Rationing in the Market for New Housing

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Abstract

The paper investigates the possibility that regulation influences the price of housing by directly limiting the quantity of new housing produced. This possibility is in contrast to the usual treatment of regulation in the housing literature, which is to assume regulation influences the housing market by increasing the cost of development, including land assembly. The paper presents strong evidence that new housing is rationed in Southern California by examining a unique dataset of nearly 19,000 newly-constructed homes in three inland counties. The estimated shadow price of new housing is in excess of $80,000 per unit in many areas, and is shown to be significantly associated with measures of the intensity of local housing regulation. These results suggest that the possibility of regulatory rationing should play a more central role in models of housing and the urban economy.

1 Introduction

An extensive literature attempts to measure the impacts of regulation in the housing market. Dowall and Landis (1982), Mark and Goldberg (1986), Katz and Rosen (1987), Pollakowski and Wachter (1990), and Green (1999) examine the effect of land use regulation on the price of housing while Maser et al. (1977), Knaap (1985), Rose (1989), and Shilling et al. (1991) examine the effects of regulation on land prices. These studies are predicated on the standard treatment of land as a factor of housing production and assume that regulation affects the price of housing by increasing the price of land and other costs of development.

We investigate the possibility of regulation directly limiting the quantity of new housing produced in an area by preventing developers from optimally subdividing land. Rationing of the housing stock is a much stronger form of regulation than standard land use controls. In fact, the possibility that housing is rationed causes some of the findings of the standard urban economics model to fail. In the neoclassical framework developed by Alonso (1964), Mills (1967, 1972), Muth (1969) and Beckmann (1969) taught to every graduate student in urban economics, land is treated as a production factor for two competing goods, housing construction and yard space. The equilibrium marginal value product of land for these competing uses should be equal; consumers' marginal valuation of lot size is equal to the economic returns to land from additional housing construction. If this equality did not hold, developers could increase their profits by subdividing to reallocate land toward the higher valued use. However, the returns to housing construction per unit of land will exceed consumers' marginal valuation of land when subdivision is constrained and there is a limited supply of developable land. New housing construction will earn positive economic profits if regulation limits production.

This line of reasoning suggests a test for the presence of rationing in the housing market. We construct a unique dataset of 18,697 newly constructed home sales in the Inland Empire of Southern California from 1993 to 2003. Limiting the dataset to new homes greatly aids in the analysis since the land was subdivided recently and avoids issues of housing vintage. We use a Geographic Information System to avoid problems of over-aggregation and allow for variation in the price of land, housing qualities, and construction costs. We use locally linear regressions to estimate the return to land for additional lot size while the returns to land for additional construction are calculated by combining location and quality specific construction cost data with the sales data. Our analysis finds strong evidence of regulatory rationing: the return to land from new construction is significantly greater than the return from increased lot size in much of the study area. The median estimated shadow value of housing is over $80,000 per house in one quarter of municipalities in our study area. We also show that areas with regulatory regimes characterized as anti-growth by Glickfeld and Levine (1992) and Quigley et al. (2004) are associated with higher shadow prices of housing.

The fact that housing is rationed has significant implications for the study of the urban economy. First, regulatory rationing creates economic rents that will not be captured by the marginal price of land. Thus, the price of land will underestimate the welfare costs of future regulations that further limit new housing construction. Second, regulations that directly limit the quantity of new housing may reduce densities. Rationing prompts developers to produce housing with larger lot sizes than they otherwise would. In fact, low density development and other common indicators of urban sprawl may themselves be a consequence of regulatory rationing. Third, rationing implies that the price of housing is determined through an auction-like process rather than by the cost of factors of production. As a result, taxes on land and other factors of production will be of limited effectiveness, and rather act as wealth transfers. This idea may explain the findings of Mayer and Somerville (2000), who estimate that fees and taxes on development had little effect on the level of new construction in their panel data of 44 metropolitan areas between 1985 and 1996.

The remainder of the paper is laid out as follows. The next section provides a discussion of the housing and land markets with and without regulatory rationing. We show the standard result: in an unrationed equilibrium the value of land for additional housing construction equals consumers' valuation of additional yard space. Next we show that the returns to new construction will be higher than consumers' valuation of additional yard space in the presence of regulatory rationing. Section 3 describes the study region and datasets used in the analysis. Section 4 presents the econometric results used to estimate the value of additional lot size. Section 5 describes our estimation procedure and results for the value of land for additional housing construction. Section 6 tests and rejects the null hypothesis of no regulatory rationing in a majority of the region. Section 7 discusses the implications of these results and the relationship between our estimate of the shadow price of housing and measures of land use regulation across the region. Section 8 presents a brief summary of the paper, a discussion of future research in the area, and some final conclusions.

