Land-use Regulation and the Production of Affordable Housing

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Abstract

Land-use regulation is generally said to affect the cost of housing by restricting the quantity of new units. The cost of a unit, however, depends not only on market supply but also on the unit's quality. By modelling the decisions of a single developer under several American regulatory regimes, this study shows how land-use regulations encourage or discourage the production of affordable housing by changing the quality that developers choose to build. Exclusionary policies are shown to make low-quality, cheaper units more expensive to build and keep low-income persons from forming efficiently-sized households. Inclusionary zoning is shown to lower the quality of market-rate units by relaxing existing restraints and by requiring quality parity between market-rate and price-controlled units.

This study presents a framework for analyzing how land-use regulations influence the construction of affordable housing. The framework is used to give a rigorous basis for the urban planning terms "inclusionary" and "exclusionary" zoning. To clarify the scope, it will help to make two points at the outset. First, "affordable housing" is taken to mean housing which either (i) has a low price or (ii) winds up occupied by lower-income persons. Second, there are at least three ways to think about how a unit comes to be affordable:

1. Fiat: The government sets a private unit's rent below the market-price through rent control laws, or acts as the landlord itself through the provision of public housing.

2. Quantity: The housing stock is large enough, relative to demand, to clear at a low price of the housing service of which a housing unit constitutes an indivisible bundle.

3. Quality: The unit's attributes—its size, age, condition, design, etc.—lead to either a low price or to lower-income renters outbidding others for tenancy there.

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The focus of this study is on the last strand of logic—quality as a determinant of affordability—which underpins essentialist labels for housing such as "workforce" or "luxury." Perhaps because they represent areas too small to shape market conditions before being flooded with development, quality also tends to be a principal interest of local policymakers. For example, in a newspaper op-ed, San Francisco supervisor David Campos writes: "In the last 7 years we've built over 23,000 luxury units, and only 1,200 units for middle class families" (Campos, 2015). A charitable reading of the statement is that "luxury units" are those with designs that solicit the highest bids from upper-income households—bids large relative to typical incomes.

The division of the housing stock among income groups by quality has already received significant attention in the literature on filtering[1]. However, it is safe to say that most studies of the link between zoning and affordability, such as Glaeser and Gyourko (2003) and Glaeser and Ward (2009), have focused on the degree to which zoning raises prices by curbing quantity. The absence of a parcel-level theory, focused on the decisions of a lone developer, can lead to rough analysis: several studies (Ellickson, 1980; Bento et al., 2009) have presented inclusionary zoning—a policy that forces developers to supply rent-controlled units in new projects—as a sort of tax in the market for "housing units" using the supply-and-demand diagram of an economics textbook. While it may be true that inclusionary zoning raises costs and market prices, the approach invites the same critique that Frankena (1975) directed at the textbook treatment of rent control: the market is for housing *services*, but rent control is a ceiling on the prices of *units,* which are bundles of service. Moreover, using building permits as an index of production to measure the effect of inclusionary zoning, as in Schuetz et al. (2011), may ignore the policy's strongest impacts.

The discussion proceeds in four parts. Section 1 exposits a model housing market and derives a diagram that makes the effects of regulations simple to analyze. Section 2 gives background on exclusionary zoning—policies alleged to discourage the building of affordable housing—and couches such policies in the diagrammatic framework. Exclusionary zoning is shown to raise the cost of building low-quality units and to prohibit low-income renters from forming efficiently-sized households. Section 3 treats inclusionary zoning, which is shown to lower the quality of new market-rate units. It does so by requiring quality parity between market-rate and rent-controlled units and, when accompanied by a density bonus, by allowing small lots. This study is the first to frame the developer's choice of unit quality and production inputs under inclusionary zoning. Section 4 concludes and suggests topics for further research.

