Supply Constraints and Housing Prices

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Abstract

We analyze the effects of supply constraints on housing prices. For plausible parameterizations, loosening regulatory constraints in individual jurisdictions would have little effect on prices, while coordinated loosening across markets could have large price effects.

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We analyze the theoretical effects of land use constraints on steady state land prices. While regulatory supply constraints are sometimes blamed for high housing prices in the coastal United States, it is difficult to assess the role of land use constraints empirically because we do not observe the same city at the same time with different regulations.[1] A key result is that loosening density restrictions in small jurisdictions would have little effect on prices for plausible parameterizations. For example, we show reasonable conditions under which, even if every building in Manhattan grew to 100 stories tall, prices would fall by less than 15 percent (ignoring induced amenity losses and wage changes). Larger effects could arise from coordinated reductions across regions.

We model freely mobile consumers who balance housing cost against wage differentials or taste for living in one city or another. This mobility scenario is similar to that described by Gyourko et al. (2004). Similar results to ours have recently been obtained by Van Nieuwerburgh and Weill (2006) in a dynamic equilibrium calibration.[2]

Supply constraints' price effects depend on the elasticities of land demand and population migration with respect to land price. "Open city" urban models assume infinite migration elasticity, so regulation cannot affect relative land prices. Arnott and MacKinnon (1979) find small welfare effects of building height restrictions in a "closed city," with zero migration elasticity . We model a more realistic intermediate case, where the migration elasticity is neither zero nor infinite.

We assume the consumer price of a square foot of structure is a constant, but land is in fixed supply. We ask what effect a small increase in the supply of land has on the price of land, ignoring amenity or wage consequences. Our model applies equally well to a city where all land is covered by a constrained number of stories of apartments with apartment space relabeled "land."

We ignore the amenity and wage effects of additional supply and abstract away from

[1] See, e.g. Glaeser et al. (2005b, 2006, 2005a).

[2] Van Nieuwerburgh and Weill (2006) gain traction by assuming that consumers are identical and that regions vary only by wages.

land heterogeneity within markets. We consider a static world, meant to represent a long-run equilibrium. We assume for simplicity that profits from land development are distributed to an absentee landlord.

A continuum of N consumers may live in any of a number of locations. In one of these locations, an island, there are only L units of land. Assuming the entire island is occupied in equilibrium, there is an endogenous price q per unit. The island approximates a region where transportation, infrastructure, and perhaps regulation constrain land development.

Preferences and land supplies give rise to the equilibrium price of land θ_i at which consumer i is indifferent between living on the island and living at their next preferred location. θ can vary across individuals if individuals vary in, e.g.: wealth, ability, taste, or wage match with the island. We assume the island is sufficiently small (or other locations have sufficiently elastic land supply) that migration between the island and other locations has negligible effects on outside land prices. The minimum value of θ that lives on an island with price q is q.

With the rest of the economy held constant, there is thus an equilibrium distribution of θ across consumers. We now analyze how this distribution relates to the effect of quantity controls on land price, starting with the land clearing condition:

$$N \int_q^\infty \overline{l(q,\theta)} f(\theta) d\theta - L = 0. \tag{1}$$

$\overline{l(q,\theta)}$ represents marshallian demand for island land at price q, averaged across all consumers of equilibrium willingness to pay θ. These consumers have probability density function $f(\theta)$ in the population.

Differentiating (1), the critical elasticity η_{qL} of prices with respect to land supply is:

$$\eta_{qL} = L \left(Nq \left(-\overline{l(q,q)} f(q) + \int_q^\infty \frac{\partial \overline{l(q,\theta)}}{\partial \ln q} f(\theta) d\theta \right) \right)^{-1}. \tag{2}$$

Noting that $\frac{L}{N} = \overline{l(q)}[1 - F(q)]$, where $\overline{l(q)}$ averages $\overline{l(q,\theta)}$ across $\theta \in [q, \infty]$:

$$\eta_{qL} = \left(-\frac{\overline{l(q,q)}}{\overline{l(q)}} \frac{f(q)}{1 - F(q)} q + \frac{\int_q^\infty \overline{l(q,\theta)\eta_{lq}(q,\theta)}}{\overline{l(q)}[1 - F(q)]} f(\theta) d\theta \right)^{-1} \tag{3}$$

