Will increasing housing supply reduce urban inequality?

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Abstract

In recent years, there has been a debate over the extent to which housing-supply regulations increase inequality and reduce workers access to more productive cities. This problem is formalized in a two-city model with skilled and unskilled workers to study the impact of one city relaxing land-use restrictions. Such a policy will raise welfare, but inequality and the number of unskilled workers locating in more productive cities may rise or fall. And when the policy does reduce inequality, there is a decline in unskilled workers in the higher productivity city. Inclusive zoning policies can mitigate this effect but weaken agglomeration economies. A city authority that takes into account equity considerations may prioritize more or less housing for unskilled workers than the market, depending on the degree of societal aversion to inequality. The model is extended to include homeownership and racial discrimination in the housing market. Homeowners are not necessarily harmed by less restrictive land-use policy, but racial discrimination reduces the benefits of homeownership for minority groups.

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1 Introduction

In many countries, aggregate growth is largely driven by a few particularly productive urban areas. However, the distribution of the gains from such growth are becoming increasingly unequal across workers of different skill levels[1]. One proposed solution to reduce urban inequality is to relax land-use regulations in cities to increase housing affordability.[2,3] For example, Hsieh and Moretti (2019) find that strict regulatory barriers inhibit growth in locations with high-productivity, as wage gains are largely offset by increasing housing prices. In this framework, high housing costs deter workers in less productive locations from moving to more productive cities. However, Rodríguez-Pose and Storper (2020) argue that housing regulations are not the source of such labor misallocation, pointing instead to the declining real wages and employment opportunities in lagging regions. They suggest that the benefits from raising housing supply in high-productivity cities would largely accrue to skilled workers, leading to greater gentrification in high income cities and increase income segregation across cities. While Anenberg and Kung (2020) find that increasing housing supply in ten large metropolitan areas would not substantially reduce rent burdens.

In light of this debate, this paper considers whether reducing land-use regulations will improve welfare for all workers, and if so, will the distribution of the benefits favor skilled workers and raise inequality, or favor unskilled workers and reduce inequality. Our contribution is to show that reducing land-use regulations will unambiguously raise welfare for all workers, however inequality may rise or fall. And when inequality does fall, cities become more segregated by income, with number of unskilled workers in the more productive city declining in response to the policy.

To study the effect of land-use regulation on welfare, urban inequality and the spatial distribution of skilled and unskilled workers, we develop a stylized, two-city extension of Helpman (1998) with imperfectly mobile workers of heterogeneous skills, housing demand, and uneven access to agglomeration economies to consider the impact of one city increasing supply of devel-

[1] See e.g. Baum-Snow and Pavan (2012), Baum-Snow and Pavan (2013), Farrokhi and Jinkins (2019)

[2] Notable examples include Turner et al. (2014), Glaeser and Ward (2009), Gyourko et al. (2008), Saiz (2010). See Gyourko and Molloy (2015) for a recent survey.

[3] We use the term "urban inequality" to refer to inequality of different types of workers within cities in contrast to inequality among similar workers across regions, such as between urban and rural locations.

opable land[4]. We measure inequality as the relative expected welfare levels between skilled and unskilled workers, which allows us to capture the distributional impacts of the land-use policy. Our results show that whether inequality rises or falls depends on the difference between the sum of residential and productive agglomeration externalities enjoyed by skilled workers and the sum of the dispersion forces faced by all agents. When agglomeration externalities dominate, an increase in supply of developable land reduces inequality; however, it leads to greater income segregation, as the number of skilled workers rises and the number of unskilled workers fall in the city with the greater supply of housing. When dispersion forces dominate, inequality rises and numbers of both skilled and unskilled workers increase in the city with more housing.

The model is adapted to consider intra-urban zoning, wherein the local government fixes the supply of land to be allocated toward housing for each type of worker. Zoning policies that maintain or increase the share of land devoted to unskilled workers may reduce inequality and increase the share of unskilled workers in the more productive region; however, such policies dampen agglomeration forces. We calibrate the model to empirical estimates of key parameters to consider the quantitative impact of an increase in supply of land in one city, and policies that link new development to increasing housing supply for lower-income workers. We then consider how a city authority chooses to allocate land to housing for both types of workers, when equity considerations are taken into account. There is a threshold level of inequality aversion such that outcomes generated by the market and the city authority coincide. For values below the threshold, the market allocates too little land to skilled workers; while for values above the threshold, the market provides too little land to unskilled workers. Finally, we extend the model to consider homeownership and racial discrimination in the housing market.

Related Literature

There is a large literature on how land-use regulations negatively effect lower-income workers. A decline in the traditional manufacturing sector in much of the US over the last 50 years has left a large number of workers in the weakened labor markets of formerly prominent cities (see Austin et al. (2018) and Glaeser (2020)). One argument for why so many workers remain in such cities is that expensive housing, driven by stringent land-use regulations, imposes a

[4] We focus our attention on limits to available developable land and not other forms of housing regulations, such as building codes. As Gyourko and Molloy (2015) point out, land prices appear to be driving the high cost of housing in cities.

high entry fee into more productive cities with stronger labor markets (Autor (2019)). Gyourko et al. (2008) develop an index to consider the extent of regulation across US municipalities and show that many of the most productive cities tend to be the most highly regulated. Hsieh and Moretti (2019) consider the impact of reducing housing-supply regulation in American cities and find that if such policies were put into effect, in the long-run, New York would more than triple in population size, while San Jose and San Francisco would see gains of 285% and 161%, respectively. Paradoxically, Florida (2017) suggests that such housing-supply restrictions may have saved Rust-Belt cities from a more rapid decline. Glaeser and Gyourko (2018) argue that the efficiency of the housing market can be gauged by the gap between the sale price of a unit of housing and the economic costs of production. The authors show that for most of the country, the housing market is relatively efficient; however, for just above a quarter of US cities, home prices exceeds 25% of the economic costs. And for a tenth of cities, the price is at least double the cost, which they contend is partially attributable to housing-supply regulations. Osman (2020) has extended the argument over the distortions created by restrictive land-use policies to consider not only labor misallocation, but the misallocation of firms and the impact to metropolitan output from lost agglomeration economies.

However, Rodríguez-Pose and Storper (2020) emphasize two reasons why reducing land-use regulations may not be effective in reducing inequality or driving unskilled workers to more productive cities: (1) the uneven distribution of agglomeration economies across workers of different skills, and (2) the relative immobility of many workers. With regards to the first point, recent literature has emphasized sorting among higher-skilled workers, such that productivity differences across cities arise due to differences in the skill composition of the local labor force (Combes et al. (2008)). Another literature has begun to quantify the role of endogenous residential amenities, building on earlier work by Roback (1982). Both Owens III et al. (2020) and Heblich et al. (2020) find strong evidence of residential externalities for Detroit and London, respectively. However, such amenities appear to favor high-skilled workers. Diamond (2016) finds that with respect to urban amenities, migration elasticity is roughly four times higher for workers with college degrees than those with high school degrees. While Jaravel (2019) shows that between 2004 and 2015, the inflation rate on retail goods and services for lower-income workers exceeded that of high earners – as firms have shifted to production of goods favored by more affluent consumers, increasing price competition in those markets. Furthermore, Rijnks et al. (2018) find that, in the case of the Netherlands, there is considerable heterogeneity over whether migration flows are driven by locational amenities or labor market conditions.[5] Regarding the second point, there has been a well-documented decline in migration rates, particularly among lower-skilled workers[6].

While a number of empirical studies have found that the welfare effects of land-use regulations tend to be negative (Turner et al. (2014), Albouy and Ehrlich (2018)), what is less clear is why they are implemented in the first place. A number of papers have emphasized the political process in determining zoning regulations. Hamilton (1978) argues that local zoning boards have an interest in restricting the supply of land in order to raise property values. Fischel (2004) views land-use regulations as a means by which homeowners in different jurisdictions protect their property values, which for many is their primary investment asset and cannot be diversified. While, Hilber and Robert-Nicoud (2013) find communities in more desirable locations are more developed but also have greater degrees of regulation. A separate strand of literature has considered the extent to which land-use regulations can be implemented as second-best policy tools to counter negative urban externalities. For instance, urban growth boundaries or minimum floor/area ratios can deter excessive urban sprawl from unpriced traffic congestion or preserve open-space amenities.[7] We address this question by extending our model to consider whether reductions in land-use regulations harm homeowners. The analysis shows that benefits of homeownership may fall, but this is not uniformly true. Particularly, if the increase in housing supply fosters additional agglomeration that leads to a rise in wages, then the benefits of homeownership rise.

An additional consideration is that early land-use regulations were often used to exclude one group or another from a local community. Silver (1997) shows how cities in the American South used zoning regulations to maintain racial segregation, while the *Euclid vs. Ambler* Supreme Court ruling, legalizing the separation of differing land-uses, viewed the addition of multifamily homes into low-density residential areas negatively (Quigley and Rosenthal (2005)). The spatial mismatch hypothesis has emphasized how as metropolitan jobs began to decentralize away from the urban core, many low-income and ethnic minorities had less access to these

[5] In our model we consider this issue by allowing workers to have heterogenous degrees of attachment to each city.
[6] See e.g., Molloy et al. (2011), Molloy et al. (2014), Ganong and Shoag (2017).
[7] see e.g., Bento et al. (2006), Anas and Rhee (2006) , Anas and Pines (2008), Anas and Pines (2013), Kono et al. (2010), and Pines and Kono (2012).

emerging labor markets due to housing discrimination.[8] While Bunel et al. (2019) have pointed to the role of both landlords and real-estate agents in the degree of discrimination in the rental-housing market through a field experiment in Caledonia. Furthermore, discrimination in the homeownership market has been tied to difficulties in building household wealth in the African-American community (Akbar et al. (2019)). Our model indicates that if one group faces higher costs to becoming homeowners due to discrimination, then a reduction in land-use regulations that raises wages will increase homeownership rates for minority groups, but to a lesser extent than groups who do not face the higher costs.

