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Zone defense: Why liberal cities build too few homes

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Abstract

In this article, I investigate a puzzling feature of American urban politics: cities with more liberal residents tend to enact more restrictive zoning policies and permit fewer new housing units each year than similar conservative cities. To help explain this puzzle, I develop a formal model in which local governments regulate the size of their population to balance the benefits of agglomeration with the costs of congestion. To defend against congestion externalities imposed by new residents, cities enact zoning policies that undersupply housing relative to the social optimum. In liberal cities, where residents value the benefits of agglomeration the most, this undersupply of housing is the most severe.

Keywords

Formal model; urban land use policy; zoning policy

1. Introduction

This article is motivated by a puzzling feature of contemporary American urban politics. In the years since the Great Recession, home prices have reached record highs in cities across the United States. But the cities with the most acute housing affordability problems are predominantly liberal, while conservative cities remain affordable by comparison. Figure 1 illustrates this stylized fact: cities with more liberal residents—as measured by Tausanovitch and Warshaw (2013)—have more expensive housing relative to their median income. The median home in Jacksonville, FL costs roughly 3 years of the median household's income, while in San Francisco, that figure is closer to 10 years.

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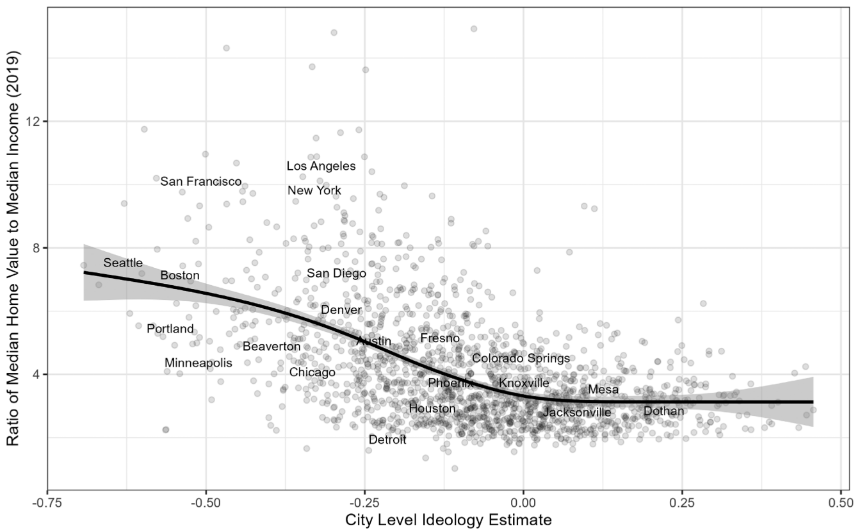

Figure 1. Median home value as a fraction of median income is higher on average in liberal cities, as measured by Tausanovitch and Warshaw (2013). Sample consists of all US cities with more than 10,000 households. Solid line is a locally estimated scatterplot smoothing (LOESS) curve, with select cities labeled.

There are, of course, a large set of factors that might explain this pattern: liberal cities tend to be coastal, older, have higher incomes, more educated residents, and less available land for housing development (Saiz, 2010), all of which tend to increase home prices. But recent empirical work suggests that these factors alone cannot fully explain the home price difference between liberal and conservative cities. Instead, this effect appears attributable in large part to differences in housing supply elasticity: municipal governments in liberal cities permit fewer new housing units when faced with increasing demand, and they impose more stringent zoning regulations on residential development than similar conservative cities. Kahn (2011) and Sorens (2018) find a strong relationship between liberalism and zoning restrictions in US cities, and survey evidence finds that liberals are more likely than conservatives to oppose relaxing their city's restrictions on new homebuilding (Manville, 2021).[1]

