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Slums, Allocation of Talent, and Barriers to Urbanization*

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Abstract

Slums are a prevalent urban phenomenon across developing countries. They are locations with low-quality dwellings, often built on valuable land, that allow poorer households to access urban markets that otherwise would be unattainable. I build a spatial general equilibrium framework to analyze the aggregate effects of anti-slum policies in India. The model takes into account individual selection and location differences in education returns, productivity, and housing rents. I find that demolishing slums in the most productive areas shrinks the size of urban population and reduces labor productivity. In contrast, decreasing formal housing distortions in India to the U.S. level increases the share of urban population by 13% and labor productivity by 1.8%, and generates a 34% reduction in the share of the urban population living in slums.

JEL Codes: E24, J61, O11, O18, O53, R12, R23, R31
Keywords: slums, urbanization, productivity, migration, talent

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1 Introduction

More than half of the total world population lives in urban regions today. Particularly, urbanization has increased dramatically in poor countries. In 1960, the urban population share was 17% and 15% in South Asia and Sub-Saharan Africa, respectively; these shares were 34% and 40% in 2017. The emergence and growth of cities are closely related to economic development (Kuznets, 1968; Glaeser, 2011); however, a prevalent feature of urban regions in poor countries is the large population share living in slums: locations characterized by low-quality housing, low provision of public services, and informal property rights.

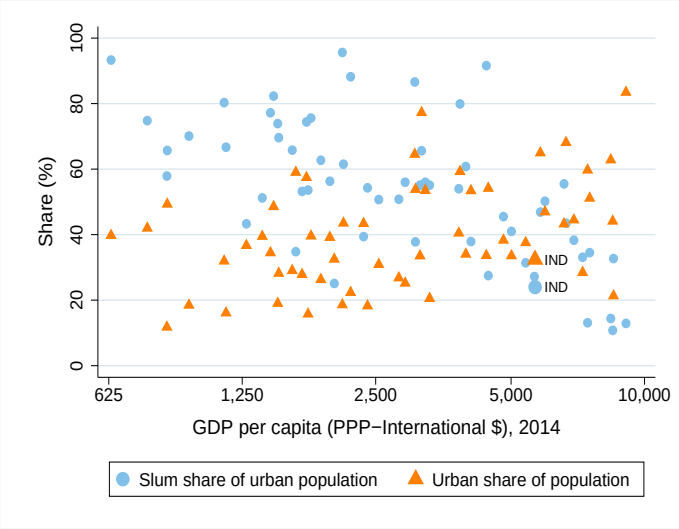
The existence of slums implies a trade-off for policymakers. On one hand, slums are locations with poorly built houses often occupying valuable land that could otherwise be used for commercial purposes or construction of formal housing.[1] On the other hand, slums are dense areas where dwellers, especially rural migrants, can gain access to labor market opportunities in urban centers. This trade-off is amplified by the presence of burdensome regulations that limit the supply of formal housing, which further raises prices in this sector and increases the demand for and value of residential space in slums.

The goal of this paper is to measure the aggregate implications of anti-slum policies in a context of inefficient housing markets. I build a general equilibrium model that features spatial differences in human capital, housing rents, and productivity. Urban locations offer better economic opportunities in terms of income and returns to education, but have a higher cost of living than rural regions. Housing rents in urban locations depend on the supply of residential land, which can be used for producing two types of housing: formal or slums. The demand for land is higher in central urban areas, so the marginal value of land occupied by slums is high; nevertheless, such slums are formed because workers want to live close to the most productive areas of the city and formal housing is costly due, in part, to regulations.

The model takes into account the general equilibrium effects of counterfactual policies through changes in prices and sorting of talent. In particular, housing prices act as a congestion

[1] For example, Henderson et al. (2016) show evidence of inefficient land-use generated by slums in Nairobi.

Figure 1: Urban and Slum Population in Poor Countries



Source: UN Habitat, World Development Indicators, 2014.

cost in urban regions due to the limited supply of land, while selection has two effects: there are potential gains of sorting based on comparative advantage across locations, but the marginal resident in each location has a relatively low productivity in that place. Furthermore, the local supply of skills is a function of returns to education in each location and wages depend on the spatial allocation of heterogeneous workers.