1 Model set-up and the Fundamental Diagram

The setting is the same as that of the "monocentric city" model developed in Mills (1967) and Muth (1969): a competitive housing market composed of renters. Renters have strictly quasi-concave, homogeneous utility functions

[1] See Muth (1973), Sweeney (1974), Braid (1984) and Rosenthal (2014)

given by $u(z, s)$, where s represents consumption of a generic housing service and z the numeraire of non-housing consumption. [2] Unlike the monocentric city model, however, we only treat a single point in the plane, and transport costs drop out.

All renters of a given income make up a 'class,' which in equilibrium exhibits one utility. Therefore, renters can be defined by vectors from the set

$$\mathcal{P} = \{...(y_i, v_i), ...\}$$

where y_i and v_i are, respectively, class i's income and utility. Utility strictly rises with income, and $\mathcal{P}$ is ordered by income. There is no particular ratio between the utility and income of a class, however.

The class endowments make it possible to solve for each class' willingness-to-pay for different qualities of housing. To do so, first define the indifference curve, $z(\cdot)$, by the relation

$$u\left[z(s, v_i), s\right] = v_i. \tag{1}$$

The concavity of u makes z convex to the origin and approach the s and z axes asymptotically. Call p the "rent" and the product sp the "total rent" of a housing unit. Substituting $z(s, v_i)$ into i's budget constraint yields

$$y_i = sp + z(s, v_i), \tag{2}$$

which begets the "rent-quality curve"

$$p_i(s) \equiv \frac{y - z(s, v_i)}{s}. \tag{3}$$

The shape of $z(s, v)$ gives $p_i(s)$ the hump shape depicted in Figure 1, going to $-\infty$ and $s \to 0$ and 0 as $s \to \infty$. These properties are intuitive: most people would have to be paid to live in a broom closet, while \$1/ sq. ft. might be too much to pay for a 30,000 sq. ft. mansion. To the author's knowledge, a curve of this shape first appears in Muth (1973) in an analysis of deterioration. The maximum of $p_i(s)$ is what urban economists call class i's "bid-rent" for the housing being considered.

As for supply, a developer builds units of quality s using the concave, constant-returns production function $f(K, L)$, where L is land and K is capital. Figure 1 illuminates the choice of s. $C(s)$ is the average cost of a unit of quality s—the unit's total cost divided by s—assuming the least-cost mix of L and K permitted by law. Constant returns-to-scale give $C(s)$ a constant value, $\bar{C}$, without regulation. The second curve, $P(s)$, is the upper envelope of the p_i's over $\mathcal{P}$—the locus of feasible rent/quality vectors. To maximize profits, the developer chooses s where the vertical gap between P and C is greatest (s^* in the diagram). At some s, the class i for whom $p_i(s) = P(s)$ winds up occupying the units. Note that, because the housing expenditure of a renter always rises

[2] For thorough reviews of the standard economic theory of housing, see Brueckner (1987) and Arnott (1987).

as $s$moves rightward along its p_i, and $P(s)$ is the upper envelope of p_i, total rent rises monotonically with quality.