The ill effects of restrictive zoning regulations are, at this point, well-documented. Because home prices must rise when increasing demand for housing is not met by increasing supply, the most regulated US cities tend to have higher rents than we would expect from construction costs and wages alone (Glaeser and Gyourko, 2003; Quigley and a. Rosenthal, 2005). In turn, these excess housing costs can have large effects on the broader economy. For one, they slow economic growth by pricing workers out of cities where they would be most productive. One estimate suggests that easing housing restrictions in the three most productive US cities alone would increase aggregate GDP by roughly 9.5% (Hsieh and Moretti, 2019). Second, by pricing poorer households out of more affluent areas, growth control policies exacerbate residential segregation, both by race (Rothwell and Massey, 2009) and by income (Rothwell and Massey, 2010). Such segregation has been shown to affect civic participation (Oliver, 1999), public goods provision (Alesina et al., 1999; Trounstine, 2015), and even life expectancy (Chetty et al., 2016). Third, density restrictions in central cities promote suburban sprawl, which increases both commuting costs and carbon emissions (Glaeser and Kahn, 2010). Finally, such restrictions may contribute to widening income inequality. Rognlie (2015) finds that the increase in capital's share of income since 1948 can be attributed *entirely* to an increase in the return to housing, something that would not have occurred if the housing supply were more elastic over that period.

Why then, do liberal cities implement more restrictive zoning than their conservative counterparts? On its face, the fact seems counterintuitive, given American liberalism's emphasis on combating income inequality, segregation, and climate change. To help explain this puzzle, I develop a formal model of municipal zoning. In this model, city governments choose how many homes to permit, selecting a city size that balances the benefits from agglomeration with the costs of congestion. As the model demonstrates, cities whose residents place a higher value on the benefits of agglomeration will enact more restrictive growth controls to defend against congestion. Since preferences for agglomeration are strongly correlated with liberalism in the United States, I argue that this mechanism helps explain why liberal cities enact particularly restrictive zoning policies.

The article proceeds in five parts. In the next section, I provide a brief introduction to US municipal zoning and review the existing explanations in the literature for their existence. Section 3 outlines the model, and Section 4 proves its key results mathematically. Section 5 concludes the article.

2. Background

Residential construction in the United States is heavily regulated by municipal governments. Zoning authority, upheld as constitutional by the landmark 1926 Supreme Court case *Euclid v. Ambler*, grants municipal governments broad discretion to regulate land use within their boundaries. This zoning power takes many forms. The most common is Euclidean zoning, which divides the entire municipality into zones, within which there is a single permitted land use (e.g. residential, commercial, and industrial).[2] Though this strict separation of uses has largely fallen out of favor among contemporary urban planners, nearly every US municipal government maintains a Euclidean zoning map specifying precisely what is permitted by right on every parcel of land.

Even cities without an explicit Euclidean zoning code retain many of its features. Other forms of land use regulation include permit limits, open space requirements, minimum lot sizes, setback requirements, parking minimums, and building height restrictions (Gyourko et al., 2008). Houston, for example, is notable for being the only major American city without a Euclidean zoning code. Nevertheless, the city strictly regulates residential land use, requiring minimum lot sizes, setbacks, and off-street parking for all new residential developments. This patchwork of land use regulations has promoted a sprawling, auto-dependent pattern of residential development in most US cities (Lewyn, 2005).

The ubiquity of these growth controls would have come as a surprise to urban political scientists writing just half a century ago. Molotch (1976) famously describes the

American city as a 'growth machine', a political entity whose principal aim is to promote business interests through population growth. Exclusionary zoning has long been a feature of wealthy suburbs (Trounstine, 2018), but it was not until the late 20th century that major cities moved to significantly limit housing development as well (Schleicher, 2013).

