Could Gentrification Stop the Poor from Benefiting from Urban Improvements?

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When policymakers invest in urban infrastructure – such as new train lines, parks, and schools – they provide a "place-based" policy because the infrastructure is provided to a specific neighborhood and not to particular people. This raises an important challenge: if people are mobile within cities, an improvement in one neighborhood may lead to an inflow of richer people who push up local prices such as rent and displace the poor. This process of infrastructure induced gentrification (IIG) has led to much debate about the proper design and impact of urban investment (see, e.g., the discussion in Kennedy and Leonard (2001)).

This paper investigates mechanisms that may lead to IIG using a general equilibrium urban commuting model. Our goal is to elucidate the channels through which IIG occurs and to understand how policy choices mitigate or accentuate gentrification. We show that a standard urban model can lead to a full range of gentrification outcomes and illustrate, through model simulation, which elasticities are important for generating specific effects. We also show that it is important to account for general equilibrium forces when understanding the distributional impacts of urban change. Simple empirical heuristics, such as relative changes in rent or population, do not necessarily sign the relative welfare impact between groups. Our companion paper Balboni et al. (2020), lays out the theoretical model in detail and then applies the method using panel data we collected in Dar es Salaam, Tanzania, as the city rolled out a Bus Rapid Transit (BRT) system.

I. Model

The model is a standard urban commuting model, based on Ahlfeldt et al. (2015). We augment the model to allow for several channels through which different types of people ("rich" and "poor") may differ. We then study how each of the following differences between types affects the welfare consequences of building a piece of urban infrastructure.

- Share of income spent on housing: if the poor spend more of their income on housing, they will be more exposed to endogenous rent changes.

- Endogenous type-specific amenities: high rents may lead to an increase in high-type amenities (such as fancy coffee shops), which are valued less by lower-income residents.

- Spatial comparative advantage: if it is less important for the poor to work in specific locations to maximize earnings, they will move more in response to infrastructure, but this does not necessarily indicate that poor incumbents gain more than rich incumbents.

- City design: how heterogeneous are neighborhoods? If IIG displaces the poor, welfare impacts will depend on whether they can find accommodation they value in other parts of the city.

- Housing market integration and returns to scale in building high-quality housing: if the rich consume a different type of housing and the cost of building housing suitable for the rich decreases as the ratio of rich to poor in a neighborhood increases, then this will strengthen the displacement pressure.

- Policy design: does a policy target rich or poor residents? For example, building public parking lots is only valuable to residents who own cars, which may be those who are richer.

- Persistence of individual heterogeneity: incumbents chose to initially live in a location based on the realization of their idiosyncratic productivity shock. If productivity is not persistent, incumbency effects are less relevant compared with average effects.

A. Welfare changes

Let the indirect utility of a location o be given by v_o^τ. Individual i, who is of type τ, chooses the location that maximizes her indirect utility:

$$\max_o v_o^\tau \epsilon_{io}^\tau$$

where ϵ_{io}^τ is i's idiosyncratic productivity shock for location o. If ϵ_{io}^τ is Frechet distributed with shape parameter θ^τ, then well-known results imply:

1) Commuting gravity:

$$\pi_o^\tau = \frac{(v_o^\tau)^{\theta^\tau}}{\sum_{o'}(v_{o'}^\tau)^{\theta^\tau}}$$

2) Average welfare:[1]

$$W^\tau = \kappa^\tau \left(\sum_{o'} (v_{o'}^\tau)^{\theta^\tau} \right)^{\frac{1}{\theta^\tau}}$$

Consider a policy shock that leads to a change in the indirect utility of a location, and possibly, via general equilibrium effects, the indirect utilities of all other locations. Let the change in indirect utility be given by $\hat{v}_o^\tau$, where $\widehat{\cdot}$ denotes "change" in the notation of Dekle, Eaton and Kortum (2008).