2 Regulation and the Housing Market

We begin by imagining a profit maximizing firm choosing the number of houses to build and the amount of land associated with each house in a particular neighborhood. Let H be the total number of houses produced, L be the quantity of land used per house, and P represent the price of a housing bundle, including the house and lot. The function $P(\cdot)$ relates the price of the home to the amount of land associated each house and the total number of houses built in the neighborhood, although we assume producers only directly affect the price through changes in lot sizes. Let the land market be defined by a scarce amount of land, $\overline{N}$. The producer's profit maximization problem is,

$$max_{L,H,\mu}\, \pi = P(L,\alpha)H - K(H) + \mu(\overline{N} - LH), \tag{1}$$

where μ is the price of land. Optimal production occurs where $P - K_H - \mu L = 0$, and $P_L H - \mu H = 0$. The equilibrium house price is equal to the marginal construction and development costs plus the equilibrium price of land. Further, the price of land, denoted by μ, is equal to consumers' marginal willingness to pay for lot space. Combining these equations yields the condition for optimal subdivision, namely,

$$\mu = P_L = \frac{P - K_H}{L}. \tag{2}$$

In words, this condition requires that consumers' marginal valuation of yard space is equal to the value of land producing additional housing. In effect, consumers purchase yard space by bidding land away from new housing construction until their marginal valuation of land is equal to the returns to land from housing construction. If this equality did not hold, a profit maximizing housing developer could increase its profits by devoting more land to the higher valued use.

The equilibrium results of Brueckner (1983) can be used to show this subdivision condition is a direct result of extending the urban economics literature developed by Alonso (1964), Mills (1967, 1972), Muth (1969) and Beckmann (1969). This neo-classical literature assumes that land is the scarce resource and accrues Ricardian rents. Somerville (1996) examines the contribution of land and structure to builder profits using a model of land scarcity and a micro-dataset of homebuilder land and structure expenditures. He finds a smaller than expected markup on land expenditures than predicted under a system of land scarcity. The coefficient on land expenditures is not significantly different from one for a majority of the Metropolitan Statistical Areas (MSAs) in his study. Rosenthal (1999) concludes the implicit market for residential buildings is efficient in Vancouver, British Columbia from 1979–1989 since deviations between the price of new buildings and their construction costs are dissipated more quickly than the time required for new construction. He concludes that any inefficiencies in the housing market must lie in the market for land.

We examine the possibility that regulatory rationing determines the housing equilibrium rather than land scarcity and production factor costs. Regulatory rationing and binding density constraints create economic rents that cannot be captured in the land market. Assume regulation constrains the maximum number of houses produced in a neighborhood to be $\overline{H}$ and λ is the shadow price of housing. Equation (1) is now replaced by

$$max_{L,H,\mu,\lambda}\,\pi = P(L,\alpha)H - K(H) + \mu(\overline{N} - LH) + \lambda(\overline{H} - H). \tag{3}$$

The equilibrium relationships between the variables of interest are shown in equation (4). Consumers' willingness to pay for more land and the value of land for new housing construction are no longer equal. Regulation limits the number of houses produced; the returns to land used to construct additional housing, $\frac{P-K_H}{L}$, are greater than consumers' valuation of land for additional yard space, P_L. This contrasts with the standard urban economics result in which they are equal.

$$\mu = P_L = \frac{P - K_H - \lambda}{L} \Rightarrow \frac{P - K_H}{L} - P_L = \frac{\lambda}{L} > 0 \tag{4}$$

A difference between $\frac{P-K_H}{L}$ and P_L persists because producers no longer have the opportunity to devote more land to housing construction. It is important to note that two other possibilities can bring about similar outcomes to equation (4). First, impact fees and other direct taxes of housing production not included in the construction cost measure will cause this difference, in which case λ will be the magnitude of the unmeasured tax. The empirical analysis that follows includes impact assessments and other development fees as production costs. Second, producer market power will cause $\frac{P-K_H}{L} > P_L$, however there seems to be little reason to suspect significant producer market power in the absence of regulations that limit entry and production.