Part of what changed was the rising influence of a group that Fischel (2001) calls 'homevoters'. In response to the inflation of the 1970s, many Americans came to view their homes not simply as a durable consumer good (like automobiles), but as an important financial investment (Fischel, 2016). For most Americans, a home is the single most expensive item in their investment portfolio. It is financed heavily by debt, and its value is strongly tied to local economic shocks. Given this precarious financial situation, homeowners tend to support public policies that protect the value of their greatest asset (Scheve and Slaughter, 2001), including restrictions on multifamily housing construction (Marble and Nall, 2021; Trounstine, 2021). Empirically, American homeowners are much more likely to be involved in municipal politics than renters, for whom financial security is not as closely tied to the health of the local real estate market (Dipasquale and Glaeser, 1999; Einstein et al., 2019; Yoder, 2020; Einstein et al., 2022).

The over-representation of homeowner interests in local politics helps explain the ubiquity of growth controls, but alone it cannot explain why liberal cities would be more strictly zoned than conservative cities—especially given that conservative cities tend to have a larger share of homeowners. Instead, any satisfying explanation of this puzzle is likely to be based on the differing preferences of voters by political ideology. The model I develop in this paper puts forward one such explanation: that zoning stringency in liberal jurisdictions reflects—almost paradoxically—their residents' taste for agglomeration.

3. Model outline

The model I develop in the next section is adapted from Albouy et al. (2019), who use it to characterize the optimal distribution of population across cities. I extend the model to incorporate the preferences of voters, and show how these preferences are likely to affect the stringency of zoning enacted by municipal governments. Before deriving these results mathematically, let us first describe the intuition behind each one.

The trade-off between economies of scale and congestion costs has been described as the 'fundamental trade-off in urban economics' (Fujita, 1989). On the one hand, large cities create a multitude of benefits for their residents. Large cities have higher economic productivity than small cities, and their residents earn higher wages (Bettencourt et al., 2007). They are also more innovative, as measured by patents per capita (Duranton and Puga, 2001; Bettencourt et al., 2007). There is a greater diversity of businesses and economic activity in larger cities. In addition to these productivity benefits, large cities have consumption advantages as well (Glaeser et al., 2001). Thanks to a deeper pool of customers and labor, big cities can offer goods and services—both public and private—that are difficult to provide in smaller jurisdictions (Schiff, 2015). Without these increasing returns to scale in both production and consumption, it is unlikely that cities would exist in the first place (Krugman, 1991).

On the other hand, there are a number of disadvantages that come with scale. Each new resident of a city imposes some negative externalities on his neighbors—crowding public spaces, taking up scarce street parking (Shoup, 2005), or congesting public service provision (Brueckner, 1981). Larger cities have higher crime rates (Glaeser and Sacerdote, 1999), more light pollution (Operti et al., 2018), and more congested roadways (Couture et al., 2018). Absent these congestion costs, cities would likely grow without limit.

The presence of these congestion externalities creates an incentive to enact zoning ordinances limiting city size. The 'optimal' city size, from the perspective of a local zoning board, is the population at which the marginal benefits from scale exactly equal the marginal costs from congestion, a population we will call n_z. But, as the model will show, this city size is smaller than the population that would maximize aggregate welfare, which we will call n_*. Because the municipal government does not take into account the welfare of non-residents when choosing its zoning policy, it will tend undersupply housing relative to the social optimum. The gap between n_z and n_* represents the stringency of zoning.

The zoned size of a city (n_z) depends in part on how much its residents value the benefits of scale relative to the costs of congestion. In the model, we will call this value α, or the *agglomeration preference* of a city's residents. When α is large, residents are willing to accept greater congestion costs in exchange for the benefits of scale, and will vote to permit a larger number of households.