This paper is structured as follows. In Section 2, we develop the model. In Section 3, we extend the model to consider intra-urban zoning. Section 4 provides a numerical example where the model parameters are calibrated to estimates from the empirical literature. In Section 5, we consider the determination of land-use for each type of worker by a city authority. In Section 6, we extend the model to consider homeownership and racial discrimination in the housing market. We conclude in Section 7.

2 A Modified Helpman Model

Consider an economy comprised of two cities indexed by $i = 1, 2$, with an exogenous mass of n_h high-skilled workers and n_l low-skilled worker, indexed by $s = h, l$.[9] For simplicity in the exposition, we assume $n_h = n_l = n$. Denote by n_{si} as the number of workers of skill level s in city i such that $\sum_i n_{si} = n$. All workers have preferences over a numeraire, homogenous consumption good, x_{si}, and heterogeneous housing, h_{si}, with the price p_{si}, for a type s worker. Workers that reside in city i are employed in the local production of the homogenous good and receive the wage w_{si}. Each worker's budget constraint is then $w_{si} = p_{si}h_{si} + x_{si}$. Preferences are given by

$$U_{si}(\epsilon_i) = u_i(n_{hi}, n_{li})q_{si}(n_{hi}, n_{li}) \left(\frac{h_{si}}{\mu}\right)^{\mu} \left(\frac{x_{si}}{1-\mu}\right)^{1-\mu} \epsilon_i, \qquad (1)$$

[8] For surveys on the spatial mismatch hypothesis see Ihlanfeldt and Sjoquist (1998), Gobillon et al. (2007), and Gobillon and Selod (2014).

[9] The focus on only two cities and two sets of workers is for demonstrative purposes. In Supplemental Appendix B.1 we show that the qualitative properties of our results continue to hold. The key differences is in the magnitude of the changes. The magnitude of the effects on inequality will be smaller between workers of more similar skills. And the magnitude of the effects on the population distribution will be smaller as workers divide themselves over a larger number of regions.

where $u_i(n_{hi}, n_{li})$ reflects urban costs associated with population size such as commuting or pollution, and ϵ_i is an idiosyncratic amenity preference parameter for location i. We assume that ϵ_i is drawn independently and identically across workers and locations from a Fréchet distribution given by $Prob(\epsilon_i \leq \epsilon) = e^{-\epsilon^{-\theta}}$, where the parameter θ governs the dispersion of amenity shocks[10]. The function $q_{si}(n_{hi}, n_{li})$ reflects residential externalities from the number of skilled and unskilled workers within the city. This formulation allows us to capture in a reduced-form manner, endogenous differences in the benefits workers of different skill levels derive from local amenities, depending on the skill composition of the city. For example, a larger number of skilled workers may increase the supply of fine-dining options that are less attractive to unskilled workers who would prefer a more affordable set of restaurants.

Utility maximization by workers yields the demand functions

$$h_{si} = \mu \frac{w_{si}}{p_{si}}, \quad x_{si} = (1-\mu) w_{si}. \tag{2}$$

The indirect utility for a worker who receives the amenity draw ϵ_i can be written as the product of a common component, V_{si}, reflecting local wages and prices, urban costs and residential externalities, and a stochastic component unique to each resident:

$$U_{si}(\epsilon_i) = \underbrace{V_{si}}_{\substack{\text{Common}\\ \text{Component}}} \times \underbrace{\epsilon_i}_{\substack{\text{Idiosyncratic}\\ \text{Component}}}, \qquad V_{si} \equiv u_i(n_{hi}, n_{li}) q_{si}(n_{hi}, n_{li}) \frac{w_{si}}{p_{si}^{\mu}}. \tag{3}$$

2.1 Production

Production of the homogenous good uses only labor and requires both skilled and unskilled workers. Total output from each city, Y_i, is produced under the technology

$$Y_i = A_i \left(b_{hi}(n_{hi}, n_{li}) n_{hi}^{\frac{\sigma-1}{\sigma}} + b_{li}(n_{hi}, n_{li}) n_{li}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{4}$$

where σ is the elasticity of substitution between types of workers; A_i is a measure of local total-factor productivity (TFP); and $b_{si}(n_{hi}, n_{li})$ are productivity externalities for a type-s worker arising from local interactions with other workers in the city. Firms take b_{si} as a parameter in making their output and labor demand decisions. The first-order conditions for cost minimiza-

[10] Due to its tractability, the Fréchet distribution is a commonly employed device to model imperfect mobility in recent spatial models such as Redding and Rossi-Hansberg (2017) and Heblich et al. (2020)

tion yield the wage ratio between skilled and unskilled workers

$$\frac{w_{hi}}{w_{li}} = \frac{b_{hi}}{b_{li}} \left(\frac{n_{li}}{n_{hi}} \right)^{1/\sigma}, \tag{5}$$

where we exclude the arguments of b_{si} for convenience. The unit cost function is then given by

$$c_i(w_{hi}, w_{li}) = \frac{\left(b_{hi}^{\sigma} w_{hi}^{1-\sigma} + b_{li}^{\sigma} w_{li}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}}{A_i}. \tag{6}$$

Perfect competition leads firms to set the price at unit cost, which equals 1 by the choice of numeraire. This implies that Y_i is also equivalent to aggregate income in city i, i.e., $Y_i = \sum_s w_{si} n_{si}$.

Assumption 1. ***(Externalities)*** *We assume that residential externalities, q_{si}, and productivity externalities, b_{si}, within a city derive solely from the number of skilled workers, and only directly benefit skilled workers.*

This assumption is largely to keep the model parsimonious. The key condition we require is that positive externalities favor skilled workers. We assume the following functional forms for residential and productivity externalities:

$$q_{hi} = n_{hi}^{\rho}, \quad q_{li} = 1, \quad b_{hi} = n_{hi}^{\eta}, \quad b_{li} = 1,$$

where the parameters $\rho \geq 0$ and $\eta \geq 0$ capture residential and productive externalities, respectively. With these functional forms, setting (6) equal to 1 and combining with (5) yields the high- and low-skilled wage in city i as a function of the population distribution,

$$w_{hi} = n_{hi}^{\eta - \frac{1}{\sigma}} A_i \left(n_{hi}^{\eta + \frac{\sigma-1}{\sigma}} + n_{li}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{1}{\sigma-1}}, \quad w_{li} = n_{li}^{-\frac{1}{\sigma}} A_i \left(n_{hi}^{\eta + \frac{\sigma-1}{\sigma}} + n_{li}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{1}{\sigma-1}}. \tag{7}$$

We write the urban skill premium in city i as the relative wage between skilled and unskilled workers,

$$\frac{w_{hi}}{w_{li}} = n_{hi}^{\eta} \left(\frac{n_{li}}{n_{hi}} \right)^{\frac{1}{\sigma}}, \tag{8}$$

where the term $1/\sigma$ measures the degree of labor supply competition that workers face, absent any externalities. Eq. (8) indicates that an equiproportional increase in both types of workers raises the skill premium.

2.2 Housing

Regulation enters the housing supply problem through the quantity of developable land.[11] We assume that there is a local government that limits the supply of developable land at the exogenous quantity L_i. All land is owned by a set of absentee landlord/developers who receive the land rent, r_{si}, for use in the construction of housing and spend all of their income on the homogenous good.[12]

To simplify the analysis, while capturing the idea of multiple housing markets (such as apartments vs. single-family homes), we assume that skilled and unskilled workers have a unique preference for housing. Developers can differentiate between workers to produce each type of housing and the production function is identical for both types. Thus, from the developer's point-of-view, there is no difference in the construction of a two-story single-family home or a two-story apartment building that uses the same amount of land and provides the same square footage of housing services. The technology is given by $H_{si}(K_{si}, L_{si}) = (K_{si}/\beta)^{\beta}(L_{si}/(1-\beta))^{1-\beta}$, where K_{si} and L_{si} are the quantity of capital and land employed in the development of housing for workers of type s. In equilibrium, $\sum_s L_{si} = L_i$, such that total land-use equals the available stock of land. Developers access capital through a world market and face an exogenous capital rental rate i, which we set equal to 1 to reduce the number of parameters. The profit function for housing in city i is

$$\pi_i = \sum_s \left(p_{si} K_{si}^{\beta} L_{si}^{1-\beta} - K_{si} - r_{si} L_{si} \right), \tag{9}$$

and the first-order conditions with respect to capital and land are

$$\beta \frac{p_{si} H_{si}}{K_{si}} - 1 = 0, \quad (1-\beta) \frac{p_{si} H_{si}}{L_{si}} - r_{si} = 0. \tag{10}$$

Given that housing markets are segmented, it follows that $p_{si} H_{si} = \mu w_{si} n_{si}$. To ensure that both types of housing are available in each city, it must be the case that land rents for each

[11] Our framework cannot exhaustively study all possible types of land-use regulations. As pointed out by Gyourko and Molloy (2015) on types of local regulations, "[c]reativity on the part of local governments appears to know virtually no bounds in this instance." Our formulation resembles work on urban growth boundaries, or greenbelts, as well as changes to local zoning ordinances that transition land zoned for industrial or retail use to residential use.

[12] The assumption of absentee landlord/developers allows us to avoid the intractability of redistributing land rents.

type of housing equalize, i.e., $r_{hi} = r_{li} = r_i$. It then follows from (10) that

$$\frac{K_{hi}}{K_{li}} = \frac{L_{hi}}{L_{li}} = \frac{w_{hi} n_{hi}}{w_{li} n_{li}} = \frac{n_{hi}^{\frac{(1+\eta)\sigma-1}{\sigma}}}{n_{li}^{\frac{\sigma-1}{\sigma}}}. \tag{11}$$

Eq. (11) implies that an equiproportional increase in both types of workers will raise the share of land devoted to housing for skilled workers. From (10), the land rent in region i can then be written as

$$r_i = \mu(1-\beta)\frac{Y_i}{L_i}.$$

In equilibrium, developers' profits are zero and the price for each unit of housing is set at unit cost such that

$$p_{si} = p_i = r_i^{1-\beta},$$

where we drop the s subscript from housing prices.

