results from growth controls are lower than those reaped by absentee landlords. Another possible explanation is put forth in our Appendix B. In a dynamic extension of our model, landowners actually realize the capital gain engendered by tight land use regulations only when they sell their property; in the meantime, they do not gain much from it because they pay rents to themselves. Thus, assuming that the building collapses at some point in the future, the capital gain is discounted by the expected duration of homeowner tenancy. Thus, like in Brueckner and Lai (1996), homeowners favor land use restrictions, but less so than landlords do.

What is the key mechanism in both models that predicts that an increase in the homeownership rate should be associated with a *lower* regulatory tax? Given a fixed number of property owners, a larger share of homeowners implies a smaller share of renters *and* landlords. The latter group has most to gain from regulatory restrictions. In our model, the reason why replacing a homeowner by a landlord and a renter tilts the political balance in favour of tighter land use restrictions is the following: renters have a shorter expected tenure duration than homeowners do, but the latter is shorter than the expected lifetime of the building, i.e. the expected duration of landlords' stream of rents. Thus, a homeowner weighs the benefits of tighter land use regulations less and weighs its costs more than the landowner-tenant pair does. Moreover, as each landlord typically owns a larger number of housing units (in contrast to homeowners), the group of local landlords is typically much smaller than the group of local homeowners. Following Olson's (1971) logic, this implies that it will be much easier for the group of landlords to prevent free-riding and influence the planning process in their favour.

Spatial sorting according to income

In the current version of the model, income has a location-specific component only. It is not difficult to extend the model for an individual-specific income w^h, with w^h being distributed over some support $\omega \subset \Re_{++}$ and described by some cdf G(.); also, it is natural to assume that people's idiosyncratic preferences for natural amenities are independent of their income, so $Corr(\nu, w^h) = 0$. With this simple extension alone we would not be going very far because the utility function V(.) is linear in income so the marginal utility of income is constant; see (2) and (3). This implies that the marginal willingness to pay for better amenities is independent of income (rather, it depends on the household's ν only); people sort according to ν only, as in the current model.

To make the model more interesting, assume that $V(h,\nu,w^h)$ is log-linear in net income; using symbols and the equilibrium relationship in (2), (1) and (3) are being replaced by:

$$\textbf{(13)} \quad V_j(h,\nu,w^h) = \ln[w^h + w_j - T_j - \tau_j N_j] \pm \frac{\nu(h)}{2} \equiv \ln[w^h + u_j(N_j, T_j)] \pm \frac{\nu(h)}{2}$$

In this situation, the marginal utility of (net) income is decreasing, meaning that rich people's willingness to pay to live in their preferred location is larger than poor people's (and conversely for the least preferred location). This holds *for any given* ν, that is, given the strength of the household-specific preference for, say, the Bay area. For any given ν, households with a lower w^h are less willing to trade off net income for natural amenities than rich people. Therefore, since a higher T_j means a lower net income (for tenants at least), highly regulated places will have fewer low income households on average; in other words, a higher regulatory tax in effect excludes poorer households; this theoretical result is entirely consistent with the empirical evidence in the Bay area provided by Gyourko, Mayer and Sinai (2006).

To summarize, this extension of the model predicts that locations endowed with desirable natural amenities attract a larger fraction of the population and thus are being more developed; this generates higher regulatory taxes; this in turn excludes from the jurisdiction the poorer segment of the income distribution for any given ν.

Endogenous population density

In the model we assume that each household consumes a fixed amount of housing (normalized to one unit) and that each unit of housing requires a fixed amount of land (also normalized to one unit). As is well-known, relaxing either of these assumptions would generate a convex bid-rent curve; see Brueckner (1987). Indeed, as land rents are higher, the lower is h, households substitute away from housing (i.e. they opt for smaller dwellings) and construction builders substitute land for capital (i.e. they build multi-storey structures). Incorporating these features would greatly complicate our model, without overturning any of our result. In particular, more populated areas will be denser, more crowded and more expensive (average rents and average commuting costs will be higher); they will also be more developed and thus more regulated. Importantly, when controlling for the joint determinants of population density and land use regulation, *the former should have no residual effect on the latter*.

To summarize the results/conjectures of this subsection:

> **Proposition 4: (a) Homeowners favor tight land use restrictions; nevertheless, the homeownership rate has a negative impact on the equilibrium regulatory tax. (b) Ceteris paribus, jurisdictions that regulate land use in a more restrictive manner should attract households with a disproportionately larger average income. (c) Population density should not have any independent effect on equilibrium land use restrictions.**

4. Empirical Analysis

In this Section we first describe the data and geographical matching procedure that we use to test the predictions of the model. Next we discuss the results.

4.1 Description of data and geographical matching procedure

Our data is derived from various sources and geographical levels of aggregation. The data is then geographically matched to the MSA level. The data sources are described below.

The land use data is derived from the National Land Cover Data 1992 (NLCD 92), which is a part of the U.S. Geological Survey. The NLCD 92 reports raster data for 21 different land uses with a spatial resolution of 30 meters for 48 U.S. states (excluding Alaska, Hawaii and Washington, DC); the database is described further in e.g. Burchfield, Overman, Puga and Turner (2006). The Wharton GIS Lab geographically matched all raster data to U.S. 2000 Census tracts (which cover the entire United States). In a next step we geographically matched the data to the MSA level.[19] Figures 4 and 5 visualize the local land scarcity for four highly regulated MSAs (San Francisco, San Jose, Los Angeles and New York) and four less regulated MSAs (Pittsburgh, Birmingham, Nashville and Oklahoma City). The land scarcity is obviously higher in the MSAs depicted in Figure 4. One special case is the metro area of Washington, DC. While we have data for the vast majority of the surface area of the MSA, the NLCD 92 does not provide any land use information for the District of Columbia itself. Hence we imputed the percentage developed land by assuming that land uses within the District are similar to that at the boundaries. This adjustment has only a very minor effect on the 'percentage developed' measure for the entire MSA (the measure increases by about half a percentage point). While the chosen approach likely underestimates the 'percentage developed land' in the District, it is worth noting that the value for the entire MSA hardly changes even if we instead assume that 100 percent of the District is developed. This is because the District covers such a small part of the surface area of the MSA (only about 1 percent). In any case, none of our empirical results changes notably if we assume that the District is either not at all or fully developed nor if we drop the MSA of Washington, DC altogether from our regression sample.[20]

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[19] The reader might worry that the boundaries of MSAs are arbitrary and, consequently, that the percentage developable land is arbitrary as well. However, it is easy to demonstrate that 'more developed' metro areas are more developed at any radius from the center than 'less developed' MSAs; in other words, any other measure would likely reinforce our results (that is, if the actual definition of MSAs introduce a systematic bias, it is a downward one). Burchfield et al. (2006) show that whatever the buffer one takes does not change the results.

[20] There may be another justification for dropping Washington, DC from our regression sample. Being the capital of the United States, many of Washington DC's land use restrictions are of a federal rather than local nature. For example, very tight height restrictions apply to buildings in a wide radius around the White House. As a consequence, Washington, DC has one of the (if not the) 'flatest' downtowns of all large cities in the US. Consistent with this observation Washington, DC is somewhat of an outlier in our sample with having relatively

The regulatory index, which we use as a measure for regulatory restrictiveness, is derived from Saks (2005). Saks created a "comprehensive index of housing supply regulation" by using the simple average of six independent surveys. The six sources are: The Wharton Urban Decentralization Project (carried out during the late 1980s), the Regional Council of Governments (1975-1978), the International City Management Association (ICMA, 1984), the Fiscal Austerity and Urban Innovation project (1983-1984), the National Register of Historic Places (NRHP) and the American Institute of Planners (1976). The method of index construction is described in detail in the Data Appendix of Saks (2005). Saks (2005) reports regulatory index values for 83 metro areas. We loose one observation in our regression analysis because the NLCD 92 does not report land use information for Honolulu, HI.

The amenity data is derived from the following sources: The 'MSA has major coast line' variable is derived from the Environmental Systems Research Institute's (ESRI) Census 2000 MSA-level shape file. The 'mean hours of sunshine in January, 1941-1970' is from the Area Resource File (ARF) maintained by Health Professions, within the Health Resources and Services Administration. The data is derived from a secondary source, the Natural Amenity Scale Data (NASD) from the Economic Research Service, United States Department of Agriculture; it is provided at the county level. We subsequently geographically matched it to the MSA level.

As a proxy for the quality of the transport infrastructure we use the average (real) annual local expenditures for highways per square kilometer of developed land, measured between 1977 and 1992. The data is derived from the U.S. Census Bureau's Census of Governments for the fiscal years 1977, 1982, 1987 and 1992.[21]

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little developed space (rank 17 out of 21 in Table 1) but a high regulatory tax (rank 5) and a high regulatory index (rank 6). It is worth noting that our regression results marginally improve if we drop Washington, DC from the sample.