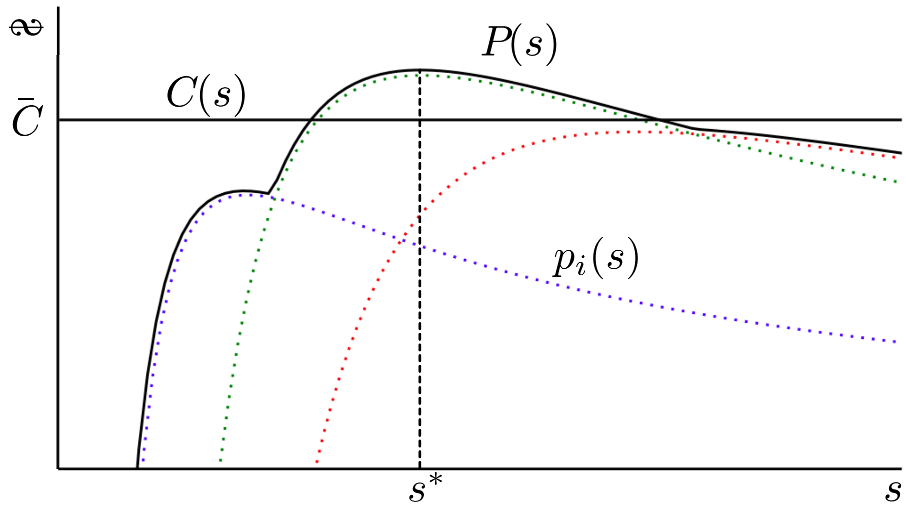

Figure 1: Fundamental Diagram

From now on the plot of P and C in $(s, \$)$ space will be called the Fundamental Diagram. The utility of the Fundamental Diagram is that it allows questions about the effects of land-use regulations to be answered and visualized by reasoning from changes in P and C.

2 Exclusionary Zoning

This section formalizes exclusionary zoning policies: those that result in housing with higher total rents or else tilt occupany toward higher-income renters. Three policies are considered: a lot-size minimum, a per-unit levy and family restrictions.

2.1 Lot-size minimum/maximum residential density

American municipalities commonly impose a minimum lot size. An equivalent, reciprocal phrasing of the rule is a maximum residential density of housing units per unit of land. While there are probably various political motives behind such rules, a purely economic motive can be traced to the negative externalities of density, which lower property values. These include both physical externalities, such as traffic congestion, as well as "fiscal externalities" associated with the strain of growth on public budgets. Inman and Rubinfeld (1978) summarizes the fiscal motive: in a town with an ad valorem property tax and an average lot size of $\bar{L}$, new arrivals who consume less than $\bar{L}$ in land consume the average public expenditure but pay a less-than-average tax bill, leading to higher taxes on incumbents.

If lot size and housing quality were one and the same, the policy's effect on affordability would be transparent. Here, while the rule does not place a *de jur* floor on quality, it does prohibit the least-cost mix of land and capital used to produce low-quality units.

Consider Figure 2. The $K(L,s)$ are isoquants of (L,K) vectors that produce one level of s. The path of least-cost combinations is E, composed of points on the isoquants where the slope of the tangent line is c_K/c_L. To incorporate regulation, let $\tilde{L}$ be the minimum lot-size. For qualities whose isoquants intersect E to the left of $L=\tilde{L}$, such as s_1, the least-cost factor mix is prohibited: the developer could use more capital and less land to produce the unit at lower cost. These are qualities lower than $\tilde{s}$ for which $L=\tilde{L}$ is efficient. By contrast, for high qualities such as s_2, the rule is irrelevant; $C(s)=\bar{C}$ for $s>\tilde{s}$.

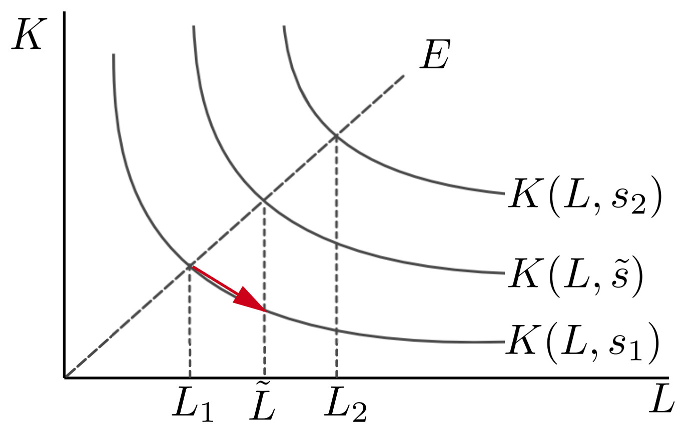

Figure 2: effect of lot-size minimum

Figure 3 plots the consequences in the Fundamental Diagram. Starting from zero, $C(s)$ falls until flattening at $(\tilde{s},\bar{C})$. Qualities where $C(s)>P(s)>\bar{C}$, such as s_1^*, are made unprofitable by the minimum lot-size. In the case depicted, production slides along $P(s)$ from s_1^* to s_2^*, thereby changing the occupying class and and raising total rent.