2.3 Spatial Equilibrium

This section develops the spatial equilibrium. We choose the functional form for urban costs as

$$u_i(n_{hi}, n_{li}) = (n_{hi} + n_{li})^{-\chi},$$

where the parameter χ governs the strength of congestion from population size. We can then write V_{si} as

$$V_{hi} = \kappa \underbrace{A_i^{1-\mu(1-\beta)}}_{\text{Productivity}} \underbrace{(n_{hi} + n_{li})^{-\chi}}_{\text{Urban Costs}} \underbrace{n_{hi}^{\rho+\eta-\frac{1}{\sigma}}}_{\substack{\text{Labor Supply}\\ \text{Competition}}} \Bigg(\underbrace{n_{hi}^{1+\eta-\frac{1}{\sigma}} + n_{li}^{\frac{\sigma-1}{\sigma}}}_{\text{City Income}} \Bigg)^{\frac{1-\mu(1-\beta)\sigma}{\sigma-1}} \underbrace{L_i^{\mu(1-\beta)}}_{\substack{\text{Land Supply}\\ \text{Constraint}}},$$

$$V_{li} = \kappa \underbrace{A_i^{1-\mu(1-\beta)}}_{\text{Productivity}} \underbrace{(n_{hi} + n_{li})^{-\chi}}_{\text{Urban Costs}} \underbrace{n_{li}^{-\frac{1}{\sigma}}}_{\substack{\text{Labor Supply}\\ \text{Competition}}} \Bigg(\underbrace{n_{hi}^{1+\eta-\frac{1}{\sigma}} + n_{li}^{\frac{\sigma-1}{\sigma}}}_{\text{City Income}} \Bigg)^{\frac{1-\mu(1-\beta)\sigma}{\sigma-1}} \underbrace{L_i^{\mu(1-\beta)}}_{\substack{\text{Land Supply}\\ \text{Constraint}}}, \tag{12}$$

where

$$\kappa \equiv (\mu(1-\beta))^{\mu(1-\beta)}$$

is a common constant. The key distinction in welfare levels in (12) is that skilled workers benefit from productive and residential externalities, respectively, when compared to unskilled workers.

The spatial equilibrium is defined such that the probability that a worker of type s locates in city i matches the actual share. Using the properties of the Fréchet distribution, this is written as

$$\frac{V_{si}^{\theta}}{V_{s1}^{\theta}+V_{s2}^{\theta}}=\frac{n_{si}}{n}. \tag{13}$$

Combining (12) and (13) and taking ratios for types h and l across cities, yields a relationship between the relative number of skilled and unskilled workers in each city:

$$\left(\frac{n_{l1}}{n_{l2}}\right)^{\psi_d}=\left(\frac{n_{h1}}{n_{h2}}\right)^{\psi_d-\psi_a}. \tag{14}$$

The term $\psi_d \equiv 1/\sigma+1/\theta$ reflects the dispersion forces, with $1/\sigma$ determining the degree of labor market competition and substitutability with skilled workers in production, while $1/\theta$ governs the level of attachment that workers have over a particular location. The term $\psi_a \equiv \rho+\eta$ reflects the agglomeration forces, which is the sum of the residential and productive externalities enjoyed by skilled workers. Using $n_{s1}+n_{s2}=n$ and combining with (14) yields

$$n_{l1}(n_{h1})=\left(\frac{n_{h1}^{\psi}}{n_{h1}^{\psi}+(n_h-n_{h1})^{\psi}}\right)n, \quad \psi\equiv\frac{\psi_d-\psi_a}{\psi_d}, \tag{15}$$

where the term ψ measures the strength of the agglomeration externalities relative to the dispersion forces. Notice that

$$\frac{\partial n_{l1}}{\partial n_{h1}} \gtreqless 0 \iff \psi \gtreqless 0,$$

indicating that skilled and unskilled workers migrate in the same direction only if $\psi>0$ such that the dispersion forces dominate the agglomeration externalities. We follow Farrokhi and Jinkins (2019) and define

$$W_s \equiv \left(V_{s1}^{\theta}+V_{s2}^{\theta}\right)^{\frac{1}{\theta}}, \tag{16}$$

as a welfare index for type s workers that is proportional to their expected utility[13]. Inserting (16) into the denominator of the LHS of (13), the relative welfare between skilled and unskilled workers in the economy can be written as

$$\frac{W_h}{W_l}=n_{hi}^{\psi_a-\psi_d}n_{li}(n_{hi})^{\psi_d}=\left(\frac{n}{n_{h1}^{\psi}+(n-n_{h1})^{\psi}}\right)^{\psi_d}, \tag{17}$$

[13] To derive the expected utility, we must multiply W_s by the scaling term $\Gamma(1+\frac{1}{\theta})$ where $\Gamma(\cdot)$ is the gamma function which solely depends on the parameter θ.

where the final equality follows from inserting (15) into $n_{li}(n_{hi})$ in (17). We use the ratio in (17) as our inequality measure.

To close the model, we use (13) and take the ratio for skilled workers in each city and combine with the definitions of V_{si} from (12) to get

$$\frac{n_{h1}}{n_{h2}} = \left(\frac{V_{h1}}{V_{h2}}\right)^{\theta} \implies$$

$$\left(\frac{n_{h1}}{n_{h2}}\right)^{\psi_d-\psi_a} = \left(\frac{A_1}{A_2}\right)^{1-\mu(1-\beta)} \left(\frac{n_{h2}+n_{l2}(n_{h1})}{n_{h1}+n_{l1}(n_{h1})}\right)^{\chi} \left(\frac{n_{h1}^{1+\eta-\frac{1}{\sigma}}+n_{l1}(n_{h1})^{\frac{\sigma-1}{\sigma}}}{n_{h2}^{1+\eta-\frac{1}{\sigma}}+n_{l2}(n_{h1})^{\frac{\sigma-1}{\sigma}}}\right)^{\frac{1-\mu(1-\beta)\sigma}{\sigma-1}} \left(\frac{L_1}{L_2}\right)^{\mu(1-\beta)}. \quad (18)$$

Eq. (18), along with the condition that $\sum_i n_{hi} = n_h = n$, pins down the equilibrium number of skilled workers in each city, which can then be used to solve for the remaining endogenous variables.

We now consider the implications of increasing the supply of developable land in city 1. Technical material is relegated to a Supplemental Appendix unless necessary for demonstrative purposes. Conceptually, our analysis is at the citywide rather than neighborhood level; thus, we focus on an interior equilibrium in which both types of workers reside in both cities. In Supplemental Appendix A, we detail sufficient conditions on the parameters to ensure that the equilibrium is stable, and we assume these conditions are met throughout. The conditions can be summarized as χ must be sufficiently large such that urban costs rise rapidly with population size, and that $\psi \in (-1, 1)$, ensuring agglomeration externalities are not too strong relative to the dispersion forces[14]. In general, there is not a closed form solution. However, an analysis around the symmetric equilibrium provides the key intuition for the problem. We now state our first result.

Result 1. *Suppose that both city 1 and 2 are ex-ante identical such that $A_1 = A_2$, $L_1 = L_2$, and in equilibrium $n_{s1} = n_{s2} = n/2$. An increase in supply of developable land in city 1 raises the expected welfare level for both types of workers, and increases the number of skilled workers in city 1. The number of unskilled workers in city 1 will rise if $\psi > 0$ and fall if $\psi < 0$. Given the sign of ψ, we summarize the comparative statics in Table 1.*

Table 1 Around Here

Proof. See Supplemental Appendix B

Figure 1 provides a graphical sketch of the proof where we consider an increase in the

[14] Intuitively, a large value of χ ensures both cities are populated, and the bounds on ψ ensure both cities host both types of workers. See Appendix A.1 for a discussion of the existence and uniqueness of the equilibrium.

supply of developable land from $\hat{L}_1$ to $\bar{L}_1$. The first-order impact of an increase in L_1 reduces rents in city 1, raising the common welfare level for skilled workers, which raises the probability that skilled workers will locate there. Thus, in equilibrium, the number of skilled workers must rise. We show in Appendix B that at the symmetric equilibrium ψ measures the elasticity of the number of unskilled workers to the number of skilled workers in city i. Thus, given that $\psi \in (-1, 1)$, our model is able to replicate the lower mobility rates for low-skilled workers found in the empirical literature. When $\psi > 0$, low-skilled workers move in tandem with skilled workers, such that the supply of both types increase in city 1. When $\psi < 0$, unskilled workers migrate in the opposite direction, such that city 1 hosts the larger share of skilled workers and city 2 hosts the larger share of unskilled workers.

Figure 1 Around Here

The intuition for this result is as follows. The spatial equilibrium condition requires that the relative expected welfare for high- and low-skilled workers equalize across cities. When $\psi_d > \psi_a$, we have a standard interpretation in which an increase in L_1 raises the attractiveness in city 1. This leads to in-migration of skilled workers. Since agglomeration externalities are relatively weak, the welfare benefits to skilled workers from the increase in housing supply are partially offset by welfare costs of a more competitive labor market from additional skilled workers moving to the city, as well as additional urban costs. The addition of skilled workers in city 1 raises the local income level and the wage rate for unskilled workers, driving up the common welfare level in city 1 and leading unskilled workers to move from city 2 to city 1. The in-migration of unskilled workers to city 1 increases labor-market competition which then lowers the unskilled wage rate, while further raising urban costs. This reduces the unskilled welfare level such that relative expected welfare levels once again equalize across cities, with city 1 hosting a larger number of both types of workers.

When $\psi_a > \psi_d$ and agglomeration externalities are strong, the in-migration of skilled workers further benefits skilled workers already residing in city 1. This raises inequality in city 1, driving unskilled workers toward city 2, which raises the nominal wages for the remaining unskilled workers in city 1. And given that unskilled workers are less mobile than skilled workers, the population, and therefore urban costs, rises in city 1 and falls in city 2. Thus, unskilled workers who migrate to city 2 see an increase in welfare from a reduction in urban costs, which raises welfare levels such that the spatial equilibrium once again holds.