[21] We believe the average expenditure over such a large time period is more likely to be a correct proxy for the quality of the transport infrastructure than just the contemporaneous one. For instance, assume that a particular MSA has been under-spending in public infrastructures for some time, with an adverse effect on quality, then a large expenditure in a given year might be because the latter might barely be sufficient to correct for the meager years; in this case, a large expenditure makes up for *poor* quality in transportation infrastructure. This would bias the results. It is also worth noting that all our results hold if we remove our measure of transportation infrastructure quality from our list of instruments, although, standard errors marginally increase.

Finally, the number of housing units and the population in 1980, 1990 and 2000, the homeownership rate in 1980, the share of households that consist of married couples without children in 1980 and the household wage in 1980 are derived from Geolytics' Neighborhood Community Database (NCDB), which covers U.S. Census data from 1970 to 2000 geographically matched to U.S. Census 2000 boundaries. We subsequently geographically matched the data to the MSA level, making sure that we compare the same geographical area over time. For example, we calculate growth rates of housing supply for the 1980s and 1990s only for those Census tracts within an MSA for which we have data for all three Census years (1980, 1990 and 2000).

Tables 1 and 2 provide a data overview. Table 1 reports the values of key variables of interest for 21 metropolitan areas, namely, those areas for which Glaeser, Gyourko and Saks (2005a) report a regulatory tax measure. The table reveals that regulatory restrictiveness is strongly negatively related to homeownership but quite strongly positively related to the 'percentage developed land' defined as developed residential and industrial land as a share of total developable land. Table 2 reports summary statistics for the variables used in the empirical analysis described below.

4.2 Empirical specification

Our objective in this section is to test the predictions of our model as directly as possible. We begin by testing the first equilibrium prediction stated in Proposition 3, namely, that places with better amenities and with better transport infrastructure will be more developed.[22] The prediction is stated in (14):

$$\textbf{(14)} \quad \%developed_j = \alpha_0 + \alpha_1\left(amenity_j\right) + \alpha_2\left(commuting\ infrastructure\ quality_j\right) + \varepsilon_j$$

Next, we test the second equilibrium prediction stated in Proposition 3. Jurisdictions that have better amenities and, consequently, are more developed should be more regulated. The prediction can be tested by estimating (15):

---

[22] It could be argued that 'access to major coastline' also captures some physical constraint on the growth of the MSA in addition to being a desirable amenity. However, this makes it an even more convincing instrument; we are grateful to Steve Gibbons for pointing this out to us.

$$\textbf{(15)} \qquad regulation_j = \beta_0 + \beta_1\left(\boldsymbol{\%developed_j}\right) + \beta_2\left(\boldsymbol{homeownership\ rate_j}\right) + \mu_j$$

The two bold variables in (15) are endogenously determined. We use the amenity variables and transport infrastructure quality of the MSA as instruments to identify the MSA's share of developed land. In the discussion of empirical results below we confirm that these amenity variables are indeed valid instruments. Equation (15) also includes the homeownership rate as a control variable. Proposition 4(a) of the model predicts that, all else equal, the homeownership rate should negatively affect the regulatory restrictiveness (see Appendix B for a derivation of this prediction). The homeownership rate is arguably endogenously determined as well. The strategy to identify the homeownership rate and the tests to confirm the validity of the instruments are described below.

Finally, a dynamic interpretation of Proposition 3 implies that all else equal, conditional on the size of the housing stock and its past growth rate, more regulated jurisdictions should grow more slowly than their less regulated neighbors. Empirically, controlling for past growth, we would expect a more developed and consequently more regulated jurisdiction to grow more slowly when compared to its less regulated neighboring location. This prediction is formulated in (16):

$$\textbf{(16)} \qquad g^H_{jt} = \gamma_0 + \gamma_1\left(g^H_{j,t\text{-}1}\right) + \gamma_2\left(\widehat{regulation}_{jt}\right) + \gamma_3 H_{jt} + \omega_j$$

where g^H_{jt} is the growth rate of the housing stock (or population) in jurisdiction *j* between time period *t* and *t*+1, $g^H_{j,t-1}$ is the equivalent growth rate between time period *t* and *t-1*, $\widehat{Regulation}_{jt}$ is the predicted level of regulatory restrictiveness in jurisdiction *j* at time *t* and $H_{j,t}$ is the housing stock at time *t.* The latter variable controls for the size of the jurisdiction taking into account that larger locations may grow at a slower (or faster) pace.

4.3 Empirical results

In Tables 3 to 6 we report the results for the empirical specifications stated above in (14) to (16). Table 7 summarizes the quantitative effects. To begin with, in Table 3 we test (14) using a sample of 82 MSAs (all MSAs with available information) and using two alternative definitions for the variable ‘percentage of developed land’. The use of two alternative definitions for the land scarcity variable provides a test for whether the measurement of our key variable of interest is sensitive with regard to its definition. Column (1) of Table 3 reports OLS results (using robust standard errors) for our *standard* definition of ‘percentage developed land’ as in (17):

$$\textbf{(17)}\qquad \%developed = \frac{developed\ \ residential + developed\ industrial\ land}{developable\ land\ area}$$

whereas ‘developable land area’ is defined as the total land area minus the surface area that is covered by barren, water, ice, wetlands or shrubland. We tested the impact of various natural amenities but only two – probably the most obvious ones – are consistently positively related with land scarcity in the metropolitan area. The first variable is ‘major access to coast line’; the coefficient of the variable is positive and statistically significant at the 1 percent level (this is striking given that we have only 82-4=78 degrees of freedom). Households obviously value access to beaches (and possibly the corresponding milder climate). The second variable is ‘mean hours of sunshine in January’. Plenty of sunshine (especially during cold and short winter days) attracts households. The effect is also statistically significant at the 1 percent level. Apart from natural amenities, we also include a variable in our empirical model that captures the effect of the quality of the transport infrastructure. We use the sum of local direct expenditures for highways in an MSA per square kilometer of developed land– measured in constant 1982-1984 U.S. dollars over 15 years – as a proxy measure for transportation network density or ‘quality’. The coefficient of the variable has the expected positive effect and is highly statistically significant at the 2 percent level. The adjusted R^2 is reasonably high with 0.37.

The specification estimated in Column (2) differs from that in Column (1) only in that we additionally include the MSA’s share of households that consist of married couples without children. This variable helps us identify the homeownership rate and is used as an instrument in our two-stage least-squares (TSLS)-estimates reported in Table 4. Married couples without children tend to have higher and more stable household incomes and are able to accumulate greater wealth over time compared to married couples with children. This makes them more likely to overcome liquidity and down-payment constraints, which can prevent households from attaining homeownership. Moreover, married couples tend to be in more stable relationships compared to their unmarried counterparts, implying a longer expected duration in their property and, consequently, greater incentives to own rather than rent. By contrast, we do not expect that the share of households that consist of married couples without children helps us identify the share of developed land. As we shall see in the immediate sequel, our empirical results are consistent with this intuition.

Column (3) reports results for the same specification as in Column (1) except that the dependent variable is now the 'percentage developed non-industrial land' as defined in (18):

$$\textbf{(18)} \qquad \%developed = \frac{developed\ residential\ land}{developable\ non\text{-}industrial\ land\ area}$$

The variable defined in (18) is identical to that in (17) except that the surface area of industrial land is removed, both from the numerator and the denominator. A comparison of Columns (1) and (3) of Table 3 reveals that the results are similar, not only in terms of statistical and quantitative significance (see Table 7), but also in terms of adjusted R^2. Column (4) replicates the specification reported in Column (2) but using the 'percentage developed non-industrial land' as dependent variable. Results are very similar. Overall, the comparison of the first 4 columns suggests that the results are very robust with regard to the definition of the 'percentage developed land' variable.[23] Column (5) reports OLS estimates of the effect of the 'share married without children' measure on the homeownership rate. As predicted, the coefficient of the 'share married without children' measure is positive and highly statistically significant at the 1 percent level.[24] Column (6) also includes the amenity and transport

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[23] Moreover, the coefficients and statistical significance levels of the included explanatory variables are quite robust with regard to the inclusion of additional explanatory variables (including arguably endogenous measures of 'economic amenities').

[24] From a theoretical point of view there is no reason why the 'share married without children' measure should be (directly) related to regulatory restrictiveness. At the same time there are strong arguments (outlined above) why the 'share married without children' measure is expected to explain the homeownership rate reasonably well. From a statistical point of view, the variable is not only strongly positively correlated with the homeownership rate (the correlation coefficient is +0.57 and is statistically significant at the 1 percent level) but also not correlated with our measure of regulatory restrictiveness in a statistical sense (the correlation coefficient of -0.07 is completely statistically insignificant with a p-value of 43 percent). We also carry out Hasen-Sargan tests (discussed below) when we estimate (14). In all specifications, the over-identifying restrictions are comfortably not rejected, implying that our instruments are valid.

infrastructure quality variables from the first four columns. These variables may not only identify the share of developed land but also the homeownership rate as locations with nicer amenities are more densely developed (closer proximity of buildings and taller buildings) and hence have a greater landlord production efficiency implying lower homeownership propensities (Linneman 1985). All four explanatory variables have the expected effect on the homeownership rate and are statistically highly significant, at least at the 3 percent level. The adjusted R^2 is quite high with 0.62.