In our companion paper Balboni et al. (2020), we derive the following expressions for the average change across the city and

the average change of welfare for people ("incumbents") who started in each location. To compute incumbent welfare we need to account for the fact that incumbents are both endogenously selected as well as account for the selection of which incumbents then respond to the change in the economic environment:

1) Change in average welfare:

$$\widehat{W}^\tau = \left(\sum_{o'} \pi_{o'}^\tau (\hat{v}_{o'}^\tau)^{\theta^\tau} \right)^{\frac{1}{\theta^\tau}}$$

2) Change in incumbency welfare under perfect persistence of shocks is a weighted sum of the destinations o' that people in o choose to move to (using $o \to o'$ to denote those that move):

$$\widehat{W}_o^\tau = \frac{\sum_{o'} \pi_{o\to o'}^\tau \hat{v}_{o'}^\tau E_{F^\tau}(\epsilon_{io'}|o \to o')}{W^\tau}$$

$$= \frac{\sum_{o'} \hat{v}_{o'}^\tau (\pi_{o'}^\tau)^{\frac{1}{\theta}} \pi_{o\to o'} E_{F^\tau}(\epsilon_{o'}|o \to o')}{\kappa^\tau \pi_o^\tau}$$

which uses the property that expected utility is equal across locations i.e., $V_o^\tau E(\epsilon_o^\tau|o) = W_t^\tau \quad \forall o$. We show in the paper that (a) the migration probability depends on the relative utility gain of a location, with $\pi_{o\to o'} > 0$ iff $\hat{v}_{o'} > \hat{v}_o$,[2] and (b) this formula can be expressed in a closed form "exact hat" representation.

3) Change in incumbency welfare under imperfect persistence of shocks is a weighted sum of the unconditional and conditional formula. That is, if $\rho \in [0,1]$ proportion of the population redraw their idiosyncratic shock each period, the incumbency gain is given by:

$$\widehat{W_o^\tau}|_\rho = \rho \widehat{W}^\tau + (1-\rho)\widehat{W}_o^\tau$$

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[1] κ^τ is a type specific constant related to the Γ function.

[2] This formula collapses to the standard case for the location that has the largest gain in indirect utility. In that case, no one who initially migrated to the location choses to leave it, so $\pi_{oo} = \pi_o$, and so $E(\epsilon_o|o \to o) = E(\epsilon_o|o) = \bar{\gamma}\pi_o^{\frac{-1}{\theta^\tau}}$. In this case, the formula collapses to $\widehat{W}_o^\tau = \hat{v}_o^\tau$ i.e., the incumbents get an increase in utility equivalent to the increase in indirect utility.

B. Indirect utility for a commuting model

To convert this model into an urban commuting model, we redefine the index o as a live-work pair. We define the indirect utility of living in location l and working in location w as:

$$v_{lw}^{\tau} = B_l^{\tau} w_w^{\tau} \left(r_l^{\tau}\right)^{-(\beta^{\tau}+m^{\tau})} d_{lw}^{-\eta^{\tau}}$$

where B_l^{τ} is the (type-specific) amenity level in the live location l, w_w^{τ} is the (type-specific) wage rate in the work location w, r_l^{τ} is the (type-specific) rental cost in l, and d_{lw} is the commuting cost between l and w. The parameter β^{τ} represents the share of income that type-τ households spend on housing. m^{τ} represents the strength of endogenous amenity spillovers: we allow for an endogenous amenity that is a function of average rents $\bar{B}_l = (r_l^{\tau})^{-m^{\tau}}$; we represent this term by substituting it into indirect utility, yielding the exponent m^{τ} on rent;[3] finally, η^{τ} converts minutes of commute time to a utility cost.

C. Housing market

We assume that housing expenditure, R_l^{τ}, is a constant fraction of earnings. The total expenditure on housing in location l depends on the commuting patterns of people who live there:

$$R_l^{\tau} = \beta^{\tau} \sum_w \pi_{lw} \text{earn}_{lw}^{\tau}.$$

We combine this with an arbitrage condition that allows for imperfect integration (modeled by the parameter λ) between the housing market and determines relative rents:

$$\frac{r_l^H}{r_l^L} = \left(\frac{\pi_l^H}{\pi_l^L}\right)^{\lambda}$$

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[3]This specification is closely related to the specification of endogenous amenities in Diamond (2016); Couture et al. (2018).