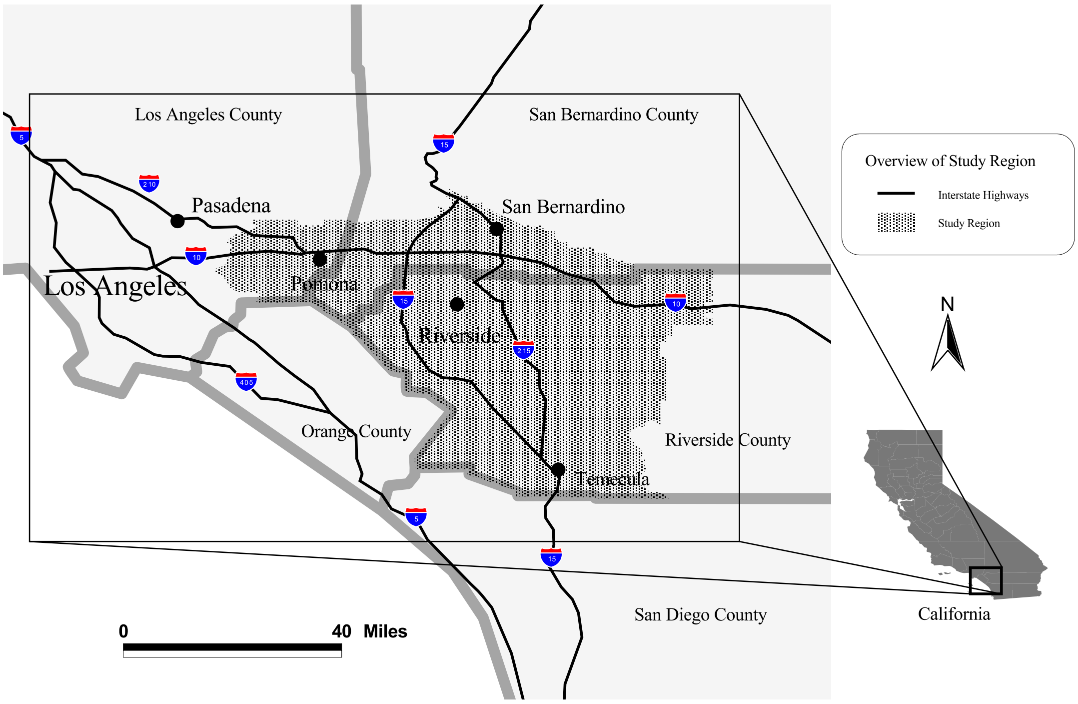
We use the test implied in equation (4) to test how the price of housing is set, through the marginal cost of inputs, or through an auction-like process because housing has been rationed. The impacts of policy interventions in a rationed market will differ from the impacts in a standard equilibrium. For instance, equation (4) shows taxes on housing production will have no effect on output as long as the tax is less than λ. Land restrictions or taxes will cause nothing more than an increase in housing density, if allowed by the regulatory regime. However, policies that further limit housing production will have marginal costs equal to the existing shadow price of housing, much larger than the zero marginal cost predicted by the envelope theorem under the neo-classical model.

The conclusions that can be drawn from comparing the values of land for yard space and new construction are important but limited. In particular, this test is not an indication of the presence or absence of regulation's impacts on the price of housing. In a nation-wide study Glaeser and Gyourko (2003) examine the relationship between regulation and housing affordability using a statistical test similar to equation (4). However, many common types of land use regulation, such as Urban Growth Boundaries, location restrictions, and land taxes, may have large impacts on the equilibrium house price, but will not be detected under a test such as this one if their primary impacts are increases in the price of land. The value of land for new housing construction will still equal the value of land for additional yard space as long as these policies allow producers to optimally subdivide. Conversely, governments may institute a rationing regime in the housing market and create a positive shadow price in the market, yet only have a minimal impact on the price of housing. The overall price impacts of rationing are ambiguous since rationing will decrease the marginal price of land.

3 Southern California Housing Data

Our empirical analysis is performed using housing market data in Southern California including parts of Los Angeles, San Bernardino and Riverside Counties (see Figure 1). It is a region characterized by high rates of recent growth and represents a substantial portion of the Los Angeles exurban growth. To the north lie the San Gabriel and San Bernardino Mountain Ranges; the Santa Ana Mountains run along the southwestern border of the study region.

Figure 1. Overview of the Study Area



The dataset includes 18,697 newly built home sales transactions between 1993 and 2002. Each observation consists of basic sales characteristics and the physical attributes of the home, including its exact latitude and longitude allowing for the use of Geographic Information Systems. A "median house" for the entire region would have four bedrooms, two-and-a-half bathrooms, 2,144 square feet of living space, a lot size of 7,405 square feet, and sell for approximately $275,000 in year 2003 dollars. The data are commercially available through DataQuick. com, a company that aggregates and distributes real estate data.