The inverse of the elasticity η_{qL} sums two terms. The first term is a product of two parts: (a) the ratio of average land demand of marginal residents to the average land demand of inframarginal residents, and (b) the marginal hazard ratio of living on the island evaluated at q, multiplied by q. Our calibrations assume that ratio (a) is equal to one.[3]

The second term, $\frac{\int_q^\infty \overline{l(q,\theta)\eta_{lq}(q,\theta)}}{\overline{l(q)}[1-F(q)]} f(\theta)d\theta \equiv \overline{\eta_{lq}}$ is the average demand elasticity for inframarginal consumers, weighted by individual land consumption.

Table 1 summarizes the elasticity of land price with respect to quantity that arises under two different values of $\overline{\eta_{lq}}$ and four different distributions of θ in the population: uniform, Pareto, normal, and lognormal. We offer no opinion on which distribution is the most reasonable. Substitution among land, choice of city, and other goods imply θ and income may be very differently distributed.[4]

For each θ distribution, we calculate the elasticity of interest, η_{qL} by: (1) specifying the fraction $1 - F(q)$ of population that lives in a region, (2) specifying the median valuation θ in the population as a fraction of the price q, (3) normalizing prices relative to $q = 1$, and (4) assuming a value for $\overline{\eta_{lq}}$. These specifications identify $f(q)$ and $F(q)$ for any distribution defined by just two parameters. This is because we know q at two points: the 50th percentile and the observed price (normalized to one) at $1 - F(1)$ (the region's observed population share). Conditional on a distribution and average elasticity, only the choice of the population median willingness to pay per acre is controversial, so we vary that parameter widely in the simulations.

We consider median valuations of 10, 30, and 60 percent of current price as population medians. That is, we assume that in the long run, the median American would want to move to the market in question if prices were 90, 70, or 40 percent lower than currently observed. In evaluating the realism of these medians, note willingness to pay should be considerably

[3]Marginal residents' lower θ could signal either lower incomes and land demand or *greater* land demand holding income constant.

[4]Under the normal and in some cases uniform distributions, there are some negative valuations; our results are unchanged if negative values are replaced with zero.

larger in the long run we consider than in the short run. The lower the population median relative to current price, the greater the magnitude of η_{qL}. We also approximate the ratio of price if supply doubled to current price by assuming a constant elasticity equal to that found if θ is lognormal, assuming η_{qL} is constant ($q = kL^{\eta_{qL}}$). Multiplying quantity by x then multiplies price by $x^{\eta_{qL}}$.

Table 1 presents calibrated price changes with varying shares of national population, naming real world areas with similar populations. For the Manhattan and Hanover, New Hampshire, the assumption that the prices of nearby areas do not adjust down if there were a population shift into the central district is wrong. There would be some negative feedback to willingness to pay in the market in question, implying our results understate the price effect. However, the population density likely spikes near q due to equilibrium indifference among locations within a metropolitan area for similar households; this likely stronger effect implies our results overstate the price effect.

We find small elasticities of price with respect to supply for individual jurisdictions. For Manhattan, a demand elasticity for apartment space of -.4 would be moderate based on Hanushek and Quigley (1980). Under the normal distribution, this implies that the elasticity of interest η_{qL} is not far from -0.1, whatever the median threshold price θ. With a constant elasticity, this implies that multiplying quantity by eight would reduce price by less than 15 percent. Multiplying quantity by eight in Manhattan would imply uniform heights of 100 stories; architects and planners tell us such heights would devastate amenity and generate high marginal construction cost.[5]

The New York metropolitan area, with between five and ten percent of national population, is more plausibly a single housing market, and land (as opposed to apartment space) is arguably the relevant commodity. Gyourko and Voith (2000) suggest that -.7 is a moderate demand elasticity for land. Table 1 shows that under the normal distribution, if the median American would be induced to move to metropolitan New York by a 70 percent reduction in price, halving land prices would require a 15-fold increase in available land. This follows

[5]The 2005 *New York City Housing and Vacancy Survey* data show a mean height of at least 12.5 stories.

from the listed elasticity of -.26: ($15^{-.26} \approx .5$). Larger effects are found under the lognormal and Pareto distributions and when median willingness to pay is smaller.