In the United States, this preference for agglomeration is strongly correlated with liberalism. When asked if they prefer to live in a community where 'the houses are larger and farther apart, but schools, stores, and restaurants are several miles away' or a community where 'the houses are smaller and closer to each other, but schools, stores, and restaurants are within walking distance', liberal respondents prefer the walkable community three-to-one (Pew, 2014). Conservative respondents report the exact opposite preference, preferring the spread out neighborhood three-to-one. As Rodden (2019) documents, this polarization by density preference has not always been quite so strong. One hundred years ago, there was no correlation between a county's population density and its Democratic vote share. Today, the correlation between these two variables is overwhelming. A number of factors might explain this 'density divide' (Wilkinson, 2019). Partly it is the historical legacy of labor organizing in 19th century industrial cities (Rodden, 2019). Partly it may be that cross-ethnic exposure in dense urban areas breeds liberalism (Brown et al., 2021). Partly it could be the increasing polarization of political parties by personality traits like openness to experience (Wilkinson, 2019). Whatever the reason, these sorts of residential preferences are now strongly sorted by political party and ideology.

In the model, two things happen when α increases. First, n_z increases. Liberal residents prefer larger cities, so cities with more liberal residents permit more homes. But the socially optimal population n_* grows even faster, such that the gap between n_* and n_z is largest in liberal cities. Despite permitting more homes than conservative cities, liberal cities have a more significant undersupply of homes relative to demand.

But if increasing city size above n_z unlocks large aggregate welfare gains, then why wouldn't residents agree to permit more housing in exchange for compensation? What prevents developers from striking a Coaseian bargain with existing residents, redistributing the surplus from new development and making everyone better off? Foster and Warren (2022) argue that transaction costs reduce the likelihood of these Pareto-improving bargains. Opponents of new development create costly project-approval processes, which diminish the amount of surplus available to compensate residents. Developers only undertake projects when the potential surplus exceeds these onerous transaction costs.

The model demonstrates that this 'NIMBY Problem' is more pronounced in liberal cities. Although the marginal gains from new development is higher in these cities, the number of residents necessary to compensate (n_z) grows faster than these marginal gains. This implies that, in the presence of the sort of transaction costs described by Foster and Warren (2022), it will be more difficult to facilitate bargains that increase the housing stock in liberal cities than in conservative cities.

4. The model

Consider a metropolitan area with two regions: a central city and rural periphery. Residents of the city receive benefits that exhibit increasing returns to scale. We can represent the value of living in a city of size n as αn^{ε}, where $\alpha, \varepsilon > 0$ are elasticity parameters. These benefits are counterbalanced by congestion costs, which are also a function of scale. As city size increases, so do crowding and commuting, which reduces the value of the city for its residents. Utility is the difference between agglomeration benefits and congestion costs:

$$u(n) = \alpha n^{\varepsilon} - n^{\gamma} \tag{1}$$

Assuming $\alpha > 0$ ensures that the optimal city size is non-negative, and assuming $\varepsilon < \gamma$ ensures the optimal city size is finite.[3] Residents of the rural area do not receive the benefits of living in the city, nor do they pay congestion costs. For simplicity, we will assume that they receive a reservation utility equal to zero.

4.1. The effect of political institutions

If people can freely migrate between the rural area and the city, they will do so until $u(n)$ equals their reservation utility. Thus the city will grow until its population equals n_f, the point at which agglomeration benefits are exactly balanced by congestion costs:

$$u(n_f) = \alpha n_f^{\varepsilon} - n_f^{\gamma} = 0$$

$$n_f = \alpha^{\frac{1}{\gamma - \varepsilon}} \tag{2}$$

By comparison, if city size is determined by a local zoning board with an objective to maximize the welfare of city residents, then the board would set city size n_z to maximize $u(n)$ as follows:

$$\frac{\partial u}{\partial n} = \varepsilon \alpha n^{\varepsilon - 1} - \gamma n^{\gamma - 1} = 0$$

$$n_z = \left(\frac{\varepsilon\alpha}{\gamma}\right)^{\frac{1}{\gamma-\varepsilon}} \tag{3}$$

The assumption that $\varepsilon < \gamma$ (i.e. the optimal city size is finite) ensures that $n_z < n_f$. The 'zoned' size of the city is smaller than what free migration would produce. This leads us to our first proposition.