I focus on the case of India for the empirical motivation and quantitative implementation of the model. The population size (around 1.3 billion) of this country makes it a particularly important case among developing countries. Moreover, India is widely considered a country with inefficient urban policies and governments have opted to demolish slums in urban areas where land is most valuable.[2] Figure 1 shows that, in comparison to countries with similar and lower levels of development, India has a small share of urban population, as well as a low share of the urban population living in slums. This paper explores the importance of anti-slum policies and restrictive building regulations in explaining such facts.

To discipline the model quantitatively, I exploit rich microdata from household surveys. Then, I use the estimated model to evaluate the aggregate effects of two different policies that

[2]See Bertaud (2002), Brueckner and Sridhar (2012), Bertaud and Brueckner (2005), Diwakar and Peter (2016), Kumar (2010), Dupont (2008), and Bhan (2009).

could reduce the urban population living in slums: evicting slum dwellers from central urban areas, which is a common policy in poor countries, and reducing distortions in formal housing. The quantitative results show that evicting half of the population from central slums generates a fall in total output of 1.5% and decreases urban population by 9.4%. Among individuals evicted from central slums, 74% move to rural regions and 19% move to formal housing in the central urban region. These results imply that destroying central slums may hinder the urbanization process by pushing people to rural regions and deterring urban migration.[3] That is, given the high price of formal housing in central urban areas, slums are the only option to gain access to the most productive urban jobs and the periphery is not an attractive alternative.

In contrast, the quantitative results show that reducing formal housing distortions in India to the U.S. level increases the urban population share by 13% and aggregate labor productivity by 1.8%, and reduces the share of the urban population living in slums by 34%. Furthermore, I find that formal housing distortions substantially amplify the negative effects of destroying central slums, especially in terms of urbanization, by limiting the capacity of the formal sector to accommodate more population with the available supply of land. The quantitative results imply that relaxing distortionary regulations is a more effective policy to increase the urbanization rate and reduce the share of the urban population living in slums.

This paper is related to a small literature that has considered the economics of slums and their aggregate implications for economic development.[4] In particular, Monge-Naranjo et al. (2018) document similar findings on economic opportunity gaps between rural and urban regions in Brazil, including slums. They stress the role of intergenerational links in explaining the emergence of slums, while this paper focuses on the allocation of land across types of housing and the importance of living in central urban areas for the formation of slums. I find similar aggregate implications of anti-slum policies and formal housing costs, but my

[3] In a recent paper, Jedwab and Vollrath (2019) also find that restricting urban migration into informal urban areas reduces welfare by keeping people in rural areas.

[4] See Marx et al. (2013) for a review of slums in developing countries and Brueckner and Lall (2015) for a survey on urbanization and housing in the same class of countries. Also, Chauvin et al. (2017) study differences in urbanization between rich and poor countries, and Jedwab et al. (2017) document the relationship between rapid urbanization and slums formation in developing countries.

model highlights the differential welfare effects on dwellers and landlords in urban locations, the geographic expansion or sprawl of urban regions, and the interaction of land and labor markets when policy changes affect the formation of slums. This provides additional insights for cases like India where slums are occupying valuable land in urban centers.

In a related paper, Cavalcanti et al. (2018) examine the formation of slums in Brazil and analyze the impact of barriers in formal markets. Their focus is on housing choices within a city, whereas this paper considers the effects of housing and slums policies on the decision to live in the countryside or one of multiple urban locations.[5] In my model, this decision depends on the comparative advantage of each worker in the type of jobs that predominate in each location. Another difference with these papers is that I study a country where most people still live in rural areas and barriers to urbanization might be a key obstacle for development.