Next, we turn to Table 4, which reports the results of the second stage of the TSLS regression using Sak's (2005) regulatory index as the dependent variable. As we demonstrate in Table 3, our measures of natural amenities and of transport infrastructure quality are potentially valid instruments to identify the 'percentage developed land' measures as they are highly correlated with the 'percentage developed land measures' but from a theoretical point of view there is no reason to presume that they are (directly) related to land use restrictiveness. Similarly, the 'share married without children in 1980' variable is a potentially valid additional instrument to identify the homeownership rate in 1980. To further validate our choice of instruments we carry out Hansen-Sargan tests for all 6 specifications reported in Table 4. In all cases, the over-identifying restrictions are comfortably not rejected (all with p-values over 0.21), implying that the instruments are valid. We report results for three different specifications. Columns (1) and (2) report results for a specification without the homeownership rate as a control, only using our two measures of 'share developed land' – 'share developed land' and 'share developed non-industrial land' – as endogenous explanatory variables (using the two amenity and the transport infrastructure quality variables as instruments). Consistent with our model, both measures of 'share developed land' have a positive causal effect on the regulatory restrictiveness. The effects are statistically highly significant (at the 1 percent level). Turn now to the 'economic significance' of the effects we have identified. Table 7 reveals that the effects are quite meaningful quantitatively. All else equal, independent of the choice of the 'share developed' measure, an MSA with average land scarcity that receives a 'development shock' corresponding to one standard deviation (+13.2 percentage points for 'share developed land' and +11.9 percentage points for 'share developed non-industrial land) jumps in the regulatory index league-table from rank 41 to rank 21. It is also worth noting that the coefficients and statistical significance levels increase when we use instruments to identify the 'percentage developed land measures' (although OLS regressions produce qualitatively similar results).

Column (3) and (4) report results when we additionally include the homeownership rate as an exogenous control variable. Consistent with Proposition 4a of the model, the homeownership rate is negatively related to Saks' (2005) regulatory index. The effect is quite significant, both in statistical terms (significant at the 2 percent level) and in quantitative terms. An increase in the homeownership rate by one standard deviation (+7.4 percentage points) is equivalent to a drop in the regulatory index league-table from rank 41 to 51. The causal effect of our two measures of 'share developed' on the regulatory index remains statistically highly significant (at the 2 percent level) as well as quantitatively meaningful. Although the coefficients are somewhat reduced in magnitude, they are not statistically different from those reported in Columns (1) and (2). An increase of the 'share developed land' equates to a jump in the regulatory-index league table from rank 41 to 23.

Columns (5) and (6) of Table 4 report results for our preferred specification, stated in (15), which assumes that both the 'share developed land' and the homeownership rate are endogenously determined. We use the two amenity variables, the transport infrastructure quality measure and the 'share married without children' as instruments to identify our two endogenous right-hand side variables. The former three variables are expected to help identify the 'share developed land' while all four measures help identify the homeownership rate. Overall results are similar to those reported in Columns (3) and (4) with the 'share developed land' having a strong positive causal effect and the homeownership rate having a strong negative causal effect on the regulatory index. Tests on the equality of the coefficients cannot reject the hypothesis of equality and statistical significance levels increase slightly with the 'share developed land' measures now being statistically significant at the 1 percent level. The quantitative effects of the 'share developed land' measure are somewhat smaller (jump in the regulatory index league table from rank 41 to 28), while the causal effects of the homeownership rate get somewhat bigger in magnitude (a drop in the regulatory index league table from rank 41 to 52).

Table 5 reports results for (15) but additionally controls for the population density in the developed area. While our model predicts that population density should not have any independent effect on equilibrium land use restrictions as per Proposition 4(b), the additional control variable represents an alternative explanation for why the tightness of land use regulations differs across metro areas. The line of reasoning is as follows. Nice amenity places are more densely populated and hence they generate more (typically negative) externalities between residents. A welfare maximizing planning board internalizes these externalities by imposing land use restrictions. In Columns (1) to (4) of Table 5 we put this proposition to the test by including the population density in the developed area as a control variable. Columns (1) and (2) report results for our two different measures of 'share developed' (as an endogenous right hand variable) and the population density in the developed area as an exogenous control variable. While the size of the coefficients of the endogenous 'share developed' variables drop somewhat, the effects are still statistically significant at the 1 percent level (in fact the effects become even more significant in a statistical sense). Similarly, the homeownership rate now has an even stronger negative effect on regulatory restrictiveness when compared to the results in Table 4. Most importantly, consistent with Proposition 4(c) of our paper, the coefficients on population density are completely statistically insignificant. When we include population density in Columns (3) and (4) as an endogenous variable and instrument for it using our amenity variables from Table 3, the results are very similar to those reported in Columns (1) and (2). In particular, the coefficients on the population density variable are still entirely insignificant in a statistical sense, again providing support for Proposition 4(c). Hence, we can reject the alternative Welfare Economics explanation for regulatory restrictiveness. It is not population density in the developed area that drives our results but the share of developed land.

We also tested Proposition 4(b) of the model which says that the locations that are more regulated attract households with larger average income. When we use our predicted regulatory index measures as an explanatory variable of the average household wage in the MSA, we find a strong and statistically highly significant positive effect (in all specifications).[25]

Finally, Table 6 reports results for the test of our most subtle model prediction outlined in (16), namely, that controlling for lagged growth and city size, more regulated jurisdictions grow more slowly than less regulated ones. We use the predicted (fitted) values of the

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[25] While our model predicts that the causality runs from regulatory restrictiveness to average income, we also tested the 'reverse view' that income may have an independent effect on the regulatory restrictiveness when added as a control variable in Tables 4 and 5. This reverse view is not supported by the data. The coefficient on the additional control variable 'household wage in 1980' is completely statistically insignificant in all specifications. All results are available upon request.

regulatory index from the estimating equations in Table 4. Because the regulatory index measures are estimated values we report bootstrapped (and robust) standard errors using 1,000 replications. Bootstrapping increases the standard errors only marginally and has virtually no effect on the statistical confidence levels. The results reported in Columns (1) to (6) of Table 5 use the predicted values from the corresponding Columns (1) to (6) of Table 4. All specifications control for the existing housing stock in the MSA in 1990 and the (lagged) housing supply growth rate in the 1980s, consistent with the predictions derived from our model. In all six specifications the predicted regulatory tax has a negative and statistically highly significant effect on the growth rate in housing supply in the 1990s. In all 6 cases the effect is statistically significant at the 1 percent level. Furthermore, as Table 7 demonstrates, an increase of the predicted regulatory index by one standard deviation (+1.0) reduces the growth rate of housing supply by between 3.4 and 3.9 percentage points depending on the specification. This is equivalent to a drop in the growth rate league table from rank 41 to 52 or 53. Overall, our results in Table 6 imply that while more ‘desirable’ MSAs grew more quickly in the past while little land was developed and the places were little regulated, their growth rate – due to tighter land use controls – has later slowed down significantly when compared with ‘less desirable’ MSAs.

5. Conclusions

In this paper we develop a parsimonious, in essence static model that provides an explanation for why ‘desirable’ locations have tighter land use regulations compared to ‘less desirable’ places. The comparative statics of the model imply that in an economy with a growing population, the jurisdictions with the best natural and economic amenities will be developed first. When in turn attractive jurisdictions become more filled up, owners of developed land (property owners) become politically more influential compared to owners of undeveloped land (e.g., farmers or land developers). Owners of developed land – in contrast to owners of undeveloped land – have an incentive to increase the cost of future development. Hence, all else equal, the more developed a jurisdiction already is, the greater should its regulatory tax be. Similarly, locations closer to the CBD are expected to have a higher regulatory tax compared to fringe locations. Moreover, while different locations may grow at different paces for various (unobserved) reasons, we would expect a more developed and consequently more regulated jurisdiction to have a smaller rate of new housing construction when compared to its less regulated neighboring location. Our empirical analysis for a reasonably sized sample of metropolitan areas in the United States confirms all the above formulated predictions of the model.

Our theoretical and empirical analyses imply that local planning authorities cater to the interests of land owners rather than to those of local voters (although in the case of homeowners the two interests coincide). Fascinatingly enough, in 1925, over 80 years ago in the early stages of land use regulation, the Committee on Community Planning of the American Institute of Architects (AIA) came to a very similar conclusion: "[Zoning] is concerned only feebly and incidentally with the community function the land will best serve; it focuses its attention mainly upon stabilizing of the existing uses and the values that are derived from them, whether these are to the best advantage of the community or not."