In order to avoid problems of improper comparisons, all analysis is in terms of 2003 dollars. Understanding that real estate prices change over time subject to

Figure 2. The Distribution of Sale Price

macroeconomic fluctuations and other market changes, the house prices were transformed into year 2003 dollars using the Conventional Mortgage Home Price Index (CMHPI), which is published quarterly by FreddieMac (2004). This index uses repeat home sales to establish a price index for Metropolitan Statistical Areas (defined by the Office of Management and Budget) over time in order to compare home prices across time. The index for Los Angeles and San Bernardino/Riverside were used for this analysis. Figure 3 shows the distribution of sales price over the entire study region. The mean sale price is approximately $300,000, with a standard deviation of $117,618. Table 1 summarizes the adjusted sales prices and other numerical variables within the study region.

The median lot size for the study region is 7,405 ft^2, with a mean of roughly 8,200

Table 1: Summary Statistics for the Study Region

	min	**25%**	**median**	**75%**	**max**	σ
Sale Price ($)	62,170	228,700	275,800	336,400	1,849,000	117,618
Lot Size (ft^2)	2,178	5,663	7,405	8,712	43,560	4,569
Living Space (ft^2)	773	1,750	2,144	2,665	7,960	675
Bedrooms	0	3	4	4	15	0.9
Bathrooms	0	2	2.5	3	8	0.6
Year Built	1992	1995	1998	2000	2002	2.8
Year of Sale	1993	1996	1998	2001	2003	2.7

ft^2 (essentially .2 acres). In the original dataset, less than 5% of homes had lot sizes over one-half acre (approximately 22,000ft^2), and in the final analysis, the data were censored to include only observations with lots smaller than an acre (this removed fewer than .9% of the observations). Although land is an important determinant of the price of a house, other characteristics of the homes are vital in any housing price hedonic function. The dataset contains information on the size of the house (living space) and the number of bedrooms and bathrooms in the house. The mean living space across the study region is just over 2,200 square feet, with a standard deviation of approximately 700. The mean number of bedrooms is 3.8 with a standard deviation of .9. The mean number of bathrooms is 2.6 with a standard deviation of .6.

4 The Value of Land for Yard Space

Section 2 argues the marginal value of yard space should equal the marginal value product of land used to produce housing if regulatory rationing is not present. This section describes and estimates the consumer valuation of yard space in our Southern California data.

Consider the general hedonic function in equation (5). The price of housing is a function of its location, lot size, and other characteristics and amenities.

$$House\ Price = P(location,\ lot\ size,\ living\ space,\ other\ amenities) \tag{5}$$

Given a hedonic function, the value of additional yard space is simply the marginal effect of lot size on price, $P_L = \frac{\partial P}{\partial L}$. P_L represents the opportunity cost of devoting one more unit of land to yard space. If the hedonic function is linear, P_L is simply the regression coefficient associated with lot size. Equation (6) is a typical linear hedonic regression, where P is an $n \times 1$ vector of prices, X is an $n \times k$ data matrix containing a column of ones and the physical characteristics of each house (lot size, living space, number of bedrooms, number of bathrooms, etc.), ε is an $n \times 1$ vector of error terms and β is the $k \times 1$ vector of marginal effects.

$$P = X\beta + \varepsilon \tag{6}$$

The commonly used model in equation (6) and Ordinary Least Squares coefficients, $\hat{\beta} = (X'X)^{-1}X'P$ is unsatisfactory because it fails to consider the underlying spatial nature of the problem at hand. There is not one marginal value of yard space in the study area; the price of land should vary across space to reflect changes in local amenities and market conditions.

We take advantage of our geo-referenced data and use a locally linear spatial econometric model to estimate the marginal value of yard space in our study region (SOME SORT OF CITATION HERE). Rather than attempting to account for spatial effects in the data through the use of artificial measures of location such as dummy variables for zip code or census tract, locally linear models allow coefficients to vary over space independent of imposed neighborhood boundaries. We allow the regression coefficients to vary over space by estimating $\hat{\beta}_i$ according to equation (7) for each location within the dataset, $i = 1, \ldots, n$. W_i is a symmetric $n \times n$ weighting matrix, where $W[i, j]$ is $1/k$ if observation j is one of the k geographically nearest neighbors to observation i, and 0 otherwise.

$$\hat{\beta}_i = (X'W_iX)^{-1}X'W_iP, \qquad \forall\, i = 1, \ldots, n \tag{7}$$

For each observation, we perform a linear regression using only the k nearest observations to observation i and assign the resulting $\hat{\beta}_i$ vector to the location of observation i. In this manner, the regression coefficients are allowed to vary across space as the data suggest. We implement the model using the nearest $1,000$, 600, 300, and 100 nearest neighbors to test the model's sensitivity to the k parameter.