This paper also contributes to the literature on India's urbanization. Munshi and Rosenzweig (2016) document large wage gaps between urban and rural regions in India, and argue that caste-based insurance networks act as a barrier to rural-urban migration.[6] I document evidence on wage differences between slums and formal housing in urban regions, and focus on anti-slum policies and housing regulations as possible barriers to urbanization in India. Additionally, this paper relates to the large macroeconomics literature on urban-rural development. Specifically, Gollin et al. (2014) and Herrendorf and Schoellman (2018) look at human capital gaps as a possible explanation for the large productivity gaps between non-agriculture and agriculture. I build on their ideas to measure spatial differences in human capital across locations.

Finally, this paper relates to the literature on quantitative spatial economics. I build on the framework of Ahlfeldt et al. (2015) and Bryan and Morten (2018), who draw on results from Eaton and Kortum (2002) to characterize the allocation of workers across locations as gravity equations that depend on congestion and agglomeration forces.[7] In a recent paper,

[5] Alves (2018) also looks at the formation of slums in Brazil and stresses the importance of differences in housing supply elasticity between slums and non-slums in cities.

[6] Hnatkovska and Lahiri (2014) find that urban-rural wage gaps in India have decreased due to urban sprawl (rural areas reclassified as urban) and migration accounts for only a small fraction of the decline.

[7] Similar frameworks include Monte et al. (2018) and Rossi-Hansberg et al. (2017).

Gechter and Tsivanidis (2017) use a quantitative general equilibrium model to assess the impact of land redevelopment based on a natural experiment in Mumbai. This paper focuses on the aggregate effects of restrictive building regulations and anti-slum policies, taking into consideration differences in labor market opportunities between urban and rural regions.[8]

The rest of the paper is organized as follows. Section 2 presents the main data used in the paper and empirical evidence from India. Section 3 describes policies related to housing development and slums in this country. Next, Section 4 introduces a spatial model of talent allocation that is consistent with the trade-offs motivated by the empirical evidence. Then, Section 5 provides a description of the estimation and presents the quantitative results of counterfactual policies. Section 6 considers robustness checks, and Section 7 concludes.

2 Empirical Evidence

In this section I document empirical evidence from India. I use survey data to present facts of rural and urban regions, splitting the latter into formal locations and slums. The data come from the India Human Development Survey-II, 2011-2012 (IHDS II). This is a nationally representative survey of 42,152 households in 1,420 villages and 1,042 urban neighborhoods. The information in these surveys includes individual data on education, labor income, and hours worked; as well as household data on expenditures and dwelling characteristics. These data have the advantage of allowing me to identify slums in urban regions and use a rich set of individual information to compare relevant outcomes that characterize the main trade-offs between rural and urban areas.

The classification of households as urban or rural in IHDS II is based on the Census of India 2011. According to the latter, urban areas are towns where local government bodies are situated, and places with: (i) a minimum population of 5,000; (ii) at least 75% of male working population engaged in non-agricultural activities; and (iii) a population density of at least 400 persons per sq.km. Therefore, urban regions include administrative centers of

[8] In a related paper, Hsieh and Moretti (2018) show that housing constraints are important for the spatial allocation of labor and aggregate labor productivity in the U.S..

local governments, such as municipal corporations, and areas with a high population density where non-agricultural activities predominate. Rural villages are areas that do not satisfy the previous definition. In 2011, urban population represented 31% of the total population in India.

I use IHDS II data to identify slums based on the definition of the United Nations (UN).[9] I define slums as urban households that: (i) do not have access to piped water or protected source; (ii) do not have a private toilet or dispose waste in open fields; (iii) have roof/walls made of thatch, mud or grass; or (iv) do not have proof of residence such as an electric bill or rent agreement.[10] Formal urban houses are dwellings located in urban areas that are not classified as slums. Adapting the UN definition to the available data is a standard practice in papers about slums or informal urban settlements. Note that the latter implies that slums are defined at the household level and this type of dwellings tend to be clustered in neighborhoods within a city.