D. Output per unit of human capital

We assume a location specific production function

$$Y_w = \bar{A}_w \left(\sum_{\tau} A_w^{\tau} Z_w^{\tau}\right)^{\alpha} T_w^{1-\alpha},$$

where Z_w^{τ} is the total amount of type τ human capital working in location w, $\bar{A}_w$ is an exogenous location w productivity, A_w^{τ} is an exogenous location w productivity for those of type τ and T_w is the amount of land available for firms in location w.[4] This production function treats L and H types as perfect substitutes and so it will be the case that $\hat{\omega}_w^L = \hat{\omega}_w^H$.

II. Gentrification definitions

We consider three related concepts:

1) Neighborhood composition: does the ratio of low to high residents change?

2) Welfare of incumbents: do rich incumbents gain more than poor ones?

3) Average welfare: across the city, do the rich gain more than the poor?

We say that a neighborhood experiences *weak gentrification* if the proportion of rich residents increases: $\frac{\hat{\pi}_l^H}{\hat{\pi}_l^L} > 1$ but welfare gains for poor incumbents are less than for rich incumbents. The neighborhood experiences *strong gentrification* if the number of poor residents decreases $\hat{\pi}_l^L < 1$. This gentrification is *compensated* if the incumbents have a net welfare gains $\hat{W}_o^L > 1$ and is *uncompensated* if the poor incumbents have a net welfare loss $\hat{W}_o^L < 1$.

III. Model simulations

The goal of this section is to simulate the model for different parameter values to show that the model can produce a full range of welfare outcomes. We simulate a simple three-location (slum, suburb, downtown) where the three locations are connected to enable commuting (see schematic

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[4]$Z_w^{\tau} = \Gamma(1 - \frac{1}{\theta}) E^t \sum_l \pi_{lw}^{\frac{\theta^{\tau}-1}{\theta^{\tau}}}$

below). In this environment, we consider the effect of a slum beautification project that increases the amenity in the slum.
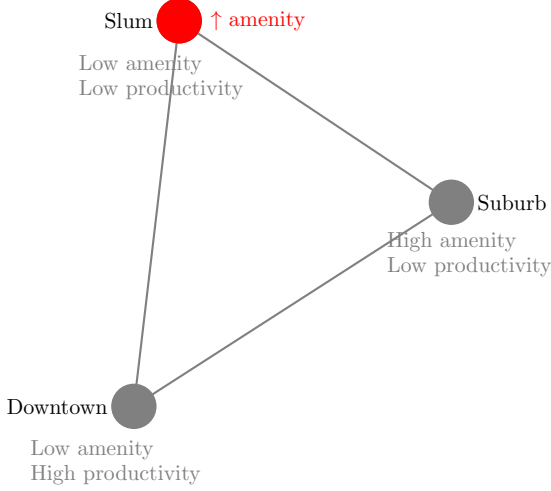
Our baseline specification considers the effect of a policy that improves the amenity of the slum by 5% equally for both L and H types. The baseline economic environment is:

- Amenities: {Downtown, slum, suburb} = {1,0.5,2}

- Productivities: {Downtown, slum, suburb} = {2,1,1}

- Housing expenditure share: $\beta^L = 0.4, \beta^H = 0.2$

- Endogenous amenity favoring the rich: $m^L = 0.4; m^H = 0$

- Integrated housing market: $\lambda = 0$

- Equal scope for comparative advantage: $\theta^L = \theta^H$

Figure 1 plots the impact on population sorting and welfare after the slum improvement. The baseline economy displays weak gentrification: as the slum becomes more attractive, both low and high move in, but poor incumbents see a smaller increase in welfare. The population of low types increases by 6.8%, and high types by 14%. In the baseline case the rental markets are integrated, so the increase in housing demand leads to a 7.4% rise in rents for both types.