5 The Value of Land for House Construction

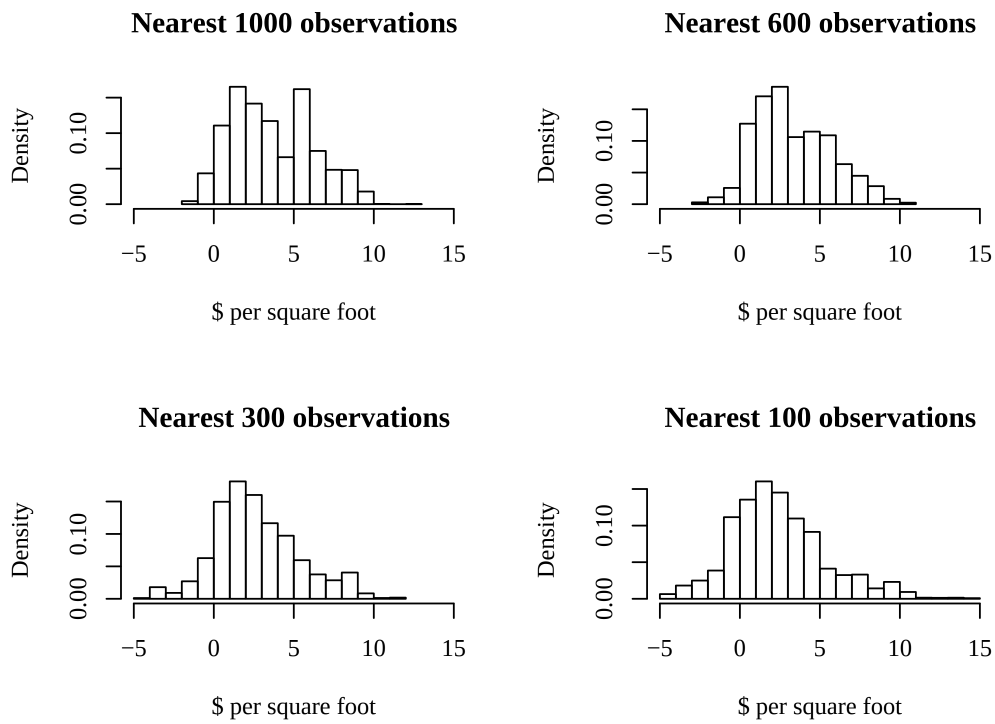
The value of land for house construction is the difference between the revenue raised from house construction, P, and the marginal costs of production, K_H, per

Table 2: Mean and Standard Deviation of Locally Linear Hedonic Regression Coefficients

	$k = 1,000$		$k = 600$		$k = 300$		$k = 100$	
	mean	σ	mean	σ	mean	σ	mean	σ
Lotsize	3.6	2.5	3.4	2.3	2.7	2.7	2.4	3.2
Squareft	91	33	90	37	90	39	84	37
Numbath	12,000	16,000	9,500	15,000	6,900	18,000	4,200	23,000
Numbed	-7,300	7,300	-6,600	8,300	-5,300	8,300	-2,600	12,000
Time	-810	3,100	-830	3,800	-370	4,600	51	6,100
(Intercept)	62,000	51,000	70,000	51,000	76,000	51,000	88,000	68,000

The median distances to the k^{th} nearest neighbors were 4.8, 3.4, 1.6, and 0.5 miles.

Figure 3. The Distribution of the Marginal Effect of Lot Size on House Price



square foot of lot size, L. We calculate the returns to land for housing construction across the study area according to equation (8).

$$\text{Land Value for House Construction} = \frac{P - K_H}{L} \tag{8}$$

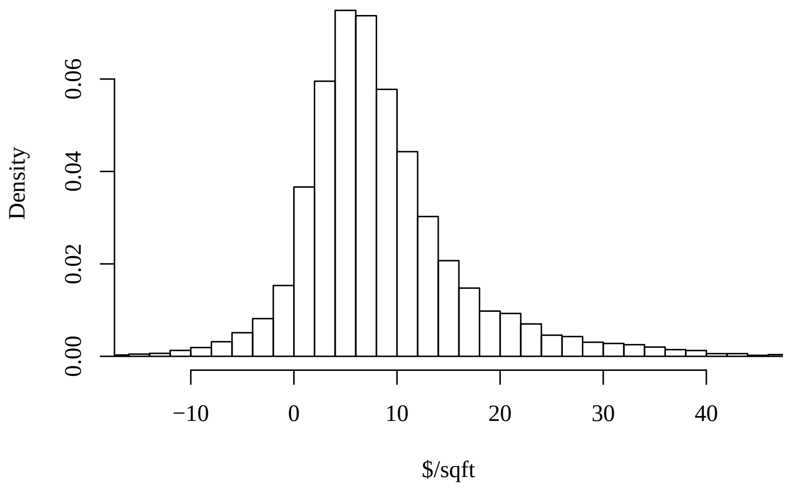
We obtain sales price, P and lot size, L data from the DataQuick dataset. We obtain measures of the construction costs, K_H, from the *Residential Cost Handbook* by Marshall and Swift (2002). The Marshall and Swift (2002) data provide cost estimates at the county and city level, providing some of most accurate cost data available. The *Handbook* provides a means of estimating the construction costs of homes based on their location, size, construction materials used, and overall quality level.