2.1 Education and labor income

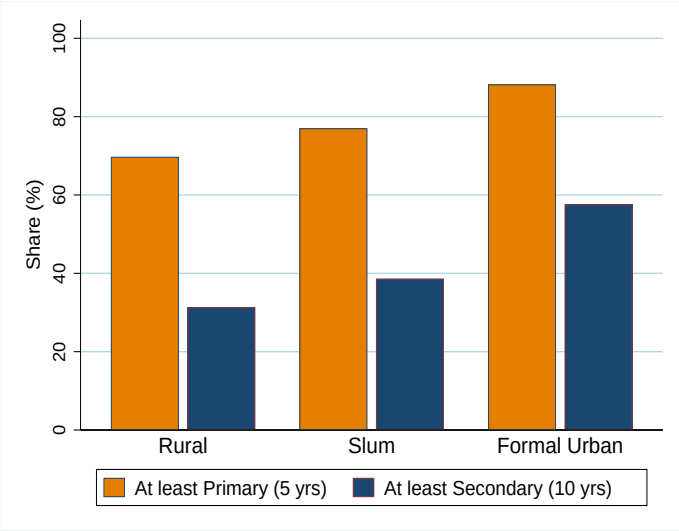
In this section I document economic opportunity gaps across location types: rural, slums, and formal urban housing. The evidence presented has two patterns: individuals living in slums have lower outcomes in terms education and labor income within urban regions, but they are more educated and have higher labor income than those in rural regions.

First, Figure 2 shows differences in educational attainment for working age (15-65 years) men. The results show that education levels are higher in both types of urban locations. The share of individuals with at least primary school is 7 percentage points higher in slums than in rural regions, and 19 percentage points higher in formal urban areas than in the countryside. Similar differences are observed for the share of individuals with at least secondary school

[9] An urban household lives in a slum if it *lacks at least one* of the following: improved source of water, improved sanitation facilities, housing durability, tenure security, or sufficient living area.

[10] IHDS II do not provide good data to measure sufficient living space. Using this definition, I obtain a share of slums population in urban regions equal to 36%. This share is higher than the one observed in the closest year to the surveys in UN data: 29% in 2009. If I do not take into account tenure security, I obtain a similar share to the UN; however, the empirical evidence is not very sensitive to this distinction and the lack of property rights is a key feature of slums.

Figure 2: Educational attainment across locations



Notes: Based on working age male population (15-65 years). Urban regions are defined according to the 2011 Census in India. Urban slums are defined by adapting the definition of the UN to IHDS II data. Formal urban refers to dwellings that are not classified as slums. See text for details. Source: Author estimates using IHDS II 2012.

between rural and slums, but the difference is larger relative to formal urban locations. These results also show that educational gaps between individuals living in slums and those living in formal urban housing are especially large for higher levels of education, which is consistent with the notion that low-skilled individuals tend to live in slums.[11]

Another key difference between rural and urban regions are labor market outcomes. Table 1 presents the gaps in hourly wages between urban locations and rural regions for working age men who worked at least part time. These gaps are obtained by running a regression of individual log-wages on location type, choosing rural areas as the omitted group. The gaps reported are equal to $\exp(\beta_\ell)$, where β_ℓ is the regression coefficient of each location type. The raw wage gap between slums and rural regions is equal to 1.4, which means that hourly wages are 40% higher in slums than in rural regions, while the raw gap between formal urban areas and rural regions is equal to 1.8. These large wage gaps are usually interpreted as suggestive evidence of barriers to labor mobility, or as a reflection of skill sorting across locations. To

[11] Differences in health outcomes might amplify the gaps in human capital suggested by comparing educational attainment across location types. Previous literature finds that health outcomes tend to be worse in slums than in other urban areas, however, the findings are mixed for the comparison between slums and rural areas. See Marx et al. (2013) and Fink et al. (2014).

Table 1: Hourly wage relative to rural regions

	Raw Gap	Adjusted Gap for Education
Slum	1.41	1.32
Formal urban	1.79	1.51
Observations	34,337	34,299

Notes: Based on working age (15-65 years) male individuals who worked at least part time and controlling for age in both cases. Urban regions are defined according to the 2011 Census in India. Urban slums are defined by adapting the definition of the UN to IHDS II data. Formal urban refers to dwellings that are not classified as slums. See text for details. Source: Author estimates using IHDS II 2012.

partially account for selection, I estimate the wage gaps controlling for educational attainment. The adjusted gaps are smaller but still large and, while there can be selection based on unobservable human capital, they suggest that there are barriers preventing individuals from exploiting opportunities across space.