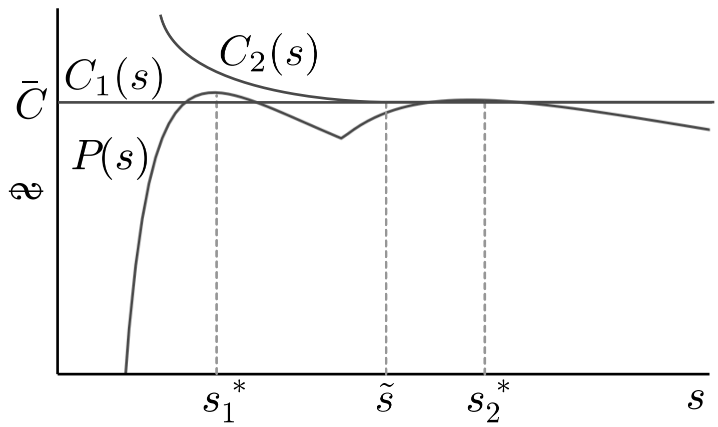

Figure 3: effect of lot-size minimum

The results can be generalized to minima placed on other attributes of housing units by considering the optimal division of a budget of s among subutilities. Minimum sizes for kitchens and bedrooms may distort the best use of floorspace in small units, while parking minima, setbacks and yard sizes may impede the enjoyment of small lots.

2.2 Per-unit levy

Municipalities often impose one-time levies on new units alongside ad valorem property taxes collected annually. A common one is a "development impact fee" earmarked for the infrastructure that new residents require. Gyourko (1991) argues that such impact fees are a less exclusive alternative to minimum lot sizes: when municipalities can charge newcomers their share of the public budget, there is less of a fiscal case for "zoning out" households who will pay a less-than-average amount of property tax.

The effect of a levy is easily deduced. A levy raises the cost of all qualities to some degree, but by doing so more intensely for low-quality units it introduces a differential in costs in a manner similar to the lot-size minimum. If $\hat{C}$ is the levy, then $C(s) = \bar{C} + \hat{C}/s$. Since $C(s)$ declines with s, lower-quality units are handicapped.

2.3 Family limits

In *Village of Belle Terre v. Boraas*, 416 U.S. 1 (1974), the US Supreme Court affirmed that municipalities have the power to legislate a maximum on the number of unrelated persons in one household. It may not be clear at first why such a limit would disadvantage poor renters per se. Poor renters might be expected to each consume less housing service, but why should this smaller consumption happen alongside more housemates?

A formal answer can be fashioned from two observations. First, there are fixed costs to the set-up of a household, including appliances, common areas, furniture, and some part of utilities. Second, crowding is a nuisance. Therefore, renters may trade savings in per-capita fixed costs for less crowding, and wealthier renters might do so sooner. Consider the following example.

Let κ be the fixed costs of a household, and n its number of renters. If fixed costs are evenly shared, each renter's bill is κ/n. Thus, the budget of a renter of class i in a household of size n is

$$y_i - \kappa/n = z + sp, \tag{4}$$

where s has become per-capita consumption of the housing service. Next, suppose utility is given by

$$u(s, z, n) = s^{\alpha} z^{\beta} n^{-\gamma}, \text{ where } \alpha, \beta, \gamma \in (0,1). \tag{5}$$