The DataQuick dataset contains the absolute location and size of each house, two of the most important determinants of housing construction costs, but assumptions regarding the construction materials and overall quality are needed in order to estimate the construction costs. Marshall and Swift (2002) distinguish among six quality levels: low, fair, average, good, very good, and excellent, and a handful of of the most common construction materials. We make the simplifying assumption that all houses are constructed of the same material, wood framed stucco. This construction material has the advantage of being common, and is neither the most, nor least, expensive material detailed in the *Handbook*. Rather than assuming all of the houses in the study are of one quality, as done by Glaeser and Gyourko (2003), we assume construction quality varies within the data. A potentially serious implication of a less-than perfect quality determination is that it may result in a type 1 error. False positives will occur if the estimated construction costs are biased downward. We assume housing qualities are solely among the four highest quality levels in order to combat potential downward bias. Construction qualities are determined as follows: homes with adjusted sales price less than $\$350,000$ are average quality, good quality for homes priced $\$350,000 - \$750,000$, very good quality for homes $\$750,000 - \$1,000,000$, and excellent quality for homes greater than one million dollars.

We also include other housing production costs, including site preparation, design, regulatory fees, and marketing costs. Just as costs of construction vary across quality levels, these additional costs vary across quality levels. Interviews with local developers resulted in estimates of $35 per square foot of living space for average quality homes, $45 for good quality homes, and $55 for higher quality houses. These costs are consistent with work in the area by Economic and Planning Systems (2005). These assumptions combined with the Marshall and Swift (2002) data result in construction cost estimates of roughly $90 per square foot of living space for the lowest assumed quality level, to $190 per square foot for excellent quality homes. Our estimates result in approximately 21% of our observations having production costs greater than 90% of their sale price.

We generate point estimates of the value of land for housing construction as described in equation (8) using the price, lot size, and construction cost data for each observation within the data set. A histogram of the results is shown in Figure 4. Negative values represent observations for which the estimated construction costs were higher than the sales price.

Figure 4. The Value of Land for Additional Housing, $\frac{P-K_H}{L}$

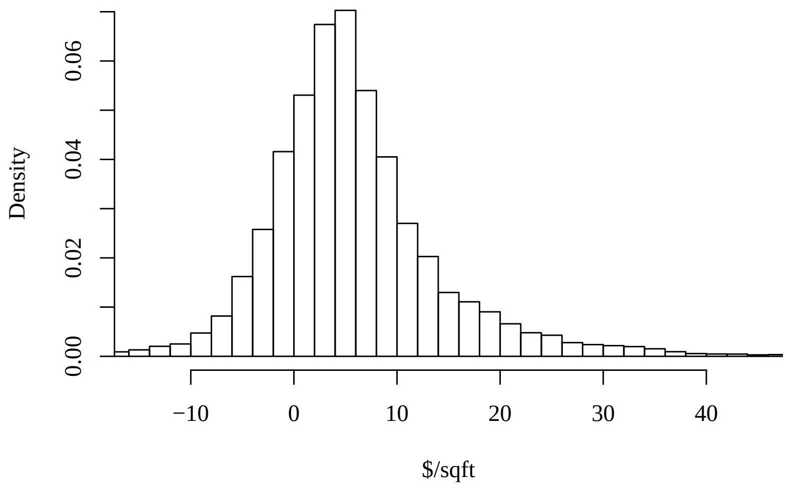


6 The Value of Land for Yard Space vs. New Construction

This section compares the estimated value of land for additional yard space to the value of new housing construction. In the absence of regulatory rationing the returns to land for these competing uses should be equal, while regulatory rationing will cause the value of land for additional construction to be larger than the return to land for additional yard space. A histogram of the differences between the value of land for housing production and yard space is shown in Figure 5. The mean difference is \$5.80 per square foot of land, with a standard deviation of \$8.46; over 79 percent of our observations have an estimated difference greater than zero.