Next, I relate the findings on education levels and wages by exploiting the micro data to compare Mincer returns to education by location type. To do so, I estimate the following log-wage regression:

$$\log(W_{i\ell}) = \beta_\ell D_\ell + \eta_j e_i + \alpha f(exp_{i\ell}) + \epsilon_{i\ell} \tag{1}$$

where $W_{i\ell}$ is the hourly wage of individual i living in location ℓ, D_ℓ is a location dummy, $f(exp_i)$ is a quartic in experience at the place of residence, e_i are education years completed by individual i, and $\epsilon_{i\ell}$ is an i.i.d. error with zero mean. In the same spirit as Lagakos et al. (2018*a*), I define potential experience as $exp_{i\ell} = \min\{\text{age} - e_i - 6,\ \text{age} - 16,\ \text{years living in } \ell\}$.[12] This definition implies that individuals start working in their current location at age 16, when they finish school, or when they move to this place, whichever comes last. The results presented in Table 2 show that returns to education are higher in urban regions, especially in formal urban areas. Thus, not only are wages higher in urban regions for a given level of education,

[12]The results are very similar if I use total experience instead of experience at the place of residence.

Table 2: Returns to education by location

Location	Mincer return
Rural	4.3%
Slum	5.1%
Formal urban	6.5%
Observations	34,074

Notes: Based on working age (15-65 years) male individuals who worked at least part time. Urban regions are defined according to the 2011 Census in India. Urban slums are defined by adapting the definition of the UN to IHDS II data. Formal urban refers to dwellings that are not classified as slums. See text for details. Source: Author estimates using IHDS II 2012.

but individuals with high educational attainment gain more from working in cities. One interpretation of these results is that urban occupations are more skill-intensive in comparison to those in rural areas.[13] However, it is worth mentioning that differences in Mincer returns across space can also reflect selection on ability or differences in other local characteristics such as education quality. Here, I just use this evidence to point out that educated workers living in urban formal housing seem to have higher returns to their education than workers in slums and rural areas.

The facts presented on education levels and labor income imply that, despite the low quality housing and low provision of basic public services, slums tend to have residents with a higher level of education than those in rural regions, and they give access to labor markets with higher returns. That said, these results also stress that outcomes are worse in slums within urban regions. One of the reasons previous papers have argued that slums have characteristics of poverty traps is due to the fact that human capital is low in those places. Having access to formal housing seems crucial to fully exploit labor market opportunities in urban regions and, as explained below, regulations limiting the supply of formal housing might be keeping too many people living in slums in India.

[13] Young (2013) formalizes this argument in a model to explain urban-rural wage gaps.

Table 3: Monthly house rent relative to rural regions

	Floor area (sq.m.)				
Location	20-30	30-40	40-50	75-100	All
Slum	1.6	1.3	1.9	1.5	1.2
Formal urban	2.0	2.1	2.4	4.2	2.4

Source: National Sample Survey 58th Round, 2002. Housing Conditions in India. Formal urban refers to urban locations that are not classified as slums in the surveys. The definition of slums used by the Government of India is similar to the UN definition.

2.2 Housing rents

The previous section focused on the benefits of urban regions. However, living in cities generally increases the costs of living for rural migrants; in particular, housing costs are higher in urban regions. Based on reports from National Sample Surveys (NSS) in India - Housing Conditions Round 58th in 2002, Table 3 presents the gaps in monthly house rents for different levels of floor area.[14] According to these reports, the average monthly rent in slums is 1.2 times higher than in rural regions, while the average monthly rent of a formal urban house is 2.4 times higher than in the countryside. Furthermore, monthly rents are higher in urban locations for every level of floor area. In comparison to the average dwelling in rural regions, which has a floor area of 30 to 40 sq.m., housing rents are 30% higher in slums and more than two times higher in formal urban areas. These rent gaps are larger for middle size dwellings and extremely large for big dwellings. The average floor area in slums is almost half of the average floor area of a dwelling in both rural regions and formal urban areas, which explains the smaller size of the average rent gap compared to the gaps conditional on floor area.