Three points are in order regarding the comparative statics. First, regardless of the sign of ψ, the share of land devoted to housing for unskilled workers falls. This implies that when $\psi > 0$ and the number of unskilled workers increases in city 1, their individual housing consumption falls. Second, the wage premium depends on the difference between the ratio of the productivity externality, η, to the dispersion parameter, θ, and the ratio of the residential externality, ρ, to the elasticity of substitution between skilled and unskilled labor, σ. Holding all else fixed, the wage premium will tend to rise with η, which raises the share of revenue allocated to skilled workers, and σ, which allows firms to more easily substitute skilled for unskilled workers. Conversely, the skill premium will tend to fall with θ, which increases mobility, and fall with ρ, as skilled workers are compensated with lower wages due to greater access to non-productive amenities. Third, an increase in L_1 has no effect on inequality. This is an artifact of undertaking the analysis around the symmetric equilibrium. However, our analysis hints at the impact of an increase in L_1 in an asymmetric setting.

Suppose that $A_1 > A_2$ such that city 1 is more productive. Given that A_1 enters as a shift parameter in the same way as L_1 implies that when $A_1 > A_2$ then $n_{h1} > n_{h2}$ and $n_{l1} > n_{l2} \iff \psi > 0$. Thus, a change in the supply of available land works through the model similarly to an additional increase in local productivity. Using (18), we can show that the change inequality is determined by the sign of

$$sgn\left(\frac{d\frac{W_h}{W_l}}{dL1}\right)|_{A_1>A_2}= sgn\left(\psi\underbrace{\left(n_{h2}^{\psi-1}-n_{h1}^{\psi-1}\right)}_{+}\underbrace{\frac{dn_{h1}}{d_{L_1}}}_{+}\right),$$

where the sign for the inner term in braces follows from the fact that $\psi < 1$. Therefore, we would expect inequality to rise when $\psi > 0$ and fall when $\psi < 0$. This follows from the assumption that urban costs are high and faced equally by both types, while only skilled workers benefit from external economies. When $\psi > 0$ and the population of both types of workers rises in city 1, the negative impact of increased urban costs from a larger population are smaller for skilled workers, given that they enjoy both the additional productivity and social benefits from agglomeration, which increases inequality.

However, when $\psi < 0$, the number of skilled workers increases in city 1 and unskilled workers increase in city 2. But, given that skilled workers are more mobile than unskilled workers implies an increase in urban costs in city 1 and a reduction in city 2. Furthermore, one can verify from (7) that wages for unskilled workers rise unambiguously in city 1, as the reduction in the number of unskilled workers weakens labor market competition. And, since the outgoing unskilled workers in city 1 are replaced with higher wage skilled workers, there is a rise in total city income, further raising the unskilled wage. Conversely, wages for skilled workers in city 1 rise only if the external productivity parameter η is sufficiently strong and may fall. Thus, unskilled workers receive greater compensation in city 1 to manage the rise in urban costs. While, unskilled workers in city 2 see a reduction in wages but are compensated by the reduction in urban costs. Our numerical analysis below confirms this result.

3 Intra-urban Zoning

The analysis in Section 2 rests on the idea that intra-urban land use is determined solely through the market. A large literature has emphasized the role of zoning in magnifying inequality within cities by excluding land-use in development of housing for certain types of workers (see Fischel (2000) and Fischel (2004) for a survey). In response, some cities have implemented policies requiring that a share of any new development be allocated to housing for lower-income households.[15] In this section, we consider the case where each city fixes not only the total supply of developable land, but also the share of land devoted to production of each type of housing. We then study the impact of an increase in developable land with restrictions on the type of development that may occur on new residential land.

We denote by $\bar{L}_{si}$ as the exogenous quantity of land zoned for housing type s workers such that $\sum_s \bar{L}_{si} = L_i$. We use a z superscript to indicate values for which intra-urban land use is determined through zoning. The only changes that need to be made to the existing model are through the housing market. In particular, given that land use is predetermined, we no longer require the equality of land rent for each type of housing within a city. The profit function for a developer is now

$$\pi_i^z = \sum_s \left(p_{si}^z \left(\frac{K_{si}^z}{\beta} \right)^\beta \left(\frac{\bar{L}_{si}}{1-\beta} \right)^{1-\beta} - K_{si}^z - r_{si}^z \bar{L}_{si} \right). \tag{19}$$

[15] There have been different approaches to promote development of affordable housing units. One method is mandatory inclusionary zoning, which imposes that a share of new development be dedicated to housing for lower-income workers. Another method is density bonuses, which allow developers to construct at higher densities if an agreed upon share of units are devoted to affordable housing. While, other cities have eliminated zoning requirements that limited much of the cities residential land to the development of singe-family homes. See Greene and Gonzalez (2019) for a current set of policy tools in use.

Since land use is fixed by the local government, the choice variables are limited to the quantity of capital to employ, K_{si}^z. The first-order condition yields

$$K_{si}^z = \beta p_{si}^z H_{si}^z = \mu\beta w_{si}^z n_{si}^z, \tag{20}$$

where the wage functions w_{si}^z are identical to (7). Land rents in each zoned area can then be written as

$$r_{si}^z = \mu(1-\beta)\frac{w_{si}^z n_{si}^z}{\bar{L}_{si}}. \tag{21}$$

Notice that land rents now depend on the aggregate income of each type of worker rather than total income. Defining $k_{si}^z \equiv K_{si}^z/\bar{L}_{si}$ as the capital land ratio used in the production of housing for a type s worker in city i implies that

$$\frac{k_{hi}^z}{k_{li}^z} = \frac{r_{hi}^z}{r_{li}^z},$$

or the capital-land ratio will be higher in locations that command a higher land rent. Traditionally, the capital-land ratio is understood as a measure of building height; however, the ratio could also reflect a measure of the quality of housing, such as nicer appliances or fitness centers within an apartment building. The price for each type of housing is

$$p_{si}^z = (r_{si}^z)^{1-\beta}. \tag{22}$$

Relative land rents, which drive differences in housing-unit prices, are given by

$$\frac{r_{hi}^z}{r_{li}^z} = \frac{(n_{hi}^z)^{\eta+\frac{\sigma-1}{\sigma}}}{(n_{li}^z)^{\frac{\sigma-1}{\sigma}}}\frac{\bar{L}_{li}}{\bar{L}_{hi}},$$

which reflect both relative income and land-use restrictions.[16]

We drop the z superscript unless necessary to differentiate from earlier results, and rewrite

[16] In line with the debate mentioned in the introduction, this paper focuses on inequality across income groups. However, an important literature on racial segregation and zoning policies finds higher urban housing prices for segregated workers (see e.g., King and Mieszkowski (1973). Our model could be used to explore this issue. Specifically, if h and l were used to differentiate between racial groups instead of skill groups, then if group l faces segregation such that L_l is considerably lower than L_h, then unit rents could be lower for group h than group l.

the common welfare terms as

$$V_{hi} = \kappa A_i^{1-\mu(1-\beta)} \frac{n_{hi}^{\rho+\eta(1-\mu(1-\beta))-(\frac{1}{\sigma}+\mu(1-\beta)(1-\frac{1}{\sigma}))}}{(n_{hi}+n_{li})^{\chi}} \left(n_{hi}^{\eta+\frac{\sigma-1}{\sigma}} + n_{li}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1-\mu(1-\beta)}{\sigma-1}} (\bar{L}_{hi})^{\mu(1-\beta)}$$

$$V_{li} = \kappa A_i^{1-\mu(1-\beta)} \frac{n_{li}^{-(\frac{1}{\sigma}+\mu(1-\beta)(1-\frac{1}{\sigma}))}}{(n_{hi}+n_{li})^{\chi}} \left(n_{hi}^{\eta+\frac{\sigma-1}{\sigma}} + n_{li}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1-\mu(1-\beta)}{\sigma-1}} (\bar{L}_{li})^{\mu(1-\beta)}. \tag{23}$$

A comparison of (23) with (12) reveals that agglomeration externalities are weaker for skilled workers and labor-supply competition is stronger. This follows from the fact the workers now only compete for housing with workers of the same skill set, rather than all workers.

Using the same methods detailed above, we can solve for the number of unskilled workers and our inequality measure in region i as a function of high skilled workers

$$n_{li} = \frac{\bar{L}_i^{\frac{\mu(1-\beta)}{\zeta_d}} n_{hi}^{\zeta}}{\bar{L}_i^{\frac{\mu(1-\beta)}{\zeta_d}} n_{hi}^{\zeta} + \bar{L}_j^{\frac{\mu(1-\beta)}{\zeta_d}} n_{hj}^{\zeta}} n, \quad \frac{W_h}{W_l} = \left(\frac{n}{\bar{L}_i^{\frac{\mu(1-\beta)}{\zeta_d}} n_{hi}^{\zeta} + \bar{L}_j^{\frac{\mu(1-\beta)}{\zeta_d}} n_{hj}^{\zeta}}\right)^{\zeta_d}, \tag{24}$$

where

$$\zeta_d \equiv \frac{1}{\theta} + \frac{1}{\sigma} + \mu(1-\beta)\frac{\sigma-1}{\sigma} > \psi_d, \quad \zeta_a \equiv \rho + \eta - \eta\mu(1-\beta) < \psi_a, \quad \zeta \equiv \frac{\zeta_d - \zeta_a}{\zeta_d} > \psi, \quad \bar{L}_i \equiv \frac{\bar{L}_{li}}{\bar{L}_{hi}}.$$

The functions in (24) are similar in form to those in (15) and (17), except now they are governed by a stronger dispersion force, weaker agglomeration force, and account for the relative supply of zoned land.

We now consider the impact of local government increased the supply of developable land such that $dL_1 = d\bar{L}_{h1} + d\bar{L}_{l1}$ and $d\bar{L}_{s1} > 0$. The latter condition indicates that some new land is devoted for housing for both types of workers. Comparative statics are now determined by changes to both the total supply of land, L_1, and the relative supply of land, $\bar{L}_1$. We focus on the case where $d\bar{L}_1 \geq 0$, such that the local government aims to promote a more inclusive land-use policy by maintaining or increasing the share of land allocated to unskilled workers, even as total available land for both types of workers increases.