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Figure 1

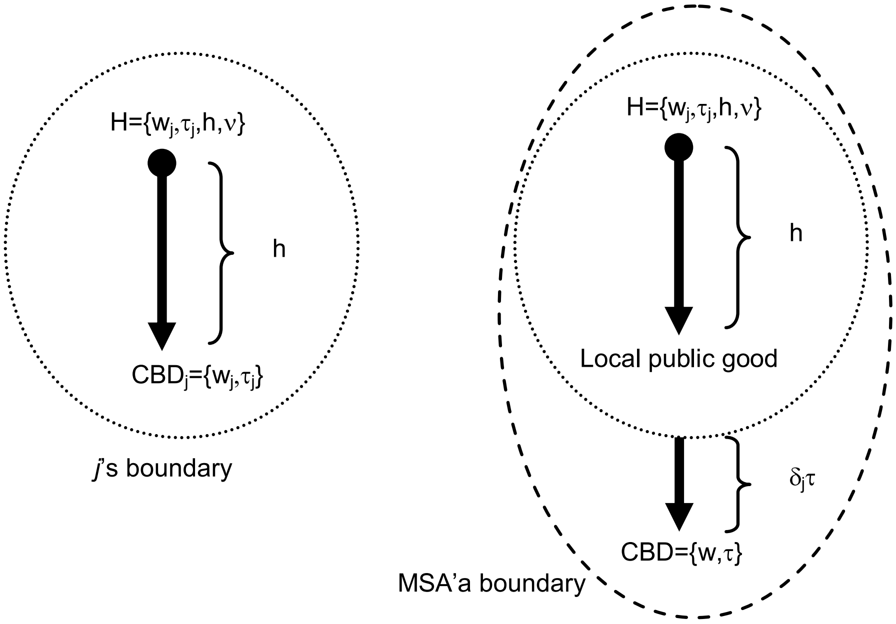


Figure 2

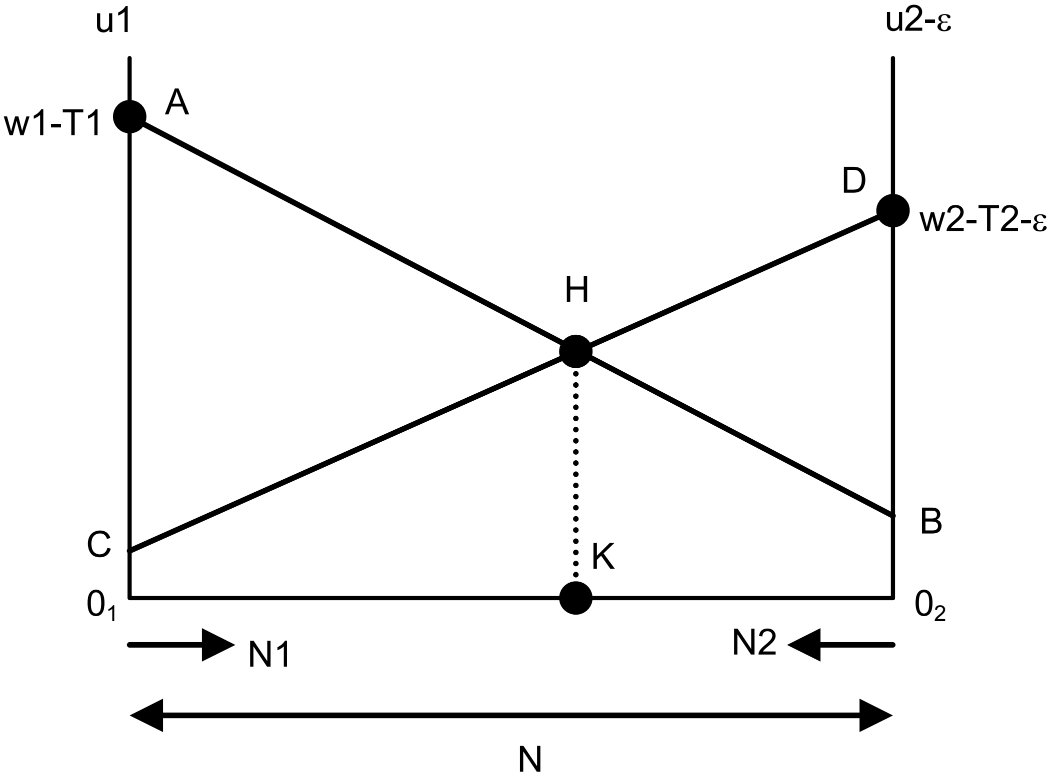


Figure 3

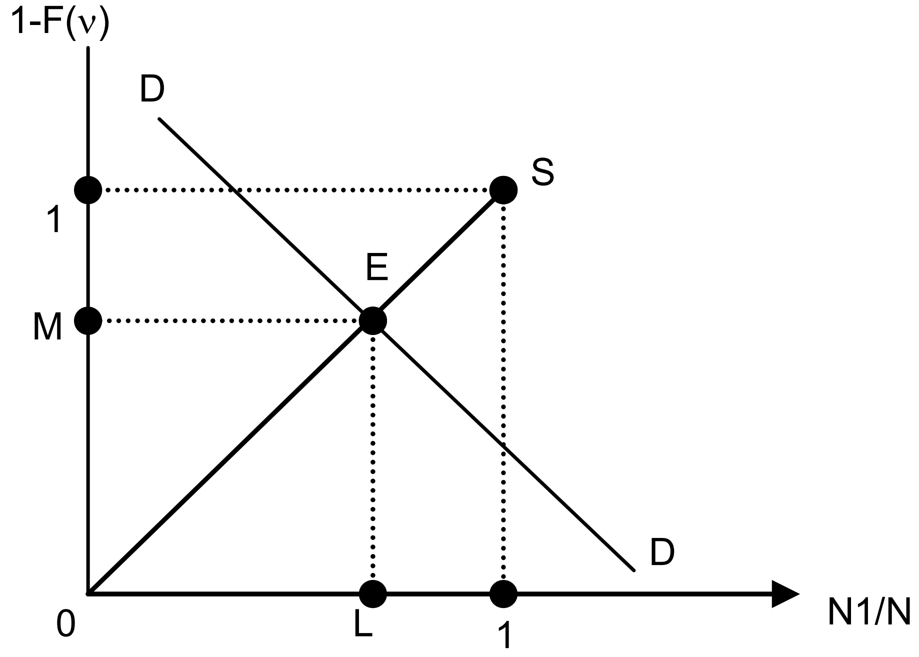


Figure 4: Land Availability in Metropolitan Areas with High Regulatory Index

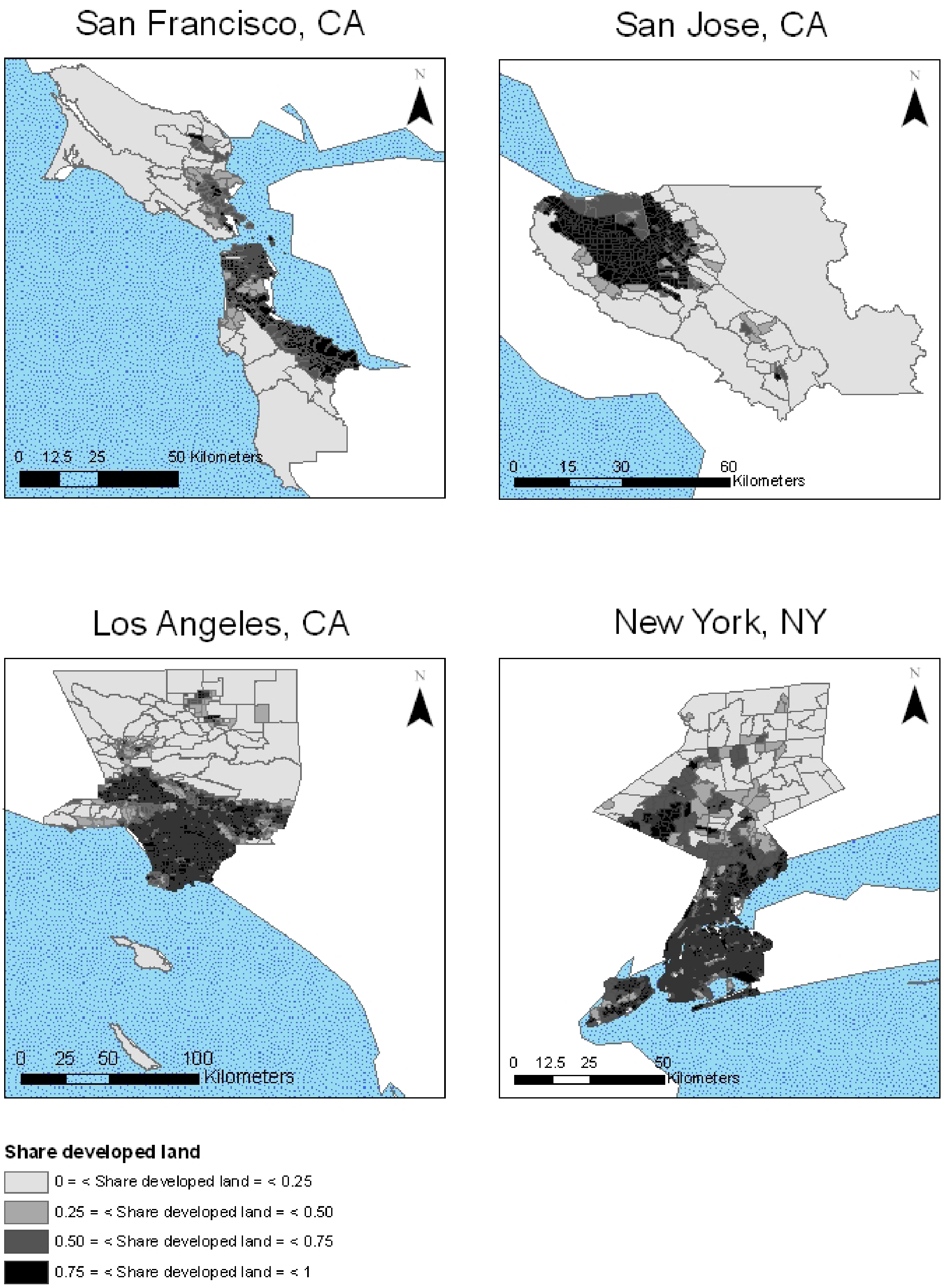
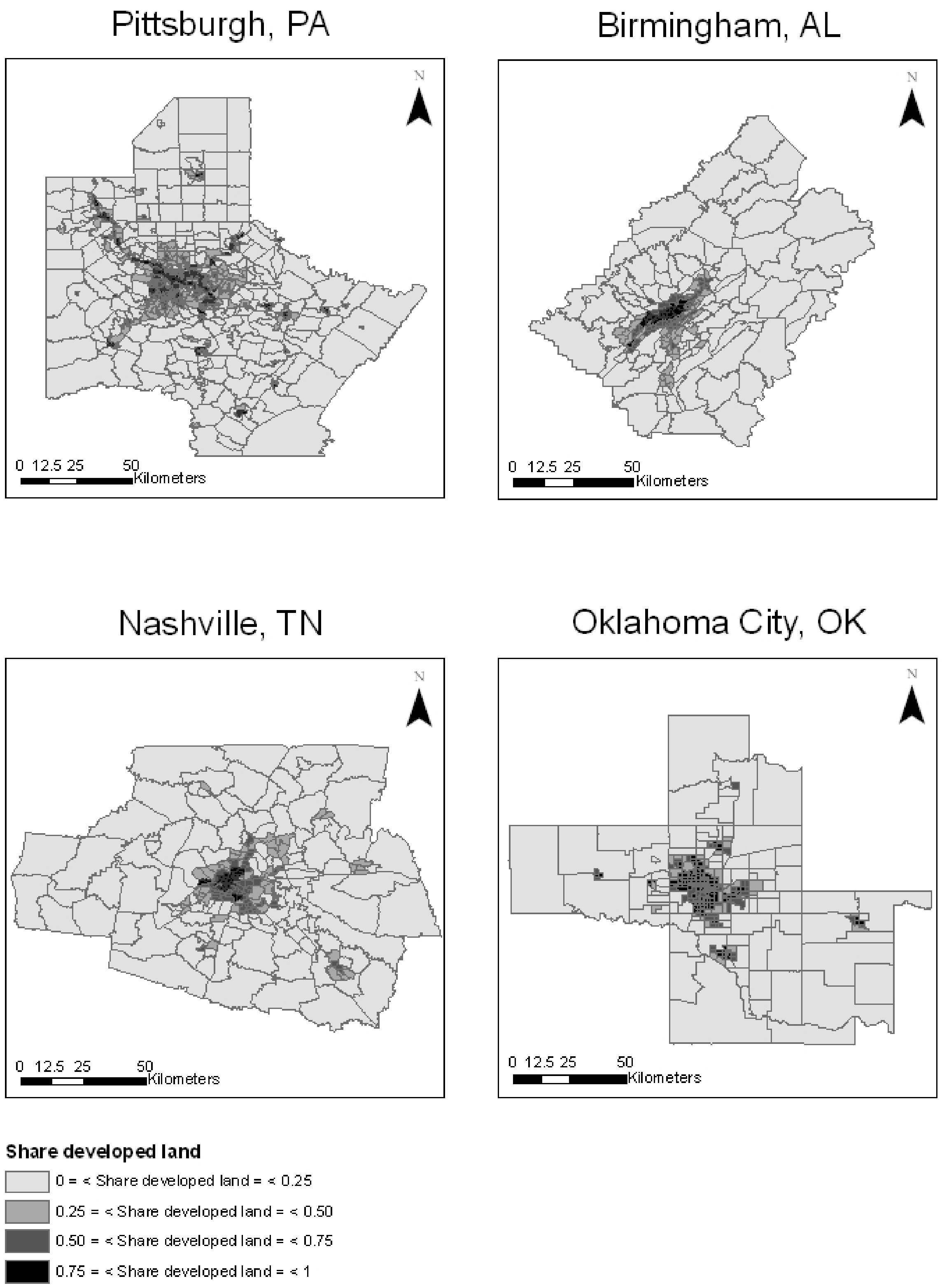