Crowding enters by the negative exponent on n. Substituting $y_i - \kappa/n - sp$ for z in u yields a modified rent-quality curve:

$$p_i = \frac{1}{s}\left(y_i - \frac{\kappa}{n} - \frac{v^{1/\alpha} n^{\gamma}}{s^{\beta/\alpha}}\right), \tag{6}$$

where the last term is equivalent to the indifference curve $z(s, v)$ above. The first-order condition on s leads to the function

$$p_i^n(n) = \alpha\beta^{\beta/\alpha}\left(\frac{y_i - \kappa/n}{v_i n^{\gamma}}\right)^{1/\alpha} \tag{7}$$

giving the maximum willingness-to-pay for the housing service, conditional on n. This expression has the same hump shape as $p_i(s)$ above. Setting $\partial p_i^n/\partial n = 0$ shows its maximum to occur when

$$n_i^* = \frac{1+\gamma}{\gamma} \cdot \frac{\kappa}{y_i}. \tag{8}$$

Since y_i is in the denominator, lower income classes prefer larger households. When $n < n_i^*$, there is a fall the local maximum of $P(s)$ over the portion where $p_i(s)$ is highest. It follows that high-income classes may outbid low-income ones in cases where the reverse would happen if low-income renters could combine. In some sense, this limit is demand-side parallel of the lot-size minimum: over-consumption of land has become over-consumption of solitude. Although this model is only a toy example, it shows that a fairly credible story is capable of producing an exclusionary result from limits on household formation.

3 Inclusionary zoning

The parallel nomenclature might suggest inclusionary zoning is the mirror image of exclusionary zoning—a mix of maximum lots sizes, per-unit subsidies and minimum household sizes, perhaps. It actually consists of making developers build affordable units into new projects. This study is the first to incorporate productive factors and endgenous quality into a model of the developer's problem under inclusionary zoning, but there is already a small economic literature on inclusionary zoning. Rubin and Seneca (1991) and Hughen and Read (2013) treat the developer's problem, but in markets for housing units, rather than bundles of housing services, and their developer's wield some market power. Rubin et al. (1990) explains the political economy of inclusionary zoning as a way of shifting the burden of providing affordable housing off of public accounts. Bento et al. (2009) find that inclusionary zoning ordinances in California increase the production of multi-family housing and shrink the sizes of single-family housing—a result in line with the conclusions reached below.

Inclusionary zoning policies are extremely variegated[3], but this section proceeds with the rules that seem most typical and which fit most naturally into the model. In Section 4.1, "affordable unit" is defined rigorously. Section 4.2 notes the consequences of requirements that affordable and market-rate units in one project have the same quality. Finally, Section 4.3 notes the trade-off a developer faces in choosing a level of "density bonus," which permits more density in proportion to the share of all units in a project dedicated as affordable.

3.1 An affordable unit

Inclusionary zoning reposes the question of what constitutes an "affordable unit." Above it was sufficient to say that an exclusionary policy made units "less affordable." But where a unit satisfies a regulatory agreement, an either/or distinction is needed to cover both rent and quality. See, for example, the recommendations made in the American Planning Association's model inclusionary zoning ordinance (Sec. 4.4, Morris, 2009).

Though one may imagine a rule demanding units too small or too shabby for upper-income households to desire, inclusionary ordinances generally rely on rent control to make affordable units affordable. The permitted total rent arises from two rules: (i) that total rent consumes no more than 30% of its occupants' incomes; (ii) that its occupants earn no more than some fraction of the median income of the metropolitan area.

Quality regulation consists of a two-tiered system: (i) minimum qualities of affordable units; (ii) parity between certain attributes of market-rate and affordable units in the same project, including finishings, number of bedrooms and size.[4]

[3]See Schuetz et al. (2009) for a summary of important ways ordinances differ.

[4]Examples of parity requirements: *Berkeley City Code* §23C.12.040, *Zoning Resolution of the City of New York* §23-96(c), and *San Francisco Inclusionary Housing Program Monitoring and Procedures Manual* §5C.