Under the neo-classical equilibrium, the value of land for housing production minus consumers' valuation of additional yard space should be equal to zero. We can test this null hypothesis for each observation using a t-test, where $\hat{\sigma}_{P_L}$ is the standard

Figure 5. The Difference in the Value of Land for Housing and Yard Space, $\frac{P-K_H}{L} - \hat{P}_L$



error of the locally linear regression coefficients.

$$\frac{\frac{P-K_H}{L} - \widehat{P_L}}{\hat{\sigma}_{P_L}} = t \tag{9}$$

Over 72 percent of the 18,697 observations have t-statistics greater than 2; the median t-statistic is 6.8. These results suggest a majority of observations have a positive and statistically significant difference between the value of land for house production and yard space, a result consistent regulatory rationing.

7 Regulation and The Shadow Price of Housing

Until now, we have been comparing the value of land per square foot for house construction and the value of an additional square foot of yard space. By rearranging equation (4), we can use our estimates to calculate the shadow price of housing,

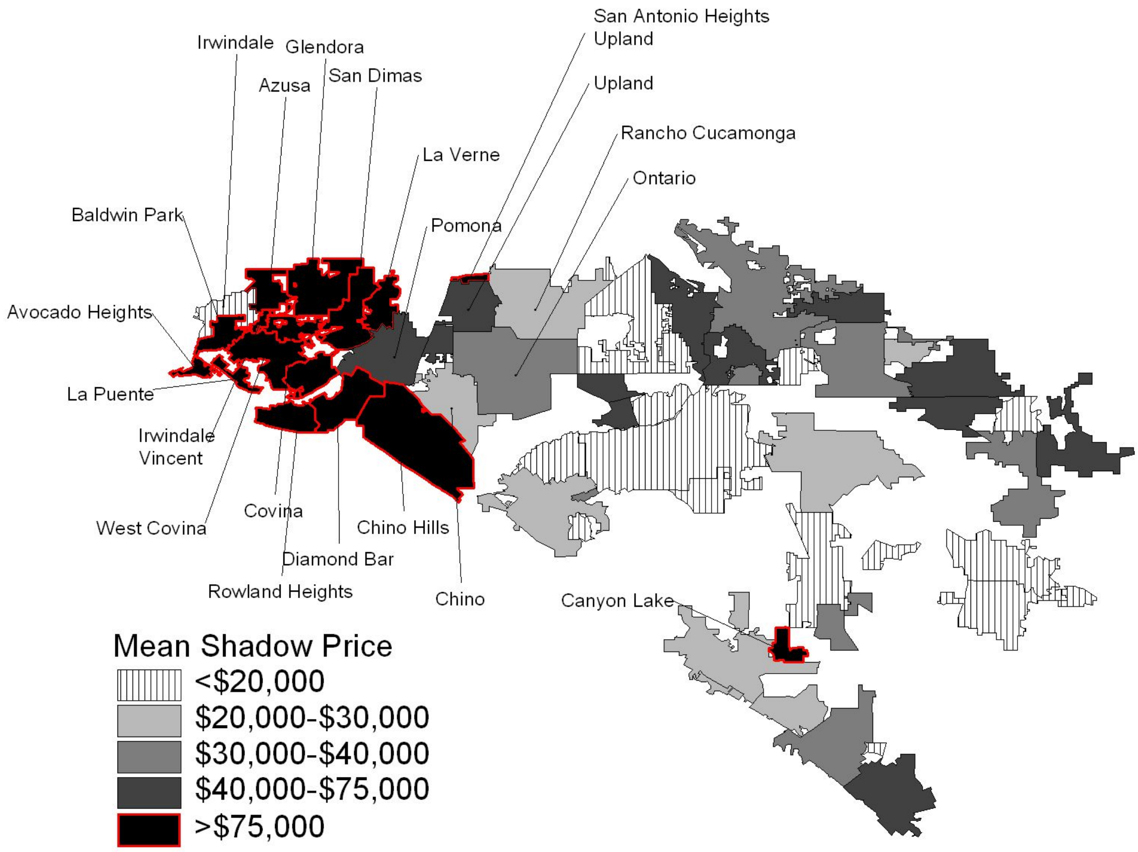
$\lambda = P - K_H - P_L L$. This section explores the link between our estimates of the shadow price of housing and local land use regulations.

Glickfeld and Levine (1992) conducted surveys of local officials in the early 1990s to obtain land use regulation data. Quigley et al. (2004) and Rosenthal (2000) use these data to construct regulatory measures by Federal Information Processing Standard (FIPS) places. In particular, a regulatory index was created for each municipality measuring the extent to which the regulatory regime is "pro-growth" and "exclusionary". Regulations that determine the measure include restrictions on the number of building permits issued, population growth restrictions, density restrictions, growth management plans, and urban growth boundaries.