Result 2. *Consider an increase in the total supply of developable land in city 1 that maintains or raises the share of land devoted to unskilled workers. Using the hat notation $\hat{x} = dx/x$, there is a constant $\omega \in (0,1)$ such that if $\hat{L}_{h1} > \omega\hat{L}_{l1}$, n_{h1} is increasing and if $\hat{L}_{h1} < \omega\hat{L}_{l1}$, n_{h1} is decreasing. The number of unskilled workers is increasing if $\zeta > 0$ and $\hat{L}_{h1} > \omega\hat{L}_{l1}$ or if $\zeta < 0$ and $\hat{L}_{h1} < \omega\hat{L}_{l1}$. If $d\bar{L}_1 > 0$ inequality unambiguously falls regardless of changes in the* *population distribution.*

Proof. See Supplemental Appendix C □

In contrast to Result 1, when intra-urban land use is determined by zoning, if the quantity of new land in city 1 devoted to housing for skilled workers is sufficiently small, the number of skilled workers will fall. The intuition is apparent with an extreme example. Suppose city 1 allocates all new land to housing for unskilled workers. The first-order effect is to reduce housing prices for unskilled workers, while having no effect on skilled workers. The reduction in rents for unskilled workers raises the common utility level in city 1 relative to city 2, inducing migration of unskilled workers to city 1. For skilled workers in city 1, this increase in the population generates two competing effects: additional urban congestion costs and an increase in total city income, which raises wages. However, given the assumption that urban costs are sufficiently high, the net effect is negative. Thus, the common welfare level in city 1 falls for skilled workers, inducing migration to city 2.

Table 2 Around Here

In Table 2, we provide the comparative statics depending on whether the relative share of land between skilled and unskilled workers is unchanged ($\hat{L}_{h1} = \hat{L}_{l1}$), slightly reduced ($\hat{L}_{l1} > \hat{L}_{h1} > \omega\bar{L}_{l1}$), or largely reduced ($\hat{L}_{h1} < \omega\bar{L}_{l1}$). The results in columns (2) and (3), where the share of land is held fixed, the signs of the comparative statics largely mirror those of Result 1. When $\zeta > 0$, both skilled and unskilled populations increase in city 1. And since $\zeta < 1$, there is a greater in-migration of skilled workers, which implies that the skilled population share rises and the unskilled share falls. Given that the allocation of land zoned to each type of worker remains fixed, unit rents for skilled workers see a smaller decline, raising relative land rents between types. This effect generates an additional term in the skill premium, $\eta\mu(1-\beta)$, reflecting the additional welfare cost of adding a skilled worker to the city due to increased housing rents. Conversely, if $\zeta < 0$, the number of unskilled workers falls, even as the land available for housing rises. This emigration lowers housing demand and reduces rents for land devoted to unskilled workers, thus raising relative land rents. Again, since our analysis focuses on changes around the symmetric equilibrium, there is no impact on inequality when $\bar{L}_i$ is left unchanged. However, when $d\bar{L}_i > 0$ differentiating (25) around $n_{hi} = n/2$ yields

$$\frac{d(W_h/W_l)}{W_h/W_l} = -\underbrace{\frac{\mu(1-\beta)}{2}}_{(-)}\underbrace{\frac{d\bar{L}_1}{\bar{L}_1}}_{(+)} < 0.$$

There are two additional points worth emphasizing. The first is that a positive increase in the share of land devoted to housing unskilled workers weakens the tendency for each city to become more segregated by income, when agglomeration economies are strong relative to the dispersion force, i.e., $\zeta < 0$, provided the increase in the share of land devoted to unskilled workers is not too large. However, larger allocations of land toward housing for unskilled workers may also generate increased income segregation by reducing the number of skilled workers in the city with the greater supply of housing. To see this, notice that when $\zeta < 0$ in columns (3) and (7), skilled and unskilled workers move in opposite directions; but in column (5), the outcome is ambiguous. This follows from the fact that the increase in available housing for unskilled workers partially offsets the additional congestion costs from a greater number of skilled workers in the city. The second point is that wage inequality and welfare inequality may move in opposite directions. The intuition is that when productive agglomeration economies are strong, productivity gains will disproportionately benefit skilled workers through higher wages. However, given that under zoning, workers compete only with their own types for housing, the disproportionate increase in the skilled wage does not transfer as strongly into higher housing costs for unskilled workers.[17]

3.1 Discussion

Before proceeding, we briefly consider the purpose of our analysis in light of the analytical results. We have found that, absent any other considerations, relaxing land-use restrictions in order to increase housing supply in a city increases the welfare for all workers. However, taking into account equity concerns, the outcomes of the policy are less clear-cut. Specifically, relaxing land-use restrictions will only reduce inequality when agglomeration economies are sufficiently strong. And if this does occur, the model suggests that the number of unskilled workers in the more productive city will decline.

[17] This reflects the point made by Moretti (2013) that it is important not to conflate wage inequality with welfare inequality.

This poses a question: How problematic is it if a land-use policy that improves welfare for all workers and leads more unskilled workers to locate in more productive cities also increases inequality?[18] There appears to be no clear consensus in the literature. One argument for why this is an issue is that inequality alone can create its own set of complications. As argued by Saez (2017), the public's interest in inequality stems from the question of whether the gains from a society are being equitably distributed. Therefore, policies that benefit all workers but favor higher-income workers may prove politically contentious. Furthermore, high levels of inequality have implications for educational outcomes (Mayer (2010), Jackson and Holzman (2020)), health outcomes (Deaton (2016), Chokshi (2018)), and intergenerational mobility (Mayer and Lopoo (2008), Chetty et al. (2017)). An additional concern is political influence, as increasing wealth among a small group of individuals may allow greater access to politicians and thus policies that favor their interests, compounding inequality over time (Birdsall (2001)). Furthermore, inequality in cities has been associated with higher levels of crime, lower growth rates, political unrest and a decline in social cohesion (Glaeser et al. (2009)). While Geelhoedt et al. (2021) find that, in the case of Spain, high levels of inequality can negatively impact employment resilience in response to a shock from the larger macroeconomy.

However, an important result in the urban public-finance literature is that cities may be limited in their ability to address equity concerns.[19] Particularly, when workers are mobile across cities, redistributive policies may lead to an influx of workers who benefit from a policy, while those workers who are harmed by the policy could locate in another city[20]. This is apparent in Table 2 where large increases in the share of land devoted to housing for unskilled workers leads to a reduction in the number of skilled workers in city 1. Furthermore, disregarding equity issues, affordable housing is a desirable goal in itself, particularly for low-income workers who bear a greater burden from high housing costs and must adjust their consumption baskets along other margins to cover higher rents (Gabriel and Painter (2020)). In addition, our model suggests that inequality will fall when agglomeration economies are strong but lead to cities that are more segregated by income. However, Cheshire (2009) finds that while income integration is an oft-stated policy goal meant to improve outcomes for low-income workers, there is little

[18] There is a literature concerning why a society should be concerned about inequality when all welfare for all workers is improving. See e.g., Milanovic et al. (2018), Krugman (2013), Birdsall (2001), and Stiglitz (2014).

[19] For a review see Keen and Konrad (2013).

[20] Epple and Romer (1991) find that mobility does impose limits on the ability to redistribute, however they do find that some redistribution is possible, particularly in cities with larger populations.

evidence that such policies are successful. He argues that some degree of segregation may be useful in improving consumption benefits or labor-market matching for lower-income workers. While more targeted measures to deal with income inequality may prove more effective than efforts to economically integrate communities.

In practice, policies are created in a complex environment with multiple stakeholders, which is not specifically addressed in our model. And the success of the policies will be measured by how well their outcomes align with their stated intent. Our results provide a level of guidance on what outcomes are feasible, given the technology within a city.

4 Numerical Example

In this section, we present a numerical example by calibrating the model to empirical estimates for the key parameters. While our framework is highly stylized, the numerical exercises illustrate a fuller picture of the mechanisms driving the impact of the policy changes in the model under reasonable parameter values. We choose a value of $n_s = 100$ and set the share of expenditure on housing at $\mu = 0.33$ (Ahlfeldt and Pietrostefani (2019)). Combes et al. (2017) find that the production function for housing is well approximated by a Cobb-Douglas technology with capital share of $\beta = 0.8$. To ensure stability of the equilibrium, we choose a value of $\chi = 0.8$. For the agglomeration and dispersion parameters, we consider a range of values. Estimates of θ range from 1 to 13 (Farrokhi and Jinkins (2019)), and estimates of σ are between 1 and 3 (Diamond (2016)), which imply that $\psi_d \in (0.41, 2)$ and $\zeta_d \in (0.57, 2)$. Estimates for η lie between 0.03 and 0.11 (Farrokhi and Jinkins (2019)), and for ρ between 0.15 (Ahlfeldt et al. (2015)) and 0.6 (Owens III et al. (2020)), which suggests a range of $\psi_a \in (0.18, 0.71)$ and $\zeta_a \in (0.17, 0.68)$. Taken together, we have range of $\psi \in (-0.73, 0.91)$ and $\zeta \in (-0.2, 0.914)$. To give a sense of how agglomeration affects the results, in our first numerical exercise, we initially consider the case where $\psi_a = 0$, such that there are no agglomeration externalities for skilled workers, while varying ψ_d to reflect the different worker mobility rates. Specifically, we use $\theta = \sigma = 2$ such that $\psi_d = 1$ and $\sigma = 3$, $\theta = 10$ such that $\psi_d = .433$. We then introduce agglomeration externalities and consider cases where $\psi > 0$ and $\psi < 0$. In particular, we chose $\eta = 0.1$ and $\rho = 0.4$ such that $\psi_a = 0.5$ and use the values of ψ_d introduced above.