3.2 Quality parity

When the total rent on affordable units is fixed and parity in quality is required between market-rate and affordable units in one project, inclusionary zoning produces lower-quality, cheaper market-rate units. Suppose the developer must make a fraction θ of all units in a new development affordable, and that these must be more-or-less identical to market-rate units. Since s describes both types of units, the average rent over all units is

$$\bar{p} = \theta\tilde{p} + (1-\theta)p, \tag{9}$$

where $\tilde{p}$ and p are, respectively, affordable and market-rate rents. To determine $\tilde{p}$, let $\tilde{y}$ be the income of the occupants of affordable units. Replacing $\tilde{p}$ with $.3\tilde{y}/s$ and p with $P(s)$ gives $\bar{p}$ as a function of s:

$$\bar{P}(s) \equiv .3 \cdot \theta\tilde{y}/s + (1-\theta)P(s) \tag{10}$$

defined over $s \geq s_{\min}$, the minimum quality allowed. Since the first term falls monotonically with s, high qualities are handicapped. A constant sum of revenue from the affordable units is spread more thinly over luxurious units. The effect is opposite to the effect of a per-unit levy, wherein a constant *cost* was spread more thinly. Higher-quality units are thus handicapped. The effect is placed in the Fundamental Diagram as part of Section 3.3 below.

New York City: Bedroom Parity

While quality parity is most common, a detour into another regime is illustrative. New York City requires that affordable units "shall contain a bedroom mix at least proportional to the bedroom mix" of market-rate units in the same project. This rule leads to something like a tax on bedrooms by interacting with three other features of the regime: (i) size minima for each number of bedrooms; (ii) the fact units with more bedrooms are rationed to larger households; and (iii) rent ceilings that vary with household size. While the regulations do not carve a specific household size for each count of bedrooms, it is reasonable to model the rule California uses[5]: an affordable unit with n bedrooms goes to a household with $n+1$ members. The rent ceiling is 30% of what the U.S. Department of Housing and Urban Development calls "low-income" for each county and household size.

Taking the ratios of rent ceilings to minimum areas yields a schedule, $\hat{P}(n)$, giving the rent per sq. ft. of affordable floorspace as a function of the number of bedrooms, n. The schedule for King County (Brooklyn) is in Table 1. $\tilde{P}(n) = .105 \cdot n^2 - .705 \cdot n + 2.94$ is exact up to three bedrooms. A 0-bedroom unit is a studio. Since the rent ceiling rises more slowly than the area, $\tilde{P} < 0$: the developer is always better off with affordable units that have fewer bedrooms.

[5]California State Code §50106(h)

n	max. income (\$/year)[6]	max. rent (\$/month)	min. size (sq.ft.)	$\hat{P}(n)$ (\$)
0	47,700	1,175	400	2.94
1	53,700	1,342	575	2.33
2	60,400	1,510	775	1.95
3	67,100	1,678	950	1.76

Table 1: affordability parameters

3.3 Density bonus

A density bonus gives the developer has some control over the burden of building affordable housing[7]. A broadly-applicable example of a density bonus law is §65915 of the California Government Code[8], which overrides municipal limits on maximum residential density per acre according to several schedules. Part of one such schedule appears in Table 2. Formally, we may say the developer faces the constraints of Sections 2.1 and 3.2 but can choose among levels of $\tilde{L}$ and θ. A smaller $\tilde{L}$ is obtained at the cost of a higher θ.

Percentage Low-income units	Percentage density bonus
10	20
11	21.5
12	23
13	24.5

Table 2: Sample density bonus schedule

Figure 4 shows the choice between two levels of density bonus A and B. Each level entails a lot-size minimum/affordability requirement vector $(\tilde{L}, \theta)$. Level A requires fewer affordable units (lower θ), making $\bar{P}_A > \bar{P}_B$ over the relevant range. But since A permits less density (higher $\tilde{L}$), cost is inflated over a longer range of qualities—illustrated by the differences between C_A and C_B and between $\tilde{s}_B$ and $\tilde{s}_A$. In the case depicted, level B is more profitable, since the resulting gap between C_B and $\bar{P}_B$ at s^*_B is larger than the one between C_A and $\bar{P}_A$ at s^*_A. The developer accepts the higher density bonus. Moreover, the occupant class changes, since s^*_B corresponds to a different hump on the underlying P curve than s^*_A does.