I use reports from NSS to compare housing rents because these surveys were made with the goal of comparing housing conditions in India, and the estimates of monthly rents include imputed rents on non-rental households based on similar dwellings in a given locality. That

[14]Compared with more recent rounds of National Sample Surveys, round 58th reports monthly rents of slums/squatters in urban regions. In these surveys, 92% of rural households and 60% of urban households reported owning their house, so the calculated rents include imputed rents to non-rental households.

said, using data from IHDS II and focusing on rental households that report positive rents, I find similar results for the gap in average monthly rent between formal urban areas and rural regions, 2.4, and a moderately larger gap between slums and rural regions, 1.9.[15]

A possible concern is that many slum dwellers in India do not have tenure security, which is evident from the common forced evictions. The latter means that payments of rents are not necessarily enforced through legal rental agreements. If many slums dwellers are occupying land illegally, then their relevant housing cost might not only be the payments done in the informal rental market, but also other types of protection payments.[16] Overall, the evidence shows that housing costs are higher in urban regions, even in slums. Thus, individuals face a trade-off between better labor market opportunities and higher costs of living in cities.

3 Urban Policies in India

This section provides a description of urban policies in India. This country is considered a notable case of inefficient urban regulations. Examples of such policies include building-height limits which restrict the available floor space per capita; rent controls that keep the rental market underdeveloped; urban land ceilings which constrain the holdings of land in the private sector; and regulations that restrict the ability to transfer property. These regulations limit the supply of formal urban housing in India and raise prices in this sector.

A common policy to control density growth in cities by restricting building heights are legal limits to the floor area ratio (FAR). The FAR is defined as the total area of floor space contained in a building divided by the area of its lot. According to a study from the World Bank in 2013, the FAR in the main cities of India is very low by international standards. For example, Delhi and Mumbai have a FAR of approximately 1.3 in the city center; by contrast, San Francisco and New York have a FAR of 9 and 15, respectively. These limits are not equal to the total number of floors that a building can have. For example, buildings can cover only

[15] In IHDS II data, 98% of rural households reported owning their house, as opposed to renting or being an accommodation provided by an employer. This share is equal to 82% in urban regions.

[16] Brueckner and Selod (2009) summarize evidence on the existence of community leaders who collect payments in slums and develop a theory of land squatting based on their power.

a section of their lot, while the remaining lot area is used for open spaces or plazas. However, a low FAR restricts the supply of urban formal housing and the capacity to accommodate population with the available supply of land (Brueckner and Sridhar, 2012).

In addition, approval processes to build new houses are lengthy and costly in India. According to 2018 data from the Word Bank *Doing Business* reports, construction permits necessary to build a warehouse cost 23% of the value of the building. The latter compares with 8% in China, 10% in South Africa, and 1% in the United States.[17] A study from KPMG in 2014 shows that the approval process for housing development in India takes between two and three years and increases construction costs by 20 to 30 per cent. These regulations increase the incentives to build high-value real estate to cover approvals costs instead of affordable housing. Furthermore, taxes and fees in India account for 30 to 35 per cent of housing development costs. The latter means that approvals costs, taxes and fees account for more than 50% of housing construction costs. As a comparison, in the U.S. government regulations at different levels account for 24% of the final price of a new house according to Emrath (2016).