Table 3 provides results. Columns (2) and (3) show that in the absence of agglomeration externalities, an increase in supply of developable land in city 1 has no impact on the skill premium, the relative share of land devoted to each type of housing, or inequality. And when

ψ_d is lower such that workers are relatively more mobile, the increase in housing supply generates a greater rise in the number of both types of workers in city 1. In columns (4) and (5), where we introduce $\psi_a > 0$, our numerical examples replicate the analytical results, with unskilled workers less mobile than skilled workers. Unskilled workers migrate toward city 1 when $\psi > 0$ and toward city 2 when $\psi < 0$. In all four scenarios, there is a sizable decline in land rents in city 1; though, the effect is smaller with agglomeration economies as the total population change in city 1 Thus demand for housing is higher than in the absence of the externalities. However, the rental rate reductions translate into much smaller declines in housing prices and welfare gains given that land rents in our calibration account for 20% of housing costs and 33% of household income is devoted to housing, while congestion costs rise in city 1 as the population grows. The change in land supply has a larger impact on the skill premium than inequality, given that the cost of land only impacts 6.6% of a worker's budget ($\mu \times (1-\beta) = 0.33 \times 0.2 = 0.066$). Additionally, in the example when $\psi < 0$, there is a net decline in total output in the economy. This result stems from the fact that in our calibration, residential externalities are strong relative to productive externalities. Given that skilled and unskilled workers are not perfectly substitutable, the additional residential externalities generate an excessive concentration of skilled workers in city 1 beyond what is optimal for the production process. This outcome is in line with research by Osman (2020) that changes to land-use regulations not only impact the location decision for workers but also the level output of firms, with impacts on the aggregate economy.

Table 3 Around Here

In Table 4, we introduce intra-urban zoning restrictions. To keep the results directly comparable, we assume that the initial zoning allocations of land match the market equilibrium in Section 2. Given our calibration, this implies that just over 40% of available land is dedicated to housing for unskilled workers. All other parameter values are left unchanged. We consider three specific scenarios consistent with the comparative statics in Table 2: (1) the share of land devoted to skilled and unskilled workers, respectively, is held fixed; (2) the share of land devoted to unskilled workers is increased to 45%; and (3) the share of land devoted to unskilled workers is increased to 55%.

In columns (2) and (3), the results mirror those of columns (4) and (5) in Table 3, except given that agglomeration effects are weakened, the impacts of the increase in land are less pronounced. Thus in-migration of skilled workers to city 1 is lower in both cases, while in-migration of unskilled workers is higher when $\zeta > 0$ and out-migration is lower when $\zeta < 0$. In addition, the reduction in rents in city 1 are higher for unskilled workers, as there is relatively less congestion in that housing market.

Columns (4) and (5) in Table 4 present results of increasing total developable land by 50% and allocating 45% of land to housing for unskilled workers. Notice that irrespective of the sign of ζ, migration for both skilled and unskilled workers moves in the same direction. In addition, the percentage change in the number of unskilled workers rises, and the number of skilled workers falls relative to the case where $\bar{L}_1$ was held fixed. The policy reverses the out-migration of unskilled workers, as additional housing and the corresponding fall in rents reduces the negative effects of additional congestion. The percentage declines in inequality are larger than when $\bar{L}_1$ was held fixed. Therefore, the numerical results from our model suggest that when agglomeration economies are present, a policy that increases developable land coupled with small increases in the share of land devoted to unskilled workers can help reduce inequality and maintain a higher degree of income diversity, by either growing or retaining a larger number of unskilled workers relative to the market outcome. In addition, note that in column (4), the skill premium rises even as inequality falls, while in column (5), they both fall. This can be understood in terms of a compensating variation. When ζ_d is high, such that mobility is more costly, skilled workers must receive a higher wage to compensate for the transfer of land to unskilled workers. However, when ζ_d is low and skilled workers are relatively more mobile, they are willing to accept smaller gains in nominal wages relative to unskilled workers who do not benefit from agglomeration externalities.

Columns (6) and (7) in Table 4 present the results for when the city increases the share of land devoted to unskilled workers to 55%. In this scenario, the percentage change in the number of unskilled workers is more substantial than other cases. Whereas, when city 1 increases its share of skilled workers, changes are relatively small and in column (7), when ζ_d is low, city 1 loses skilled workers. Intuitively, the large increase in $\bar{L}_1$ leads to migration of unskilled workers toward city 1, which drives up congestion in city 1 and reduces congestion in city 2. This leads skilled workers away from city 1, who now benefit from the greater agglomeration economies in city 2. Interestingly, notice in column (7) that due to the increasing concentration of skilled workers in city 2, housing prices for skilled workers in city 2 actually rise.

A final point regarding output: in columns (4) and (5) of Table 3, net output may rise or fall from an increase in the supply of developable land. In columns (4) and (5) of Table 4, net output rises in both cases, when both developable land and $\bar{L}_1$ increase. The rationale is that when agglomeration economies are driven by residential externalities, an increase in the supply of land may oversupply skilled workers to the city with more housing. However, this effect can be partially mitigated through land-use policy that limits housing for skilled workers, reducing the incentive to migrate toward city 1.

Table 4 Around Here

5 Division of Land by a City Authority

Up to this point, our analysis has considered only the impact of an increase in housing supply on the equilibrium allocation of workers, land-use, housing prices, and inequality. However, we have not addressed how land should be prioritized for the housing of each type of worker when societal inequality concerns exist. In this section, we extend the model to consider a city authority (CA) in each city that has instruments L_{si} available to maximize a social-welfare function for urban residents in a decentralized economy, taking into account the degree of societal aversion toward inequality. This allows us to (1) consider the extent to which the market succeeds or fails in allocating land within cities across different kinds of workers, and (2) gauge the degree of efficiency of existing land-use policies in cities with intra-urban zoning. We assume that the CA is only concerned with the welfare of urban residents and ignores that of absentee landlords. Following Atkinson (1970), we write the CA's problem in city i as

$$\max_{L_{si}} \frac{1}{1-\epsilon}\left(\underbrace{n_{hi}W_h^{1-\epsilon}}_{\substack{\text{Aggregate Skilled}\\ \text{Welfare}}} + \underbrace{n_{li}W_l{}^{1-\epsilon}}_{\substack{\text{Aggregate Unskilled}\\ \text{Welfare}}}\right), \quad for\, \epsilon \neq 1,$$

$$\underbrace{n_{hi}\, ln\, W_h}_{\substack{\text{Aggregate Skilled}\\ \text{Welfare}}} + \underbrace{n_{li}\, ln\, W_l}_{\substack{\text{Aggregate Unskilled}\\ \text{Welfare}}}, \quad for\, \epsilon = 1,$$

$$s.t. \quad L_i = \sum_s L_{si} \quad for\, i = 1, 2, \quad s = h, l, \tag{25}$$

where we insert (23) into (16) for W_s. The parameter ϵ measures a society's aversion to inequality. When $\epsilon = 0$ (25) is a utilitarian welfare function, while when $\epsilon \to \infty$ (25) is a Rawlsian welfare function, where the planner prioritizes the welfare of the least well-off agent. We focus on the symmetric case. The derivation is standard and detailed in Supplemental Appendix D. We use the superscript p to denote solutions to the local planner's problem.

Result 3. *The relative supply of land chosen by the social planner to devote to skilled and unskilled workers, respectively, in a symmetric equilibrium is given by*

$$\frac{L^p_{hi}}{L^p_{li}} = \left(\frac{n}{2}\right)^{\frac{(\rho+\eta(1-\mu(1-\beta)))(1-\epsilon)}{1-\mu(1-\beta)(1-\epsilon)}}.$$

If $\epsilon = \frac{\rho}{\eta+\rho}$, *the allocation of land in the market equilibrium is identical to that of the city authority. For* $\epsilon < \frac{\rho}{\eta+\rho}$, *the market allocates too little land to skilled workers; while for* $\epsilon > \frac{\rho}{\eta+\rho}$, *the market supplies too little land to unskilled workers, relative to the city authority.*

Proof. See Supplemental Appendix D. □

Under the market equilibrium, the relative supply of land between workers is determined by relative wages and only takes into account productive externalities but not residential externalities. The planner, on the other hand, takes into account relative welfare levels which also include, for skilled workers, residential externalities as well as external congestion costs through higher housing prices from additional workers moving to the city. Thus η is weighted by the term $1 - \mu(1 - \beta)$. Therefore, when societal aversion to inequality is low, the social planner can raise aggregate welfare by shifting additional land resources towards housing skilled workers. Conversely, given that skilled workers receive such external benefits, when societal aversion to inequality is high, the planner can increase social welfare by increasing the share of land devoted to unskilled workers.

6 Extensions

The analysis above focused on a specific issue, namely, the impact of relaxing land-use restrictions in an economy with only two types of workers, all of whom rent housing. In this section we develop two simple extensions of the model from Section 2 to consider homeownership and racial discrimination in the housing market. We provide the bulk of the derivations from this section in Supplemental Appendix E.

6.1 Homeownership

Land-use regulations may benefit homeowners at the expense of renters by keeping property values high. Thus an important motivation in relaxing land-use regulations is to increase housing affordability. However, this may harm existing homeowners by reducing the value of their properties, and create political resistance to implementing less restrictive land-use policies. We address this issue by extending our model to add a tenure choice decision using the framework of Binner and Day (2015) to consider how homeowners are impacted by a reduction in land-use regulations relative to renters. We apply the superscript O and R to denote a variable for an owner and a renter, respectively.