Proposition 1. (*Neither local zoning nor free migration is welfare-maximizing*) *A city will grow larger than the socially optimal size when people can migrate without restrictions, but smaller than the socially optimal size under zoning.*

To prove this proposition, consider a Benevolent Urban Planner with an objective to maximize *total* utility, $nu(n)$:

$$\frac{\partial nu(n)}{\partial n} = \alpha(\varepsilon + 1)n^{\varepsilon} - (\gamma + 1)n^{\gamma} = 0$$

$$n_* = \left[\frac{(1+\varepsilon)\alpha}{1+\gamma}\right]^{\frac{1}{\gamma-\varepsilon}} \tag{4}$$

The assumption $\varepsilon < \gamma$ implies that $n_z < n_* < n_f$. Thus the socially optimal city size lies somewhere between the local zoning and free migration equilibria. Zoning yields cities that are too small, while free migration yields cities that are too large.

4.2. The effect of agglomeration preferences

We can think of the parameter α as representing the value that a city's residents place on the benefits of scale relative to congestion costs. For the reasons discussed above, this preference tends to be strongly correlated with liberalism in the United States. From this, we can demonstrate the following proposition.

Proposition 2. (*Liberal cities undersupply housing*) *The zoned city size n_z is increasing in α, but so is the undersupply of housing, represented by $n_* - n_z$.*

To prove the first half of the proposition, take the derivative of n_z with respect to α:

$$\frac{\partial n_z}{\partial \alpha} = \frac{\varepsilon}{\gamma}\left(\frac{\varepsilon\alpha}{\gamma}\right)^{\frac{1}{\gamma-\varepsilon}-1}\left(\frac{1}{\gamma-\varepsilon}\right) = \frac{n_z}{\alpha(\gamma-\varepsilon)} > 0$$

Each term in this expression is positive, implying that liberal cities will permit more housing in equilibrium than conservative cities. Despite this, their zoning policies are more restrictive relative to the social optimum. As α increases, the gap between n_* (the socially optimal city size) and n_z (the number of people permitted to live in the city under local zoning) widens. To demonstrate this proposition, one must show that

$\frac{\partial n_*}{\partial \alpha} > \frac{\partial n_z}{\partial \alpha}$, or equivalently:

$$\frac{1}{\gamma - \varepsilon}\left(\frac{1+\varepsilon}{1+\gamma}\right)\left[\frac{(1+\varepsilon)\alpha}{1+\gamma}\right]^{\frac{1}{\gamma-\varepsilon}-1} > \frac{1}{\gamma - \varepsilon}\left(\frac{\varepsilon}{\gamma}\right)\left(\frac{\varepsilon\alpha}{\gamma}\right)^{\frac{1}{\gamma-\varepsilon}-1} \tag{5}$$

Once again, the assumption $\varepsilon < \gamma$ ensures that this inequality holds (complete proof in the appendix). By a similar logic, the gap between n_f and n_z widens as α increases. Figure 2 illustrates both these results.

4.3. Transaction costs

If increasing the city's population from n_z to n_* unlocks large aggregate welfare gains, then why do developers not simply pay off the existing residents to compensate them for increased congestion costs?

In the model presented here, the potential welfare gains from relaxing zoning is largest in liberal cities (this follows from Proposition 2). But, paradoxically, the amount of potential gains *per resident* is smaller in liberal cities, so it is more difficult for a developer 'buy off' existing residents in these cities. The next proposition proves this result.