In popular discussion "two Americas" are sometimes posed: one containing large coastal metropolitan areas, with tight land regulation, and the other consisting of largely unregulated interior regions.

Considering the 10 largest metropolitan areas (mostly coastal) as a single "island" region and the remainder of the country into another, the assumption that outside prices do not change when island land supply changes may be reasonable, since land supply is elastic in the second region. In Table 1, we find that with approximately 30% of US population, the price elasticity with respect to land supply in the meta coastal region would be approximately .5 if the median American would move into the coastal region if the land price fell forty percent. In this case, prices would fall by approximately thirty percent if land supply doubled in the largest coastal cities. By contrast, with skewed distributions and lower median willingness to pay, an elasticity of one or more arises, so that a doubling of supply could cut coastal land prices in half.

We conclude that individual jurisdictions are unlikely to increase "affordability" by encouraging more supply and recent housing price increases most plausibly reflect demand changes. A richer analysis would be required to estimate the welfare effects of local regulations, but given the large dollar value of regulated land, even small changes in prices may be associated with substantial economic loss. Metropolitan or federal coordination of loosened regulation might result in considerably stronger price reductions.

Table 1: Elasticity of land price with respect to land quantity η_{qL} under different distributions of willingness to pay θ and different land demand elasticities $\overline{\eta_{lq}}$

Top panel: land demand elasticity $\overline{\eta_{lq}} = .4$

Share	Analog	$\frac{\text{Median } \theta}{\text{price } q}$	Elasticity η_{qL} under distribution... Pareto	Lognormal	Normal	Uniform	Price Effect of $2L$
0.0020%	Hanover, NH	.3	-0.113	-0.066	-0.039	-0.000	-4.47%
0.7%	Manhattan	.3	-0.253	-0.164	-0.098	-0.010	-10.77%
10.0%	Metro New York	.1	-0.910*	-0.726	-0.345	-0.206	-39.56%
10.0%	Metro New York	.3	-0.576	-0.441	-0.277	-0.164	-26.33%
10.0%	Metro New York	.6	-0.282	-0.208	-0.166	-0.096	-13.44%
30.0%	Top 10 Metro	.1	-1.608*	-1.506	-0.930	-0.877	-64.79%
30.0%	Top 10 Metro	.3	-1.213*	-1.105	-0.788	-0.739	-53.52%
30.0%	Top 10 Metro	.6	-0.714*	-0.629	-0.521	-0.484	-35.34%

Bottom panel: land demand elasticity $\overline{\eta_{lq}} = .7$

Share	Analog	$\frac{\text{Median } \theta}{\text{price } q}$	Pareto	Lognormal	Normal	Uniform	Price Effect of $2L$
0.0020%	Hanover, NH	.3	-0.110	-0.065	-0.038	-0.000	-4.38%
0.7%	Manhattan	.3	-0.236	-0.157	-0.095	-0.010	-10.29%
10.0%	Metro New York	.1	-0.715*	-0.596	-0.313	-0.194	-33.86%
10.0%	Metro New York	.3	-0.491	-0.389	-0.256	-0.156	-23.66%
10.0%	Metro New York	.6	-0.260	-0.196	-0.158	-0.093	-12.70%
30.0%	Top 10 Metro	.1	-1.085*	-1.037	-0.727	-0.694	-51.28%
30.0%	Top 10 Metro	.3	-0.889*	-0.830	-0.638	-0.605	-43.75%
30.0%	Top 10 Metro	.6	-0.588*	-0.529	-0.451	-0.423	-30.70%

Note: * denotes that the results relate to a Pareto distribution with an infinite mean. "Share" stands for population share of the market, "$\frac{\text{Median } \theta}{\text{price } q}$" is the fraction of the current price at which the median individual would be willing to move to the metropolitan area and "Price Effect of $2L$" is the implied price change of doubling the land supply under the lognormal valuation distribution assuming constant elasticity of demand.

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