Among the financial benefits of owning a home are the ability to build equity and reap capital gains after the sale of house. However, homeowners face costs that renters do not. These may include mortgage costs from financing a home, search costs, which are likely higher in markets with more buyers, and maintenance costs.[21] Thus, a worker must consider the interaction of these costs and benefits in deciding to purchase a home. In our extension, workers may rent or buy housing from absentee landlords at the same price per unit. If a type s worker chooses to buy a home, they must take out a mortgage and pay the borrowing costs m_s. We assume that m_s is exogenous and determined in the broader economy, and that $m_l > m_s$ such that skilled workers receive better terms for a mortgage than unskilled workers.[22] The problem faced by renters remains the same as in (1). Conversely, homeowners receive a utility premium $\delta > 1$, such that $U^O_{si} = \delta U^R_{si}$. The parameter δ captures benefits of ownership such as expected capital gains or the ability to customize a property. Homeowners, denoted by n^O_{si}, face the costs of the mortgage such that total housing payment is given by $(1 + m_s)p_i h^O_{si}$. However, in paying off their mortgage, homeowners build equity such that their net payment is simply $m_s p_i h^O_{si}$. Additionally, there are costs that homeowners face such as searching for and maintaining a property, closing costs on a mortgage or homeowner's association fees. We assume that these ownership costs are paid for in terms of the numeraire and take the form $c_{si}(n^O_{si}) = Q(n^O_{si})^\gamma$, where $\gamma > 0$ is the elasticity of homeownership costs to the number of homeowners of type s

[21] The degree of maintenance may be set by an outside authority, such as a homeowners association (HOA), which imposes a lower bound on the level of maintenance that must be undertaken. Unlike mortgage interest, HOA fees are not tax deductible. Additionally, Patacchini and Venanzoni (2014) find that maintenance quality may be driven by peer effects among homeowners.

[22] The term m_s summarizes a number of features related to mortgages including the interest rate, the loan-to-value ratio, tax benefits or whether mortgage insurance is required.

and $Q > 0$ is a scaling parameter.[23] Intuitively, the number of workers looking to buy homes increases the costs of searching for a house or peer effects on other homeowners to maintain the quality of housing. The budget constraint for a homeowner is then $w_{si} = m_s p_i h^O_{si} + x^O_{si} + c_{si}(n^O_{si})$.

In equilibrium, a worker who chooses to locate in region i must be indifferent between renting and owning a home, such that $V^O_{si} = V^R_{si}$. We show in Supplemental Appendix E that this yields the following function for the number of homeowners of each skill type

$$n^O_{si} = \left(\frac{(\delta - m^{\mu}_s) w_{si}}{Q} \right)^{1/\gamma}, \tag{26}$$

which is rising in the utility premium, δ, and in the wage rate, and falling in the mortgage costs, m_s[24]. Since δ represents the expected capital gains, then the term, $\delta - m^{\mu}_s$, captures net capital gains per unit of housing. This term is multiplied by the wage, which determines the number of units of housing that are purchased. Thus, we can interpret the number of workers who choose to own a home as a function of the net capital gains from a home chosen by a type s worker, scaled by the costs of homeownership. Given that skilled workers receive higher wages and lower mortgage costs, it follows directly from (26) that in a symmetric equilibrium, there will be relatively more skilled workers who are homeowners than unskilled workers.

Under our extension, the comparative statics from Table 1 continue to hold, which we can use to consider how reducing land-use regulations will alter homeownership rates. Specifically, the relative number of skilled to unskilled homeowners is an increasing function of the skill premium. Therefore, from Table 1, the number of skilled workers who choose to purchase a home will rise relative to unskilled workers, when $\eta/\theta > \rho/\sigma$, and fall when $\eta/\theta < \rho/\sigma$.

While our results are derived from a simple extension,[25] (26) makes clear how homeowners would be affected by a city reducing land-use regulations. Specifically, if higher wages in larger cities are being driven by higher housing costs, then policies that make housing more affordable

[23] Given that workers of different skills desire different types of housing, we assume that costs only depend on the number of homeowners in each housing market,

[24] For a city to have both owners and renters we also require that $n^O_{si} < n_{si}$. In Supplemental Appendix E we detail the parameter restrictions that ensures this condition holds. We assume that these conditions are met throughout the analysis

[25] To focus on the intuition, we have treated both capital gains, δ, and the mortgage cost term, m_s, as parametric. An interesting extension for future research would be to suppose that that capital gains depending on the prevailing housing price, i.e., $\delta_i(p_i)$ with $\delta'_i(p_i) > 0$, and that mortgage costs depend on the wage, i.e, $m_{si}(w_{si})$ with $m'_{si}(w_{si}) < 0$, such that expected capital gains rise with the prevailing housing price in the city, while higher wages lead to lower mortgage costs. Furthermore, one could introduce a down-payment constraint by using a Stone-Geary utility function with respect to housing.

could lead to a reduction in wages. This would, in turn, lower the net capital gains of a property and reduce the benefit of homeownership. In this case, welfare for homeowners would fall relative to renters and drive down the demand for owner-occupied housing. In our model, this could occur when η is close to zero, such that agglomeration economies are largely driven by residential externalities.[26] However, if η is relatively large, and increasing housing supply helps to foster agglomeration and drives up wages, this would raise the net capital gains and increase the number of homeowners. Therefore, our analysis suggests that while there is some merit to the concern that homeowners may be negatively impacted by relaxing land-use restrictions, it is not necessarily the case this will occur.

6.2 Racial Discrimination

An important issue in the study of racial inequality is how discrimination in the housing market limited the ability of minority groups to accumulate wealth by investing in homeownership. The literature has considered a number of reasons for this, such as discriminatory lending policies, real estate agents who only provide access to less desirable properties, as well as government policies that reinforce racial segregation.[27] In this subsection, we show how the previous extension can be used to consider whether reducing land use regulations will increase homeownership rates for minority groups given that they face barriers that other workers do not.

Suppose there are two groups within each set of workers of skill s, with the exogenous share χ of type b workers and $1-\chi$ of type c workers.[28] Given that our focus is on how discrimination works through the market for homeownership, to simplify the analysis, we assume that there is no discrimination in the labor or rental market such that the deterministic portion of welfare is equal for both groups[29]. Each group faces a different set of costs to purchase a house. Specifically, we assume that type b faces higher mortgage costs than type c, with $m_s^b > m_s^c$. Furthermore, suppose that ownership costs now take the form $c_{si}^{O,b} = Q(n_{si}^{O,b})^{\gamma_b}$ and

[26] See Supplemental Appendix E.1 for a technical discussion of when wages would rise in response to an increase in L_1.

[27] For an overview see Akbar et al. (2019) and Rothstein (2017). Quillian et al. (2020) find that while some forms of discrimination have declined since the implementation of the Fair Housing Act, other forms of discrimination persist.

[28] This implies that in the symmetric equilibrium, we would have $n_{si}^b = \chi n/2$ and $n_{si}^c = (1-\chi)n/2$.

[29] This assumption is to isolate the impact on homeownership, as different groups face different barriers to entry. However, there are a myriad of issues that should be taken into account in understanding how discrimination affects the welfare of different types of workers, which includes discrimination in both the labor and rental housing markets.

$c_{si}^{O,c} = Q(n_{si}^{O,c})^{\gamma_c}$ with $\gamma_b > \gamma_c$, such that ownership costs rise faster for type b workers. We assume again that costs depend on workers of the same group. This may occur, for instance, if real estate agents show different properties to different groups. We show in Supplemental Appendix E that these additions yield the following function for relative number of type s workers from group b and c that are homeowners

$$\frac{n_{si}^{O,b}}{n_{si}^{O,c}} = \frac{(\delta - m_s^b)^{1/\gamma_b}}{(\delta - m_s^c)^{1/\gamma_c}} \left(\frac{w_{si}}{Q}\right)^{1/\gamma_b - 1/\gamma_c}. \tag{27}$$

Given that $1/\gamma_b - 1/\gamma_c < 0$, it follows that if reductions in land use regulations lead to a higher wage, for example when η is high, the number of homeowners will rise in both groups. However, given that group b workers face additional costs of homeownership, they will be underrepresented in the share of type s workers who are homeowners.

7 Conclusion

This paper developed a model to consider whether policies aimed at relaxing land-use restrictions in order to increase the supply of urban housing would benefit all workers, and how those benefits would be distributed across workers of different skills. Our analysis shows that welfare will rise for both skilled and unskilled workers. However, if the dispersion forces are strong, such policies will raise the number of unskilled workers in more productive cities but increase inequality. When agglomeration economies are strong, inequality will fall, as will the number of unskilled workers in the more productive city. We adapted the model to consider intra-urban zoning policy and show that zoning may mitigate inequality or reduce the outflow of unskilled workers from the more productive city, but at the expense of weakening agglomeration economies. The model was calibrated to simulate the impact of an increase in housing supply under various parameter estimates.

We then considered how a city authority would choose to divide urban land to devote to housing for skilled and unskilled workers, respectively, given the degree of societal aversion towards inequality. We find that when societal aversion to inequality is low, the market allocates too little land to skilled workers; when societal aversion to inequality is high, the market prioritizes too little land to unskilled workers. Finally, we extend the model to consider homeownership and racial discrimination in the housing market. Reducing land-use regulations may benefit homeowners if agglomeration is largely driven by productive externalities, such that worker's wages rise in response to an increase in population. Additionally, if wages rise but discriminatory policies in the housing market raise the costs for a specific racial group of purchasing a home, reduced land-use regulations will raise homeownership rates for the racial group, but to a lesser extent than their counterparts who do not face the higher costs.