A lesson is that the developer will more readily accept the density bonus when there is a robust market for low-quality housing. If $P(s)$ is high at low s, the relaxed density limits permit low-quality units to be built with an efficient land-capital ratio, while the downgrading that results from parity erodes profits

[7]Moreover, it is sometimes possible for developers to pay a fee in-lieux of building the affordable units. A striking example is Chicago, where "The Density Bonus has resulted in the construction of 5 on-site affordable units and resulted in in-lieu collections of nearly \$33 million" (Chicago Dept. of Planning and Development).

[8]A history of the California state density bonus law, from its genesis in 1979, can be found in Blackwell (2009).

less intensely. It should be noted, however, that half of this logic only holds in regimes where regulation caps the number of units per acre. In New York City, by contrast, the Inclusionary Housing Program grants relief from limits on the Floor Area Ratio (the floorspace per acre), and there is no minimum plot of land which must be consumed per unit.

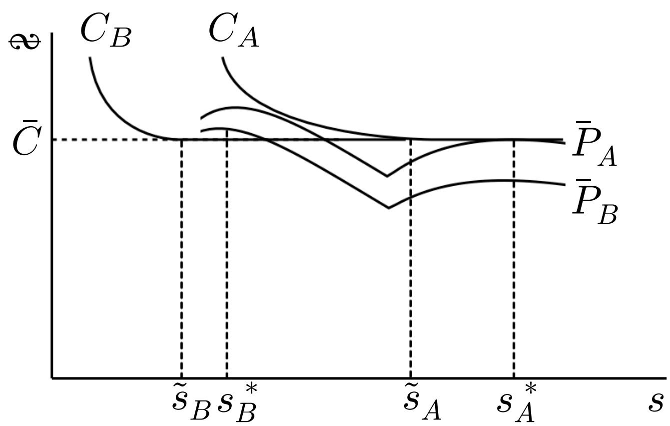

Figure 4: choice of density bonus

4 Conclusion

This study has placed several inclusionary and exclusionary housing policies into static models of the housing market with endogenous quality and multiple income classes. A diagrammatic approach allowed regulations' effects to be framed as changes in the shapes of curves for the developer's costs and earnings. Exclusionary zoning was shown to distort the developer's choice of inputs to housing production and the low-income renter's choice of household formation. Inclusionary zoning, especially with a density bonus, was shown to lower the quality of the market-rate housing produced in covered projects.

The models applied have been simple, but, even so, have demonstrated that common land-use rules can produce effects more nuanced than a glance at the supply and demand schedules for housing units would suggest. There is, thus, a need to unpack links between the parcel-level and market-level impacts of inclusionary and exclusionary policies. On its own, the strictly local analysis seems most relevant to the political economy of areas with myriad small jurisdictions. Consider, for example, the councilor from a gentrifying neighborhood: inclusionary zoning will certainly advance the optical and political goal of seeing more low- and middle-income families housed comfortably in his or her neighborhood, whatever the effect on households in other neighborhoods may be.

Two additional extensions appear worthwhile. Regarding welfare economics, the 30%-of-income rule deserves scrutinty, especially given that changes in transport costs account for such variation in the urban landscape. The *New York*

Times reports that one inclusionary housing project in Manhattan costs the landlord $90,000 per year in foregone rent—well above beneficiaries' incomes and enough to pay rent for several households only a few miles away(Barro, 2014). A second worthy application is the theory of labor markets in space. Models where location and employment interact—such as those found in Zenou (2009)—could gain explanatory power by incorporating land-use regulations that relocate income groups.

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