Figure 5: Land Availability in Metropolitan Areas with Low Regulatory Index



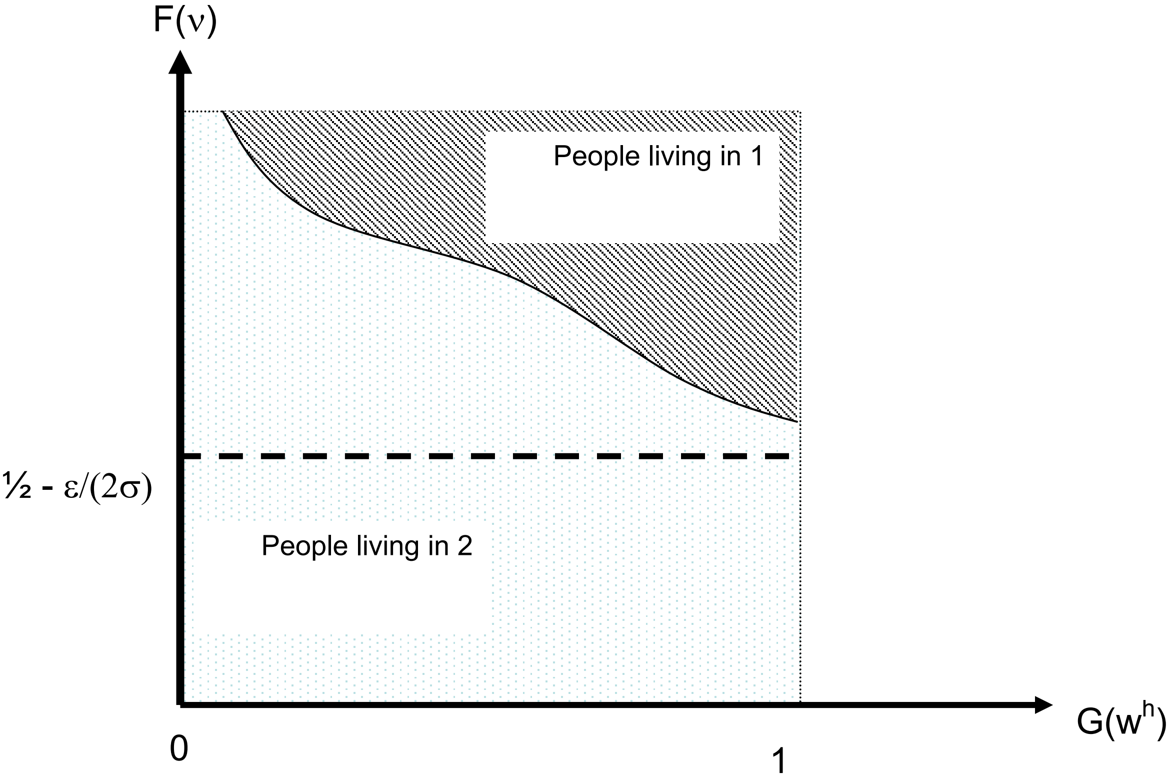
Pittsburgh, PA

Birmingham, AL

Nashville, TN

Oklahoma City, OK

Figure 6: Spatial Sorting with Respect to Income



Summary Statistics and Tables

Table 1: Relationship between Regulatory Restrictiveness, Homeownership and Degree of Land Development