Proposition 3. (*The 'NIMBY Problem' is more difficult to overcome in liberal cities*) *As α increases, the welfare gains per resident from new development decreases. Note that this result holds only for decreasing marginal congestion costs ($\gamma < 1$).*

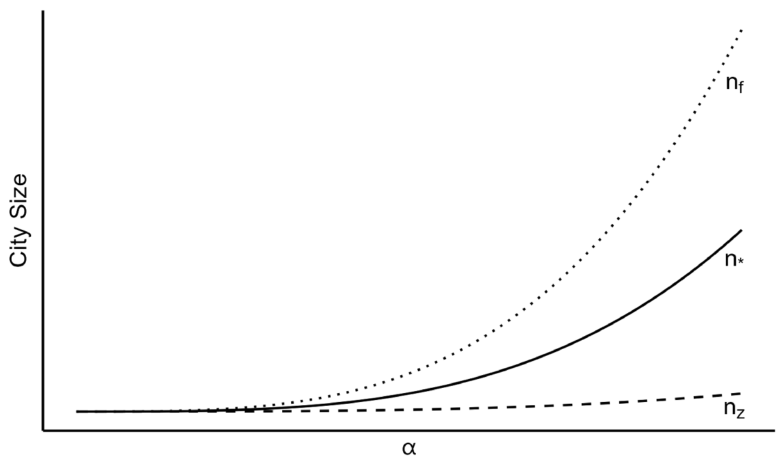

Figure 2. City size under free migration (n_f), local zoning (n_z), and the socially optimal size (n_*) varying α. Zoning yields cities that are too small, while free migration yields cities that are too large. All these values are increasing in α, but the gap between n_* and n_z grows wider for more liberal cities.

To see why, note that the marginal surplus per resident can be expressed as $\frac{\partial nu(n)}{\partial n} \times \frac{1}{n_z}$, where the first term represents the total additional utility that comes from increasing the city's population above n_z, and the second term represents the number of residents that must be compensated. When this product is large, it is easier for a new development to overcome transaction costs and compensate existing residents. When it is small, there is less surplus available per resident to win political support.

To see whether this expression is larger or smaller in liberal cities, we can take the derivative with respect to α (see Appendix for proof):

$$\frac{\gamma - 1}{\gamma} n_z^{\varepsilon - 1}$$

This expression is strictly negative when $\gamma < 1$, implying that Proposition 3 holds only when marginal congestion costs are decreasing. For most types of congestion that urban residents face, it is reasonable to characterize marginal costs as decreasing. For example, if a public park with area A is shared among n residents, the amount of space available to each person is $\frac{A}{n}$, so each resident's marginal loss of park area is decreasing in n. The intuition is similar for other congestible public services provided by municipalities, like fire protection (Brueckner, 1981).

This result suggests that liberal cities face a double-bind. Not only do they enact stricter zoning regulations than conservative cities, but it is more difficult to find political bargains that relax zoning while making everyone better off.

5. Concluding thoughts

In this article, I have developed a theory to explain the systematic differences in zoning policy between liberal and conservative US cities. The model explains the relationship as driven by demand for agglomeration: if residents of liberal cities place a greater value on the benefits of scale, then zoning can help defend those benefits from erosion by congestion costs. Ironically, it is in the places where residents most value agglomeration that we expect to observe the greatest undersupply of housing relative to the social optimum.

As Foster and Warren (2022) note, one route to ameliorating this undersupply of housing is reduce transaction costs and make it easier for developers to compensate residents for congestion externalities. Unfortunately, the model presented here suggests that these sorts of solutions are most difficult to achieve in the very places where they would do the most good: tightly zoned liberal cities. Going forward, this highlights an important avenue for political science research—identifying political institutions that best reduce transaction costs and facilitate these Pareto-improving bargains to expand the housing supply.

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Appendix

Proof of Proposition 3

To prove this proposition, we must demonstrate that $\frac{\partial n_*}{\partial \alpha} > \frac{\partial n_z}{\partial \alpha}$, which is equivalent to the following inequality:

$$\frac{1}{\gamma-\varepsilon}\left(\frac{1+\varepsilon}{1+\gamma}\right)\left[\frac{(1+\varepsilon)\alpha}{1+\gamma}\right]^{\frac{1}{\gamma-\varepsilon}-1} > \frac{1}{\gamma-\varepsilon}\left(\frac{\varepsilon}{\gamma}\right)\left(\frac{\varepsilon\alpha}{\gamma}\right)^{\frac{1}{\gamma-\varepsilon}-1}$$