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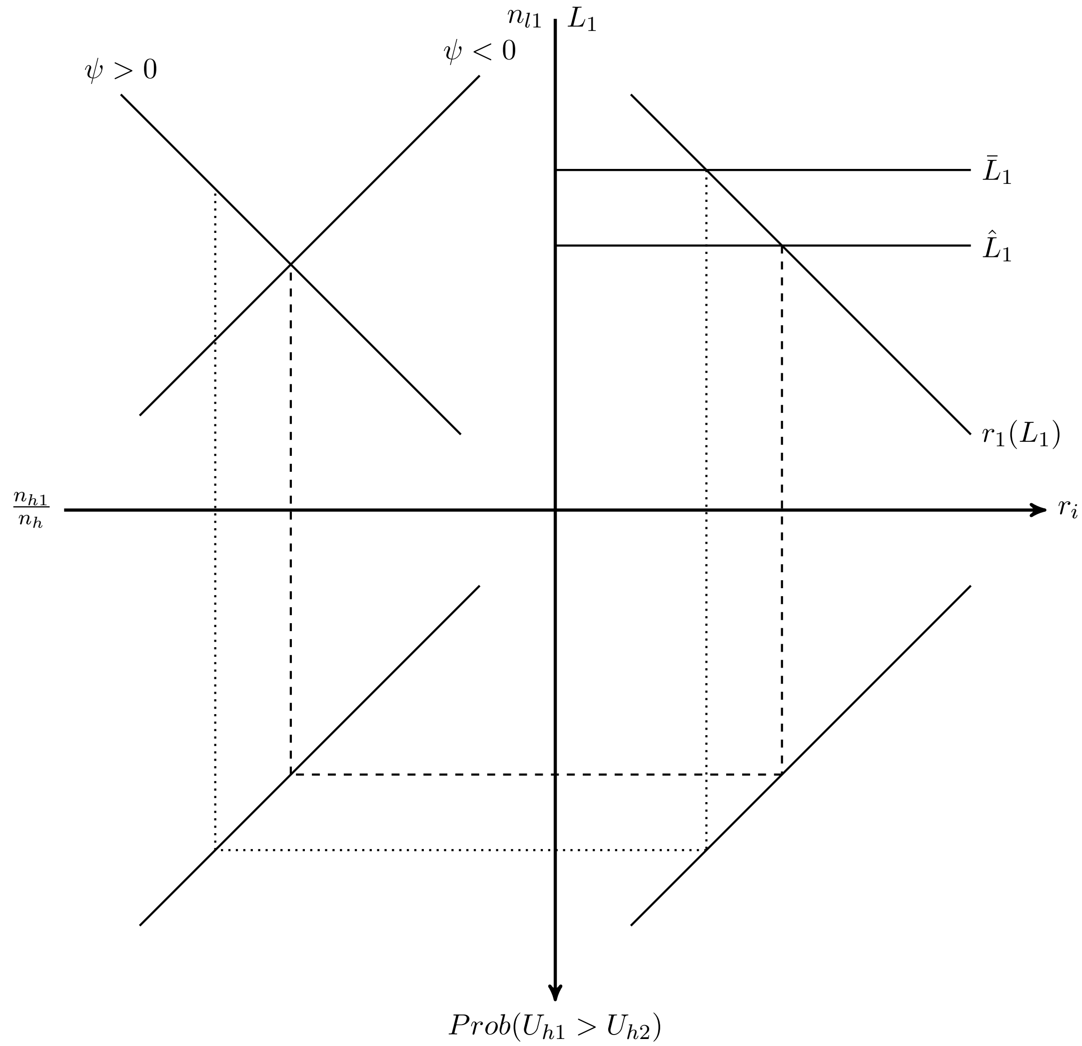

Figure 1: Comparative statics of an increase in the supply of developable land in city 1 from $\hat{L}_1$ to $\bar{L}_1$ on population distributions by skill group.

	$\psi > 0$	$\psi < 0$
Skilled Pop. (n_{h1})	+	+
Unskilled Pop. (n_{l1})	+	-
Skill Premium 1 (w_{h1}/w_{l1})	$sgn(\frac{\eta}{\theta} - \frac{\rho}{\sigma})$	$sgn(\frac{\eta}{\theta} - \frac{\rho}{\sigma})$
Skill Premium 2 (w_{h2}/w_{l2})	$sgn(\frac{\rho}{\sigma} - \frac{\eta}{\theta})$	$sgn(\frac{\rho}{\sigma} - \frac{\eta}{\theta})$
Land Ratio 1 (L_{h1}/L_{l1})	+	+
Land Ratio 2 (L_{h2}/L_{l2})	-	-
Welfare High(W_h)	+	+
Welfare Low (W_l)	+	+
Inequality (W_h/W_l)	0	0

Table 1: Comparative statics for the symmetric equilibrium with respect to an increase in L_1.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	$\hat{L}_{h1} = \hat{L}_{l1}$		$\hat{L}_{l1} > \hat{L}_{h1} > \omega\hat{L}_{l1}$		$\hat{L}_{h1} < \omega\hat{L}_{l1}$	
	$\zeta > 0$	$\zeta < 0$	$\zeta > 0$	$\zeta < 0$	$\zeta > 0$	$\zeta < 0$
Skilled Pop. (n^z_{h1})	+	+	+	+	−	−
Unskilled Pop. (n^z_{l1})	+	−	+	+/−	+/−	+
Skill Premium 1 (w^z_{h1}/w^z_{l1})	$sgn(\eta - \frac{1}{\sigma}(1-\zeta))$	$sgn(\eta - \frac{1}{\sigma}(1-\zeta))$	+/−	+/−	+/−	+/−
Skill Premium 2 (w^z_{h2}/w^z_{l2})	$-sgn(\eta - \frac{1}{\sigma}(1-\zeta))$	$-sgn(\eta - \frac{1}{\sigma}(1-\zeta))$	+/−	+/−	+/−	+/−
Relative Rent 1 (r^z_{h1}/r^z_{l1})	+	+	+	+	+/−	+/−
Relative Rent 2 (r^z_{h2}/r^z_{l2})	−	−	−	−	+/−	+/−
Welfare High (W_h)	+	+	+	+	+	+
Welfare Low (W_l)	+	+	+	+	+	+
Inequality (W^z_h/W^z_l)	0	0	−	−	−	−

Table 2: Comparative statics from an increase in L_1 when intra-urban land-use is determined by zoning. Columns (2) and (3) consider the case where the share of land devoted to skilled and unskilled workers is held constant. Columns (4) and (5) consider the case where there is a small increase in the share of land devoted to skilled workers. Columns (6) and (7) consider the case when there is a large increase in the share of land devoted to unskilled workers.

(1)	(2)	(3)	(4)	(5)
	High ψ_d	Low ψ_d	High ψ_d	Low ψ_d
% Change	$\psi = 1$	$\psi = 1$	$\psi = 0.5$	$\psi = -0.15$
Skilled Workers (n_{h1})	0.894	1.267	1.747	12.094
Unskilled Workers (n_{l1})	0.894	1.267	0.874	-1.870
Skill Premium 1 (w_{h1}/w_{l1})	0.000	0.000	-0.258	-3.239
Skill Premium 2 (w_{h2}/w_{l2})	0.000	0.000	0.267	3.692
Relative Land Shares 1 (L_{h1}/L_{l1})	0.000	0.000	0.606	10.529
Relative Land Shares 2 (L_{h2}/L_{l2})	0.000	0.000	-0.617	-10.522
Land Rents 1 (r_1)	-32.737	-32.489	-32.264	-28.320
Land Rents 2 (r_2)	-0.894	-1.267	-1.602	-7.570
Welfare High (W_h)	1.229	1.232	1.233	1.194
Welfare Low (W_l)	1.229	1.232	1.229	1.252
Inequality (W_h/W_l)	0.000	0.000	0.004	-0.057
Output 1 (Y_1)	0.894	1.267	1.604	7.520
Output 2 (Y_2)	-0.894	-1.267	-1.602	-7.570

Table 3: The percentage change of key variables from a 50% increase in developable land in city 1. Note: $\psi = 1 - \psi_a/\psi_d$. The results in columns (2) and (4) use $\psi_d = 1$ and columns (3) and (5) use $\psi_d = 0.43$. Columns (2) and (3) use $\psi_a = 0$ and columns (4) and (5) use $\psi_a = 0.5$.

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	$d\bar{L}_1 = 0$		$d\bar{L}_1 > 0$ (Small Increase)		$d\bar{L}_1 > 0$ (Large Increase)	
	High ζ_d	Low ζ_d	High ζ_d	Low ζ_d	High ζ_d	Low ζ_d
% Change	$\zeta = .52$	$\zeta = -.04$	$\zeta = .52$	$\zeta = -.04$	$\zeta = .52$	$\zeta = -.04$
Skilled Workers (n_{h1}^z)	1.715	7.986	1.207	4.213	0.011	-4.300
Unskilled Workers (n_{l1}^z)	0.893	-0.349	1.183	1.024	1.730	3.937
Skill Premium 1 (w_{h1}^z/w_{l1}^z)	-0.236	-1.891	0.108	-0.621	0.857	2.340
Skill Premium 2 (w_{h2}^z/w_{l2}^z)	0.244	2.080	-0.109	0.664	-0.864	-2.295
Skilled Land Rents 1 (r_{h1}^z)	-32.116	-28.053	-26.679	-24.550	-11.303	-14.944
Unskilled Land Rents 1 (r_{l1}^z)	-32.506	-32.326	-39.478	-39.170	-50.505	-50.057
Skilled Land Rents 2 (r_{h2}^z)	-1.821	-7.883	-1.393	-4.322	-0.361	3.740
Unskilled Land Rents 2 (r_{l2}^z)	-1.240	-1.585	-1.262	-1.788	-1.220	-2.209
Welfare High W_h^z	1.233	1.230	0.985	1.048	0.372	0.360
Welfare Low W_l^z	1.229	1.237	1.565	1.570	2.186	2.197
Inequality (W_h^z/W_l^z)	0.004	-0.007	-0.573	-0.574	-1.775	-1.798
Output 1 Y_1^z	1.590	5.335	1.342	3.306	0.704	-1.384
Output 2 Y_2^z	-1.587	-5.342	-1.340	-3.300	-0.707	1.340

Table 4: The percentage change of key variables from a 50% increase in developable land in city 1 with zoning. We use an initial value of $\bar{L}_1 = (n/2)^\eta = 0.403$ to match the relative share of land in the market equilibrium. In columns (2) and (3) $\bar{L}_i$ is held fixed. In columns (4) and (5), we raise the share of land devoted to unskilled workers to 45%. In columns (6) and (7), we raise the share of land devoted unskilled workers to 55%. Note: $\zeta = 1 - \zeta_a/\zeta_d$. High $\zeta_d = 1.03$ and Low $\zeta_d = 0.473$ and $\zeta_a = 0.494$.