Metropolitan Area	Regulatory Tax in % of House Value [i] 1998	Rank	Regulatory Index [ii] 1980s	Rank	Home Ownership Rate [iii] 2000	Rank	Percentage Developed Land [iv] 1992	Rank
San Francisco	53.1%	1	2.10	2	49.0%	19	20.8%	10
San Jose	46.9%	2	1.65	3	59.8%	15	19.9%	12
Los Angeles	33.9%	3	1.21	4	47.8%	20	44.2%	1
Oakland	32.1%	4	0.10	14	60.4%	14	26.6%	5
Washington, D.C.	21.9%	5	0.86	6	63.0%	12	10.2%	17
Newport News, VA	20.7%	6			62.7%	13	17.5%	13
Boston	18.6%	7	0.86	7	59.0%	18	33.2%	4
New York	12.2%	8	2.21	1	34.7%	21	43.9%	2
Manhattan	>50%							
Salt Lake City	11.9%	9	0.96	5	71.2%	3	23.3%	6
Chicago	5.7%	10	-1.01	20	64.6%	11	22.4%	7
Baltimore	1.8%	11	0.80	8	66.6%	9	14.2%	15
Birmingham	0%	12	-0.46	16	70.7%	5	4.8%	21
Cincinnati	0%	12	0.16	12	65.6%	10	9.3%	18
Detroit	0%	12	-0.69	19	72.4%	1	22.3%	8
Houston	0%	12	-0.52	17	59.5%	17	14.8%	14
Minneapolis	0%	12	-0.16	15	72.3%	2	11.1%	16
Philadelphia	0%	12	0.47	9	69.9%	6	21.1%	9
Pittsburgh	0%	12	0.26	11	71.2%	4	8.5%	19
Providence	0%	12	0.35	10	59.8%	16	20.6%	11
Rochester	0%	12	-0.68	18	67.9%	8	5.3%	20
Tampa	0%	12	0.16	13	69.8%	7	35.6%	3

Pair:	Rank Correlation	Correlation
(Homeownership rate, percentage developed land):	-0.41	-0.63
(Regulatory tax, regulatory index)	0.65	0.68
(Regulatory tax, homeownership rate):	-0.63	-0.55
(Regulatory index, homeownership rate):	-0.52	-0.69
(Regulatory tax, percentage developed land):	0.36	0.33
(Regulatory index, percentage developed land):	0.34	0.48

Sources: [i] Estimated regulatory tax values are from Glaeser, Gyourko and Saks (2005). [ii] Regulatory index values are from Saks (2005). [iii] Homeownership rates are from the Census 2000 (tract level data geographically matched to the metropolitan area level). iv) Developed residential and industrial land as percentage of developable land. Land use data is derived from the National Land Cover Data 1992.

Table 2: Summary Statistics of MSA-Level Variables (N=82)

Variable	Mean	Std. Dev.	Min.	Max.
Saks-index of housing supply regulation, late 1980s [a]	-.011	1.0	-2.4	2.2
Developed land as % of developable land, 1992 [b]	.15	.13	.014	.73
Developed residential land as % of developable non-industrial land, 1992 [b]	.12	.12	.0088	.68
Homeownership rate, 1980	.64	.074	.28	.76
Metropolitan area has major coast line [c]	.28	.45	0	1
Mean hours of sunshine in January, measured between 1941 and 1970 [d]	158.0	40.9	51.8	248
Real direct general local expenditures for highways in '000 dollar per square kilometer of developed land, average of FY1977, FY1982, FY1987 and FY1992 [e]	118.2	71.6	23.5	536.7
Share of households that consists of married couples without children, 1980	.30	.035	.20	.45
Household wage, 1980	15982	2379	9172	21967
Number of housing units in metro area x 10^{-6}, 1990 [f]	.62	.64	.035	3.44
Housing construction growth rate, 1980-1990 [f]	.21	.15	.013	.64
Housing construction growth rate, 1990-2000 [f]	.13	.087	.027	.48
Population density in developed area per square kilometer of land, 1990 [g]	1529	763	207	6106

Sources: a) Saks (2005); Method of index construction is described in Data Appendix of Saks (2005). b) National Land Cover Data 1992 (NLCD) from the U.S. Geological Survey. The NLCD 92 reports raster data including 21 different land uses with a spatial resolution of 30 meters for 49 U.S. states. The data has been geographically matched to the MSA level (using Census 2000 boundary files) by the authors of this paper. c) Derived from ESRI's Census 2000 MSA-level shape file. d) Original source of county level data is Area Resource File (ARF) maintained by Health Professions, within the Health Resources and Services Administration. See: http://www.arfsys.com. (Data has been derived from Natural Amenity Scale Data (NASD) from the Economic Research Service, United States Department of Agriculture (http://www.ers.usda.gov/Data/NaturalAmenities/). Data has been geographically matched from the county level to the MSA-level by the authors of this paper. e) U.S. Bureau of the Census: 1977, 1982, 1987 and 1992 Census of Governments (Government Finances). County-level data has been geographically matched to MSA-level by the authors of this paper. CPI data derived from Bureau of Labor Statistics, CPI-base period: 1982-1984=100. f) Data derived from Geolytics' Neighborhood Community Database (NCDB) covering U.S. Census data from 1970 to 2000 geographically matched to the Census tract level. Data has been geographically matched to MSA-level by the authors of this paper. g) Data derived from NLCD and NCDB.

Table 3: The Effect of Amenities on Metro Area-Land Scarcity

	Dependent Variable:					
	% Developed Land		% Developed Residential Land		Homeownership Rate	
	(1)	(2)	(3)	(4)	(5)	(6)
Metropolitan area has major coast line	.12 ***	.11 ***	.11 ***	.10 ***		-.053 ***
	(.033)	(.031)	(.030)	(.028)		(.011)
Mean hours of sun in January, 1941-70	.00087 ***	.00078 **	.00077 ***	.00068 **		-.00029 **
	(.00032)	(.00031)	(.00029)	(.00028)		(.00013)
Highway expenditure per km^2 of developed land in ‘000, 1977-92	.00037 **	.00047 ***	.00035 **	.00046 ***		-.00036 **
	(.00016)	(.00016)	(.00015)	(.00015)		(.00015)
% Households with married couples and no children, 1980		.61		.63	1.2 ***	1.2 ***
		(.49)		(.46)	(.22)	(.16)
Constant	-.066	-.24	-.074	-.26 *	.28 ***	.39 ***
	(.057)	(.16)	(.051)	(.15)	(.071)	(.055)
Number of obs.	82	82	82	82	82	82
Adjusted R^2	.37	.39	.37	.40	.33	.62

Notes: Numbers in parentheses are robust standard errors. *** Indicates statistical significance at the 1% level. ** Indicates significance at the 5% level. * Indicates significance at the 10% level.

Table 4: The Causal Effect of Land Scarcity on Land Use Restrictions Method: Two-Stage-Least-Squares

	Dependent Variable: Saks (2005) Index of Housing Supply Regulation, late 1980s					
Specification:	Without homeownership as control		With homeownership as exogenous variable		With homeownership as endogenous variable	
	(1)	(2)	(3)	(4)	(5)	(6)
% Developed Land	5.7 ***		4.4 **		3.9 ***	
	(1.9)		(1.8)		(1.4)	
% Developed Residential Land		6.3 ***		4.8 **		4.2 ***
		(2.1)		(2.0)		(1.5)
Homeownership rate			-3.4 **	-3.3 **		
			(1.3)	(1.4)		
Homeownership rate					-4.2 **	-4.3 **
					(1.7)	(1.7)
Constant	-.86 ***	-.77 ***	1.5	1.5	2.1 *	2.2 *
	(.26)	(.23)	(.99)	(1.0)	(1.1)	(1.1)
Number of obs.	82	82	82	82	82	82

Notes: **Bold** variables are endogenous. Instruments for % developed land and % developed residential land are the amenity variables from Table 3 (first stage). Columns (5) and (6) include the share of households with married couples and no children as an additional instrument to help identify the homeownership rate. Numbers in parentheses are robust standard errors. *** Indicates statistical significance at the 1% level. ** Indicates significance at the 5% level. * Indicates significance at the 10% level. The quantitative effects increase and statistical significance levels improve significantly if TSLS regressions are estimated instead of OLS.

Table 5: Regulatory Index Regressions with Controls for Density Method: Two-Stage-Least-Squares

	Dependent Variable: Saks (2005) Index of Housing Supply Regulation, late 1980s			
Specification:	With population density as exogenous variable		With population density as endogenous variable	
	(1)	(2)	(3)	(4)
% Developed Land	3.7 ***		3.7 ***	
	(1.3)		(1.3)	
% Developed Residential Land		4.0 ***		4.0 ***
		(1.4)		(1.4)
Homeownership rate	-5.5 **	-5.8 **	-5.4 **	-5.7 **
	(2.5)	(2.5)	(2.6)	(2.6)
Population density in developed area	-.00019	-.00022		
	(.00019)	(.00019)		
Population density in developed area			-.00016	-.00019
			(.00024)	(.00024)
Constant	3.3 *	3.5 *	3.1	3.4 *
	(1.9)	(1.9)	(2.0)	(2.0)
Number of obs.	82	82	82	82

Notes: **Bold** variables are endogenous. Instruments are the amenity variables and the share of households with married couples and no children. Numbers in parentheses are robust standard errors. *** Indicates statistical significance at the 1% level. ** Indicates significance at the 5% level. * Indicates significance at the 10% level.