To do so, first multiply each side by $(\gamma - \varepsilon)$ and rearrange:

$$\left(\frac{1+\varepsilon}{1+\gamma}\right)\left[\frac{(1+\varepsilon)\alpha}{1+\gamma}\right]^{\frac{1}{\gamma-\varepsilon}-1} > \left(\frac{\varepsilon}{\gamma}\right)\left(\frac{\varepsilon\alpha}{\gamma}\right)^{\frac{1}{\gamma-\varepsilon}-1}$$

$$\left(\frac{1+\varepsilon}{1+\gamma}\right)\left(\frac{1+\varepsilon}{1+\gamma}\right)^{\frac{1}{\gamma-\varepsilon}-1}\alpha^{\frac{1}{\gamma-\varepsilon}-1} > \left(\frac{\varepsilon}{\gamma}\right)\left(\frac{\varepsilon}{\gamma}\right)^{\frac{1}{\gamma-\varepsilon}-1}\alpha^{\frac{1}{\gamma-\varepsilon}-1}$$

$$\left(\frac{1+\varepsilon}{1+\gamma}\right)^{\frac{1}{\gamma-\varepsilon}} > \left(\frac{\varepsilon}{\gamma}\right)^{\frac{1}{\gamma-\varepsilon}}$$

$$\frac{1+\varepsilon}{1+\gamma} > \frac{\varepsilon}{\gamma}$$

The assumption that $\varepsilon < \gamma$ ensures this inequality holds. Next, to prove that the gap between n_z and n_f also widens as α increases, we must demonstrate that this derivative is positive:

$$\frac{\partial(n_f - n_z)}{\partial \alpha} = \frac{1}{\gamma-\varepsilon}\alpha^{\frac{1}{\gamma-\varepsilon}-1} - \frac{1}{\gamma-\varepsilon}\left(\frac{\varepsilon}{\gamma}\right)\left(\frac{\varepsilon\alpha}{\gamma}\right)^{\frac{1}{\gamma-\varepsilon}-1}$$

Doing so is equivalent to demonstrating that the following expression holds.

$$\frac{1}{\gamma-\varepsilon}\left(\frac{\varepsilon}{\gamma}\right)\left(\frac{\varepsilon\alpha}{\gamma}\right)^{\frac{1+\varepsilon-\gamma}{\gamma-\varepsilon}} < \frac{1}{\gamma-\varepsilon}\alpha^{\frac{1+\varepsilon-\gamma}{\gamma-\varepsilon}}$$

To do so, first, divide each side by $\frac{1}{\gamma-\varepsilon}$, then rearrange.

$$\left(\frac{\varepsilon}{\gamma}\right)\left(\frac{\varepsilon\alpha}{\gamma}\right)^{\frac{1+\varepsilon-\gamma}{\gamma-\varepsilon}} < \alpha^{\frac{1+\varepsilon-\gamma}{\gamma-\varepsilon}}$$

$$\left(\frac{\varepsilon}{\gamma}\right)\left(\frac{\varepsilon}{\gamma}\right)^{\frac{1+\varepsilon-\gamma}{\gamma-\varepsilon}}\alpha^{\frac{1+\varepsilon-\gamma}{\gamma-\varepsilon}} < \alpha^{\frac{1+\varepsilon-\gamma}{\gamma-\varepsilon}}$$

$$\left(\frac{\varepsilon}{\gamma}\right)^{\frac{1}{\gamma-\varepsilon}} < 1$$

The assumption that $\varepsilon < \gamma$ ensures this inequality holds.