These data include regulation indices for 40 municipalities within our study region, encompassing 14,694 of our 18,697 observations. The pro-growth index ranges from 0 to 7 with higher values representing local government attitudes and regulations encouraging growth. The mean value for our data is 3.3 with a standard deviation of 1.9. The exclusionary index ranges from 0 to 19, with larger values representing local government attitudes and regulations preventing certain types of growth. The mean value for our data is 9.7 with a standard deviation of 4.7.

Table 3 displays the median shadow price of housing and the local regulatory indices by FIPS place. We perform a simple linear regression of median shadow price of housing on the two regulatory indices. We use the median shadow price of housing since the mean shadow price of housing is subject to skew from extreme

Figure 6. The Spatial Distribution of the Shadow Price of Housing by FIPS Place



values. We a priori assume the pro-growth index to have a negative relationship with our estimate of the shadow price of housing, as governments become more "pro-growth" it seems less likely that housing is rationed in their municipality. We also predict that local governments with "exclusionary" regulatory regimes may be more likely to enact policies that ration housing and increase our estimate of the shadow price of housing. Table 4 displays the results of our regression. An increase in the pro-growth index is associated with a $13,557 decrease in the median shadow price of housing for the municipality. This result is statistically significant and of the predicted sign. The coefficient associated with the exclusionary index is -824, but statistically insignificant.

Table 3: Median Shadow Price of Housing and Regulatory Indices by FIPS Place

	N	λ	Pro-growth	Excl.
Azusa	7	84,330	3	8
Baldwin Park	12	97,177	1	3
Banning	474	58,483	7	8
Beaumont	24	30,411	0	0
Calimesa	36	56,480	3	6
Canyon Lake	1	83,343	0	8
Chino	190	28,756	2	12
Chino Hills	1390	97,389	2	9
Colton	131	45,148	6	10
Corona	1803	29,230	5	18
Covina	42	138,456	2	5
Diamond Bar	1	172,406	1	14
Fontana	1782	17,769	4	14
Glendora	5	247,596	2	5
Grand Terrace	4	37,181	3	11
Hemet	369	−5,166	3	18
Highland	354	56,823	4	8
Irwindale	15	−41,953	4	8
La Puente	3	193,245	2	8
La Verne	141	180,652	3	15
Lake Elsinore	630	23,813	7	6
Loma Linda	58	7,041	4	9
Montclair	38	42,596	2	3
Moreno Valley	689	30,306	5	10
Murrieta	1081	32,953	0	2
Norco	132	−62,002	4	12
Ontario	268	41,967	2	14
Perris	373	14,333	6	11
Pomona	32	75,115	4	6
Rancho Cucamonga	581	23,141	4	7
Redlands	57	32,144	2	12
Rialto	404	43,816	5	11
Riverside	683	18,505	3	19
San Bernardino	336	31,181	5	19
San Dimas	46	132,053	1	6
San Jacinto	343	−2,372	7	10
Temecula	1758	43,103	4	3
Upland	57	61,884	5	14
West Covina	163	172,723	2	10
Yucaipa	181	45,106	4	15

8 Conclusion

The standard neo-classical approach to urban growth suggests that the returns to land for competing uses will be identical in equilibrium. This concept is both sim-

Table 4: The Shadow Price of Housing and Local Land Use Regulation

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	113,432	24,608	4.61	0.0000
Pro-growth Index	−13,557	5,330	−2.54	0.0153
Exclusionary Index	−824	2,123	−0.39	0.6999

ple and appealing: if land is more valuable being devoted to the production of additional housing, then land should be subdivided to produce more housing. Regulatory constraints on the allowable number of housing units precludes this process.

Our paper utilizes a unique dataset to test whether housing is rationed in Southern California. We find strong evidence that housing is directly rationed through regulation rather than indirectly controlled through land use restrictions. These results are robust to different econometric specifications used to estimate the value of additional yard space and various assumptions regarding the quality of housing across the area. Our study also yields estimates of the shadow price of housing resulting from regulation. Importantly, we also find a statistically significant relationship between our estimates of the shadow values of housing and conventional measures of regulation intensity.

Rationing is a stronger type of regulation than zoning and other land use restrictions. Our analysis says little to nothing about the efficiency of the regulations in place. However, the rationale of regulation as a market correction would appear to be stronger for zoning and other land use restrictions than it is for regulatory rationing. Directly limiting the number of houses produced may instead suggest exclusionary zoning and rent seeking.

Our results underscore the central role regulation should play in models of the urban economy. Future research should be undertaken to determine whether our results apply to other areas as well. Future work is also necessary to collect and catalogue regulation data across markets.

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