Table 6: Explaining the Growth Rate of Housing Supply

	Dependent Variable: Growth rate of housing supply between 1990 and 2000					
Based on estimated regulatory index from:	Column (1) Table 4	Column (2) Table 4	Column (3) Table 4	Column (4) Table 4	Column (5) Table 4	Column (6) Table 4
	(1)	(2)	(3)	(4)	(5)	(6)
Growth rate of housing supply, 1980-1990	.37 ***	.37 ***	.36 ***	.36 ***	.35 ***	.35 ***
	(.049)	(.050)	(.051)	(.052)	(.055)	(.053)
Estimated regulatory index (fitted values)	-.035 ***	-.034 ***	-.039 ***	-.038 ***	-.039 ***	-.037 ***
	(.012)	(.012)	(.0099)	(.010)	(.0096)	(.0098)
Housing units in metro area x 10^{-6}, 1990	.0032	.0019	.0075	.0060	.0069	.0054
	(.010)	(.011)	(.011)	(.012)	(.012)	(.012)
Constant	.056 ***	.057 ***	.055 ***	.057 ***	.057 ***	.058 ***
	(.013)	(.012)	(.012)	(.013)	(.013)	(.012)
Number of observations	82	82	82	82	82	82
Adjusted R^2	.46	.46	.45	.45	.44	.44

Notes: Standard errors are (robust) bootstrap standard errors, computed using the bootstrap procedure in order to account for the fact that the regulatory index variable is estimated (the fitted values from columns (1) to (6) of Table 4). We performed 1000 bootstrap replications for each of the six regressions reported in columns (1) to (6) of Table 6. Bootstrapping only slightly increases the standard errors. Statistical significance levels are little changed. *** Indicates statistical significance at the 1% level. ** Indicates significance at the 5% level. * Indicates significance at the 10% level. Results are qualitatively virtually unchanged if the 1990 population size is used as control variable instead of the number of housing units in 1990.

Table 7: Quantitative Effects

	Effect of major access to cost line	
	Relative change in land scarcity (Change in percent)	Absolute change in land scarcity (Change in percentage points)
Table 3 (1)	30.2%	3.5%
Table 3 (3)	35.0%	3.1%

	Effect of increase in mean hours of sunshine in January by one standard deviation (+40.9 hours)	
	Relative change in land scarcity (Change in percent)	Absolute change in land scarcity (Change in percentage points)
Table 3 (1)	31.0%	3.5%
Table 3 (3)	35.2%	3.2%

	Effect of increase in average annual local highway expenditures per square kilometer of developed land by one standard deviation (+71,565 constant US-dollars; base-period: 1982-1994)	
	Relative change in land scarcity (Change in percent)	Absolute change in land scarcity (Change in percentage points)
Table 3 (1)	23.0%	2.6%
Table 3 (3)	28.2%	2.5%

	Effect of increase of land scarcity by one standard deviation (+13.2 / +11.9 percentage points) on regulatory restrictiveness	
	Change in regulatory index	Change in rank order
Table 4 (1)	+0.75	Rank 41 → Rank 21
Table 4 (2)	+0.75	Rank 41 → Rank 21
Table 4 (3)	+0.58	Rank 41 → Rank 23
Table 4 (4)	+0.58	Rank 41 → Rank 23
Table 4 (5)	+0.52	Rank 41 → Rank 28
Table 4 (6)	+0.51	Rank 41 → Rank 28

	Effect of an increase in the homeownership rate by one standard deviation (+7.4 percentage points) on the regulatory restrictiveness	
	Change in regulatory index	Change in rank order
Table 4 (3)	-0.25	Rank 41 → Rank 51
Table 4 (4)	-0.24	Rank 41 → Rank 51
Table 4 (5)	-0.31	Rank 41 → Rank 52
Table 4 (6)	-0.32	Rank 41 → Rank 52

	Effect of increase in predicted regulatory index by one standard deviation (+1.0) on the growth rate of housing supply	
	Change in the growth rate of housing supply between 1990 and 2000	Change in rank order
Table 6 (1)	-3.5%	Rank 41 → Rank 52
Table 6 (2)	-3.4%	Rank 41 → Rank 52
Table 6 (3)	-3.9%	Rank 41 → Rank 53
Table 6 (4)	-3.8%	Rank 41 → Rank 53
Table 6 (5)	-3.9%	Rank 41 → Rank 53
Table 6 (6)	-3.7%	Rank 41 → Rank 52

Notes: The marginal effects are measured at the means of the independent variables. The marginal effect of having major access to a coast is measured for an MSA that does not have major access to a coast. The change in rank order is calculated for the MSA with the median regulatory index and the median growth rate in the 1990s respectively.

Appendix B: The Impact of Homeownership

In this appendix we show that for given N_j, the homeownership rate has a negative effect on the marginal benefit of increasing regulation (as perceived by the planning board). We take a dynamic version of the model in a sense that will become clear in the immediate sequel.

Recall (2) from the model:

(19) $$u_j(h) = w_j - T_j - \tau_j h - R_j(h)\,, \qquad j = 1,2$$

That is, u_j is decreasing in T_j. Now, let us define total rent as

(20) $$r_j(h,T_j) \equiv T_j + R_j(h) = \tau_j(h - N_j) + T_j$$

which is a reformulation of (9).

Let us define the value of a dwelling unit as:

(21) $$W_j(h,T_j(t)) = \int_0^{\infty} e^{-(\rho+\delta)t} r(h,T_j(t),t)\,\mathrm{d}t$$

where ρ is the discount rate and δ is the dying rate, i.e. the expect duration of a building is 1/δ years. (At each time t, there is a probability δ that the dwelling unit collapses.) Let us study the properties of a stationary steady state; thus, from now on, we can omit the time variable t. At steady state, (21) simplifies to

(22) $$W_j(h,T_j) = \int_0^{\infty} e^{-(\rho+\delta)t} r(h,T_j)\,\mathrm{d}t = \frac{r(h)}{\delta+\rho}$$

Homeowners

At each time t, owner-occupiers have an exogenous probability λ_O of leaving the *city*. Implicitly, they do so only if they gain from it; in a stationary equilibrium, they would do so if there was a shock to their preferences, ν. Let W_j^O denote the value of homeownership for one unit of land; at steady state, the return on this asset is equal to:

(23) $$\rho W_j^{O}(h,\square) = 0 + \lambda^{O}[W_j(h,\square) - W_j^{O}(h,\square) - \bar{W}^{O}] - \delta W_j^{O}(h,\square)$$

where 0 is the flow of income from the dwelling (it is zero because they pay the rent to themselves), λ^O is the instantaneous probability the homeowner leaves, in which case the term inside the square brackets is the capital gain, and δ is the probability that the dwelling collapses, in which case the capital loss is the value of the property itself; $\bar{W}^{O}$ is the lifetime gross cost of leaving city j; it includes a moving cost of C^O. Homeowners care about the lifetime aggregate of rents insofar as they eventually leave because they sell the house (or rent it) from then on.

Tenants

At each time t, tenants have an exogenous probability λ_T of leaving the *city*. Implicitly, they do so only if they gain from it; in a stationary equilibrium, they would do so if there was a shock to their preferences, ν. Also, if the dwelling collapses before they move out to another city, assume that they relocate to another dwelling in the same city at no cost. The reduced form of these assumptions yields:

(24) $$\rho W_j^{T}(h,\square) = -r(h,\square) + \lambda^{T}[W_j^{T}(h,\square) - \bar{W}^{T}]$$

where the rent r comes with a negative sign because this is an expense and $\bar{W}^{T}$ is the lifetime gross cost of leaving city j; it includes a moving cost of C^T.

Absentee Landlords

The question as to whether absentee landlords eventually sell their lot or not is immaterial: with perfect foresight, the value of their property reflects the stream of future rents, so whether they sell it or not does change its value. Thus, the asset value of a piece of land owned by an absentee landlord, W^A, is worth W in (22); at steady state, this simply is:

(25) $$W_j^A(h,\square) = W_j\,(h,\square) = \frac{r(h,\square)}{\delta+\rho}$$

or if, when the dwelling collapses the regulation does not apply to them,

(26) $$W_j^A(h,\square) = W_j^A(h,\square) = \frac{r(h,\square)}{\rho}$$

Aggregate Welfare

With a given mass of residents, N_j, owners of undeveloped land earn zero. Assume that the planning board maximizes the welfare of the agents who *currently* have stakes in T, i.e. $\Omega \equiv \Sigma W + \alpha W^A$, namely, the planning board puts no weight on future residents' wellbeing and it puts an extra weight on the welfare of the (absentee) landowners; $\alpha=0$ if the board is fully benevolent. Consider first the case in which (25) applies. Solving for the steady state values of the W's in (23) and (24), the closed form solution for Ω is:

(27) $$\begin{aligned}\Omega(T) &= (1-\theta)[(1+\alpha)W^A(T)+W^T(T)]+\theta W^O(T)\\ &= (1-\theta)[(1+\alpha)\frac{\overline{r}(T)}{\delta+\rho}-\frac{\overline{r}(T)}{\lambda^T+\rho}]+\theta\frac{\lambda^O}{\delta+\rho+\lambda^O}\cdot\frac{\overline{r}(T)}{\delta+\rho}+\text{constant}\end{aligned}$$

where θ is the homeownership rate and $\overline{r}(T) = T + \tau N/2$ is the average rent. Since there is no risk of confusion, we can omit the subscript j from now on. Consider the first line of (27). The term in the square bracket trades-off the interests of the tenants against those of their (absentee) landowners; clearly, T is a transfer from the former to the later. However, the former are expected to stay (and thus to be hurt by T) $1/\lambda^T$ years and the later are expected to benefit from the rents generated by the dwelling for 1/δ on average. Clearly, it is reasonable to assume that dwellings last longer than tenures, on average, i.e. $\lambda^T > \delta$, thus it is clear that the wellbeing of landowners weight more than the wellbeing of the tenants, even if $\alpha=0$. The second term represents the wellbeing of the homeowners; they benefit from a higher T because this increases the value of their property. To sum up, renters only are being hurt by an increase in T. Therefore, in this simple model in which N is constant and, as a result, T affects neither N nor the well-being of owners of undeveloped land, it is clear from (27) that Ω is increasing in $\bar{r}(T)$ and thus increasing in T for all economically reasonable parameter values (in particular for any homeownership rate); to see this formally, rearrange (27) and note that $\lambda^T>\delta$ which implies $\partial\Omega/\partial T>0$.