Proof of Proposition 4

In the proof of Proposition 1, we showed that the derivative $\frac{\partial nu(n)}{\partial n}$ is equal to:

$$\frac{\partial nu(n)}{\partial n} = \alpha(\varepsilon+1)n^{\varepsilon} - (\gamma+1)n^{\gamma}$$

So the expression $\frac{\partial nu(n)}{\partial n} \times \frac{1}{n_z}$, evaluated at $n = n_z$, can be written as follows:

$$\alpha(\varepsilon+1)n_z^{\varepsilon-1} - (\gamma+1)n_z^{\gamma-1}$$

Taking the derivative of this function with respect to α yields the following expression:

$$(\varepsilon+1)n_z^{\varepsilon-1} + \alpha(\varepsilon-1)(\varepsilon+1)n_z^{\varepsilon-2}\frac{\partial n_z}{\partial \alpha} - (\gamma+1)(\gamma-1)n_z^{\gamma-2}\frac{\partial n_z}{\partial \alpha}$$

To determine whether this derivative is positive or negative, we will divide by a series of positive terms. First, divide by $n_z^{\varepsilon-2}$:

$$(\varepsilon+1)n_z + \alpha(\varepsilon-1)(\varepsilon+1)\frac{\partial n_z}{\partial \alpha} - (\gamma+1)(\gamma-1)n_z^{\gamma-\varepsilon}\frac{\partial n_z}{\partial \alpha}$$

Next, divide by $\frac{\partial n_z}{\partial \alpha}$ (see Proposition 2 for that equation):

$$(\varepsilon+1)\alpha(\gamma-\varepsilon) + \alpha(\varepsilon-1)(\varepsilon+1) - (\gamma+1)(\gamma-1)\frac{\varepsilon\alpha}{\gamma}$$

Divide by α and simplify:

$$(\varepsilon+1)(\gamma-\varepsilon)+(\varepsilon-1)(\varepsilon+1)-(\gamma+1)(\gamma-1)\frac{\varepsilon}{\gamma}$$

$$(\varepsilon+1)[(\gamma-\varepsilon)+(\varepsilon-1)]-(\gamma+1)(\gamma-1)\frac{\varepsilon}{\gamma}$$

$$\gamma-\varepsilon-1+\frac{\varepsilon}{\gamma}$$

Multiply this expression by γ and rearrange:

$$(\gamma-1)(\gamma-\varepsilon)$$

And so the derivative of $\frac{\partial nu(n)}{\partial n}\times\frac{1}{n_z}$ with respect to α can be expressed as the following product:

$$(\gamma-1)(\gamma-\varepsilon)\frac{\alpha}{\gamma}n_z^{\varepsilon-2}\frac{\partial n_z}{\partial\alpha}$$

Substituting the definition of $\frac{\partial n_z}{\partial\alpha}$ from Proposition 2 yields:

$$\frac{\gamma-1}{\gamma}n_z^{\varepsilon-1}$$

This expression is strictly negative when $\gamma < 1$, completing the proof.

Notes

1. There is mixed empirical evidence on whether liberal *political parties* are more or less likely to support new housing development—regression discontinuity estimates from Spain find that when left parties are narrowly elected to local councils, they subsequently restrict the rate of residential development (Solé-Ollé & Viladecans-Marsal 2013), while similar estimates from the United States find null effects for narrowly elected Democratic city councils and positive effects for narrowly elected Democratic mayors (de Benedictis-Kessner et al. 2022). Nonetheless, it is clear that liberal *places* tend to be more restrictive on average.
2. A common misconception is that the name 'Euclidean zoning' is an homage to Euclid the ancient Greek geometrician. It is actually a reference to the town of Euclid, Ohio, whose pioneering zoning code was the subject of the aforementioned Supreme Court case. In a twist on the twist, however, the town of Euclid was itself named for Euclid the mathematician after it was settled by Case Western Reserve cartographers in the 1700s. So the original misconception is, in a way, partly correct (Wolf 2008).
3. For a derivation of this particular functional form, and a more extensive workup of the model involving a heterogeneous continuum of potential city sites, see Albouy et al. (2019).

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