The welfare increase for incumbents is positive – 1.9% for low incumbents and 3.4% for high ones – with the high types receiving a larger gain because they spend a smaller proportion of their income on housing and so are less exposed to rent increases. Finally, the policy has a small but positive welfare effect across the city. On average, low types receive a welfare gain of 0.2% and the high types a gain of 0.1%; the gain is larger for low types as they face compensating general equilibrium effects through lower rents in other parts of the city.

B. Alternative simulations

We now consider a range of other alternatives to illustrate several mechanisms present in the model. We display the key outcome variables in Table 1.

Starting with the role of preference parameters, we first consider a case where rich and poor spend the same share of their income on housing. In this case, both groups experience the same proportional increase in welfare – a 3.1% gain for the incumbents and a 0.1% gain across the city as a whole. Next, we consider endogenous amenities that favor the rich. The impact of this is to accentuate the cost of higher rents for low-income households. The welfare gain for poor incumbents falls from 1.9% to 1.2%. We then consider the role of asymmetric comparative advantage by decreasing the parameter θ^H and increasing the parameter θ^L. Changing these parameters has two effects: first, it (approximately) increases the relative dispersion of the productivity shocks for high types, increasing the importance of the match between the individual and the place for high types. This could approximate that high-income workers may be more likely to have specific skills, whereas low-income workers are more homogenous. The second impact is that because of the greater specificity of skill, the migration elasticity of low-income workers is higher than that of high-income workers. As a result, low types now move in to benefit from the higher amenities proportionally more than high types (2.2 percentage points more, compared with 7.2 per-

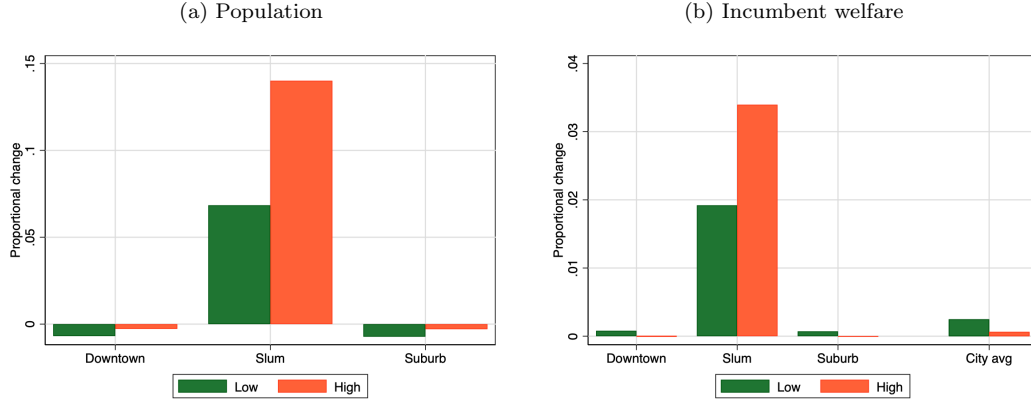(a) Population   (b) Incumbent welfare

Figure 1. : 5% improvement in slum amenity: baseline

centage points less in the baseline). Still, the overall gain in population is smaller. The lower influx of people leads to a smaller increase in rents and larger welfare gains for low incumbents relative to baseline(2.1% vs 1.9%). Despite low types appearing to value the policy more than high types (they move in more), the incumbency gain is still lower for low incumbents than high ones (2.1% compared with 3.5%).

Next, we consider the effect of the underlying structure of the city. In our baseline economy, the suburb has a high amenity value, and the initial population allocation has many fewer people (both low and high) living in the slum. If the neighborhoods are more homogenous ex-ante, more of the population is initially living in the slum. As a result, the inflow into the slum is smaller, and hence house prices do not rise as much. This proportionally affects the low incumbents who receive a gain of 2.6% compared to 1.9% in the baseline simulation. Because more people initially live in the slum, the overall benefits of the improvement are also larger. On average, low-types across the city receive a 1.6% welfare gain (compared to 0.2% in the baseline).