However, even in this simple case we can already something useful before making N endogenous; specifically, we can see how the homeownership rate changes the rate at which Ω increases with respect to T. This is:

$$\begin{aligned} \frac{\partial^2\Omega}{\partial T\partial\theta} &= \frac{\partial\bar{r}(T)}{\partial T}\left(-\frac{1+\alpha}{\delta+\rho}+\frac{1}{\lambda^T+\rho}+\frac{1}{\lambda^O+\delta+\rho}\cdot\frac{\lambda^O}{\delta+\rho}\right) \\ &= -\frac{\lambda^T-\lambda^O-\delta}{(\lambda^T+\rho)(\lambda^O+\delta+\rho)}-\frac{\alpha}{\delta+\rho} \end{aligned} \tag{28}$$

which is ambiguous. The regulatory tax T is *inversely* related to the homeownership rate if this expression is negative.

The economic intuition for this result is as follows. First, when the homeownership rate increases, this increases the fraction of people who gain from the regulatory tax and reduces the amount of people who lost from it (tenants). However, when θ increases it also decreases the mass of absentee landlords, who are the people who gain most from the regulatory tax. Indeed, absentee landlords gain most from an increase in T because they do not forego the opportunity cost of living in their property whose value increases with T.

To see this, note that homeowners are in favor of a high regulatory tax because this increases the value of their property; however, they will realize a capital only when they sell it, namely, $1/\lambda^O$ years ahead for the average household. By contrast, renters are immediately hurt by this tax, and they will be so for an average of $1/\lambda^T$ years to come. Empirically, $1/\lambda^O > 1/\lambda^T$ seems to hold most of the time, so the first term in the right hand side of the bttom expression in (28) is negative. The second term is also negative. The third term is negative; thus, $\partial^2\Omega/\partial T\partial\theta$ is more likely to be negative, the more the planning board caters the interests of the landowners.

It makes also economic sense to assume that λ^T, $\lambda^O > \delta$, as said. A sufficient condition for the homeownership rate to influence positively the regulatory tax is that $\lambda^T > \delta+\lambda^O$ which holds if $\lambda^T>2\delta$, that is, if the expected lifetime of a dwelling is more than twice the expected tenure of a renter, a condition that is likely to hold in practice.

Appendix C: Spatial sorting according to income

In a partial equilibrium, the mechanism we describe in the text implies that rich people outbid poor people and hence are more numerous for any given ν in any location. Of course, in a general equilibrium everybody finds a place to live, so this effect has to be strongest in more desirable locations and, in the least desirable one, poor individuals actually outbid the richer ones. Which is the mechanism whereby poorer households are being outbid? In our model, the high regulatory tax associated with the area with the best natural amenities will make this jurisdiction undesirable for low-income households.

To see this, fix T_2, N_1 and N_2 and define

$$\textbf{(29)} \qquad \tilde{u}_j \equiv w_j - \tau_j N_j$$

as the location-specific component of net income that does not depend on regulatory taxes. Next, let $T_1^h(\nu,T_2)$ be the amount of money household h with income w^h and idiosyncratic preference for j=1 given by ν would be willing to forego to live in her preferred location instead than in the other one (without loss of generality, assume ν>0); formally, this is a 'compensated variation' and an 'equivalent variation' (there are the same in this case because the individual faces the same consumer price for an unspecified numeraire good in both locations). Let $\Delta T^h \equiv T_1^h(\nu,w^h,T_2) - T_2$ for short. Thus, by definition, household h is indifferent between living in j=1 and living in j=2:

$$\textbf{(30)} \qquad \ln(w^h + \tilde{u}_1 - \Delta T^h - T_2) + \frac{\nu}{2} = \ln(w^h + \tilde{u}_2 - T_2) - \frac{\nu}{2}$$

Under the assumption ν>0, the expression above implies $\Delta T^h > \tilde{u}_1 - \tilde{u}_2$ (conversely ν<0 implies $-\Delta T^h > \tilde{u}_2 - \tilde{u}_1$); in words, households are willing to sacrifice some net income to live in their preferred location. We now want to understand how this compensated or equivalent variation ΔT^h varies with individual gross income w^h. Total differentiation of (30) yields:

$$\textbf{(31)}\quad \mathrm{d}\Delta T^h = \frac{\Delta T^h - (\tilde{u}_1 - \tilde{u}_2)}{w^h + \tilde{u}_2 - T_2}(\mathrm{d}w^h - \mathrm{d}T_2) \gtrless 0 \iff \nu \gtrless 0$$

Given T$_2$, dT$_2$=0 thus the right hand side of this expression implies that the equivalent/compensated variation is increasing in w^h if, and only if, ν>0 (we have established that $\Delta T^h - (\tilde{u}_1 - \tilde{u}_2)$ is positive in this case). Conversely, using a symmetric argument, it is immediate that ν<0 implies that the symmetric relationship holds: $\mathrm{d}(-\Delta T^h)/\mathrm{d}w^h > 0$. Thus, for any given ν, rich households are able to outbid poorer households in their preferred location. Note that the larger is T$_2$ to start with, the lower is the net income and hence the larger is the marginal utility of income at all income levels and thus the weaker is this effect.

All these results follow directly from the concavity of V(.) in (net) income in (13). At the margin, people with lower income are less willing to substitute money for natural amenities. As a consequence of this, for given T$_1$ and T$_2$, only households with both an income w^h and an idiosyncratic preference for jurisdiction 1 sufficiently large so that their equivalent/compensating variation ΔT^h is larger than the actual gap T$_1$-T$_2$ will actually chose to live in jurisdiction 1. Formally:

$$\textbf{(32)}\quad N_1(T_1, T_2; \tilde{u}_1, \tilde{u}_2) = N \int_{\Delta T^h > T_1 - T_2} \mathrm{d}G(w^h)\,\mathrm{d}F(\nu);\quad \Delta T^h = \Delta T^h(w^h, \nu; \tilde{u}_1, \tilde{u}_2, T_2)$$

Without loss of generality, assume that the actual gap in the regulatory tax is such that the net income in region j=1, u$_1$, is lower than u$_2$ (this will in general be the case at equilibrium; see (10) and (11)). In this case, all households who prefer jurisdiction 2's natural amenities, i.e. whose ν is negative, end up living there. There is no outbidding here: the regulatory tax in j=2 excludes no one. By contrast, the regulatory tax in j=1 does generate spatial sorting according to income: the case with '>' applies in (31). In plain language, this implies that average household income in any given jurisdiction should be (at least weakly) positively correlated with the extent of land use regulation in that jurisdiction; the model suggests that this relationship is causal.

Given that ν is orthogonal to w^h, the mass of people with any preference ν who end up living in j=1 is non-decreasing in w^h. This intuition is illustrated in Figure 6, which pictures the fraction of people desiring to live in each region given u_1 and u_2 (in particular, given T_1 and T_2) as a function of their income and of their idiosyncratic preference for either jurisdiction's natural amenities. If land use regulations and 'economic amenities' were the same in both regions, then only a fraction $\frac{1}{2}-\varepsilon/(2\sigma)$ of households *of any class of income* wishes to live in 2; this corresponds to the area below the dashed line in the figure; however, given that j=1 is more regulated, the actual fraction of households who wish the live in j=2 is strictly larger – and is decreasing in w^h. In the case pictured, the poorest households cannot afford to live in j=1, not even those with a very high ν>0.

To sum up, the fraction of households with a given positive ν that desire to live in region 1 is non-decreasing in income (reading the figure from left to right); this is sorting by income. Likewise, the fraction of household with any given w^h that desire to live in region 1 is increasing in ν (reading from bottom to top); this is sorting by preferences for natural amenities. When households are heterogeneous along both dimensions, a rich sorting result emerges, but only the first type of sorting can be observed by the econometrician (unless survey data about the ν's were also available).

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