We then consider the effect of imperfectly-integrated housing markets by setting $\lambda = -0.3$. This represents decreasing costs of converting land to high-type housing. As a result, the rental increase for high-type households is smaller

than that faced by low-type households (4.6% vs. 7.3%), leading to a larger gap in the welfare gain of high incumbents compared to low incumbents.

The next row considers the effects of an amenity improvement targeted towards the rich. An example could be the impact of building parking garages in a setting where only higher-income people have cars. We model this as an improvement in the slum amenity of 5% for the rich while leaving the slum amenity unchanged for low types. This policy leads to strong uncompensated gentrification: low-income people move out of the slum in absolute terms, and the welfare of the initial low types who were living in the slum falls by 1.5%. Across the city, the welfare of low types falls by 0.2%, mostly reflecting the losses of poor incumbents. In comparison, incumbent high types receive a gain of 4.1% (the average welfare of high types is unchanged across the city).

Finally, we show the importance of the persistence of the idiosyncratic shock in determining the incumbency effect. If all residents redraw their shock every period, then the initial location does not reveal any information about the individual match of that location the following period. As a result, an incumbent has the same average characteristics as the average resident in the city, and so the incumbency welfare gains

are equivalent to the average welfare gain.[5]

These simulations also illustrate another important reason to use a spatial general equilibrium model when analyzing urban investments' impact. Simple heuristics, such as examining the relative gain in rent or the relative inflow of people, are not enough to sign the relative incumbency effects. This is clearly seen in the counterfactual that increases the scope for comparative advantage between low and high types. There was a larger relative inflow of low types than high types in that simulation, yet low incumbents fared worse than high ones. In most of the other simulations, the welfare gain of high incumbents was larger than the welfare gain of low incumbents, despite the two groups often facing the same increase in rental rates.

IV. Conclusion

Across the world, especially in low-income countries, urbanization rates are increasing. As urban density increases, policy-makers invest in public infrastructure such as schools, parks, and transportation routes to improve the environment. However, by nature, these investments are place-based: if people are mobile within a city, improvements in one neighborhood may lead to higher rental rates, pushing out the poor and leading to gentrification. Our goal in this paper was to illustrate economic channels that may lead to infrastructure induced gentrification through the lens of a general equilibrium spatial model. While simple, the model is rich enough to lead to a full range of equilibrium outcomes ranging from pro-poor to pro-rich outcomes. Our companion paper, Balboni et al. (2020) considers the impact of one such intervention, the introduction of the Bus Rapid Transit system in Dar es Salaam, and illustrates how to employ the theoretical model in an empirical setting.

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[5]Note that this is true in the current model because there are no costs of migrating.

Table 1—: Impact of slum improvement

	Population		Rent		Incumbent welfare		Avg welfare	
	(1) Low	(2) High	(3) Low	(4) High	(5) Low	(6) High	(7) Low	(8) High
Baseline	1.068	1.140	1.074	1.074	1.019	1.034	1.002	1.001
Preference parameters								
Equalize housing share	1.126	1.126	1.092	1.092	1.031	1.031	1.001	1.001
Strong endog. amenities	1.009	1.190	1.022	1.022	1.012	1.045	1.009	1.000
Rich stronger comparative adv.	1.126	1.104	1.069	1.069	1.021	1.035	1.001	1.001
City design								
Equal baseline amenities in slum/suburb	1.042	1.090	1.057	1.057	1.026	1.038	1.016	1.016
Housing market								
Nonintegrated housing	1.071	1.165	1.073	1.046	1.020	1.040	1.003	1.001
Policy design								
Pro-rich slum improvement	0.945	1.174	1.037	1.037	0.985	1.041	0.998	1.000
Persistence								
Redraw idio. shock	1.068	1.140	1.074	1.074	1.002	1.001	1.002	1.001

Notes: Table shows proportional change for slum neighborhood. A value greater than 1 indicates a net gain. All simulations except for the last row assume that idiosyncratic shocks are fully persistent.