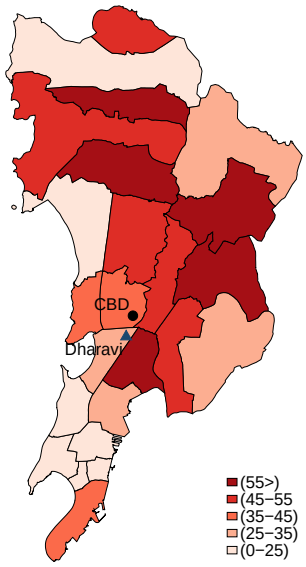
Now, with respect to slums, governments in India have carried on massive forced demolitions in recent decades. For example, between 2004 and 2005, at least 90,000 slums houses were demolished in Mumbai, which represented around 8% of the slum population in the city; similarly, not less than 45,000 slums houses were demolished in Delhi from 2004 to 2007. Governments have tried to recover valuable land occupied by slums in the main cities of the country, and a significant amount of slums located in central urban areas have been demolished. In most cases, only a small fraction of evicted dwellers are offered subsidized relocation, mainly to peripheral areas of the city: 20 to 40 kilometers from the original location.[18] To put this into context, according to the 2011 Census, 78% of urban commuters in India work within 10 kilometers from their home. In Mumbai, the average one-way commute is just 5.3 kilometers for all workers and 3.9 kilometers for the poor (see Baker et al., 2005).

Therefore, it is not surprising that slums dwellers displaced to outskirts of the cities tend

[17] These costs include fees associated with obtaining land use approvals, construction inspections, utility connections, and registration of the warehouse.

[18] See Bhan (2009), Kumar (2010), Dupont (2008) and Diwakar and Peter (2016).

Figure 3: Share of population living in slums in Mumbai (%)



Notes: Division by Ward (subdistrict). CBD: Central Business District (Bandra Kundra Complex). Dharavi is one of the biggest slums in the world. Source: Development Plan for Greater Mumbai 2014-2034. Municipal Corporation of Greater Mumbai.

to lose their livelihoods. A study from slums evictions and resettlements in the city of Chennai revealed that 80% of evicted dwellers lost their employment after being relocated. The forced eviction of slum dwellers in central urban areas fails to recognize that such slums are formed because households want to live close to the most productive areas of the city. To see this, Figure 3 shows the distribution of slum population across Mumbai subdistricts. Slums are located in almost every area of the city and, in particular, they are located close to the business districts in the center and south of the city. In fact, one of the biggest slums in the world, Dharavi, is located just 5 kilometers away from the main Central Business District (CBD) of Mumbai. This case exemplifies the fact that slums occupy valuable land in the most attractive urban locations, which partially explains the incentives of governments to evict their dwellers and allocate that land to the formal sector.

4 Model

This section introduces a static general equilibrium model with spatial sorting. There is a mass one of individuals in the economy and three regions indexed by $x \in \{c, p, r\}$: urban center (c),

urban periphery (p), and rural (r). Each urban region is divided in two types of neighborhoods: slums (s) and formal urban (f). To simplify the notation, I will use $\ell \in \{cf, cs, pf, ps, r\}$ to denote the five possible residential locations. There are no trade costs and individuals can freely choose their place of residence.

The model builds on the quantitative spatial framework of Bryan and Morten (2018), which itself relates to Ahlfeldt et al. (2015), Monte et al. (2018), and Hsieh et al. (2018). The model also adapts ideas from the macro-development literature on sectoral productivity gaps and human capital, particularly Gollin et al. (2014) and Herrendorf and Schoellman (2018).

4.1 Preferences and individual problem

Every individual i living in location ℓ has preferences over consumption $c_{i\ell}$ and housing $h_{i\ell}$ given by

$$U_{i\ell} = \left(\frac{c_{i\ell}}{1-\alpha}\right)^{1-\alpha} \left(\frac{h_{i\ell}}{\alpha}\right)^{\alpha} \left(1 - \mu\, \mathcal{I}_{[x \neq r]}\right), \tag{2}$$

where α is the expenditure share on housing, μ represents possible compensating wage differentials of living in urban regions, and $\mathcal{I}_{[x \neq r]}$ is an indicator function that takes the value of one if the individual lives in an urban region. The value of μ captures potential characteristics of cities that tend to offset the benefits of urban consumption and labor markets, such as pollution and traffic, risk of unemployment and crime, or loss of family networks. In the context of India, μ could also capture barriers to urban migration related to the caste system.[19] As described below, the costs of living in slums will be captured by differences in labor productivity and the value of education in individual human capital.

Then, individuals living in location ℓ maximize utility by choosing consumption and housing subject to their budget constraint: $c_{i\ell} + r_\ell h_{i\ell} = W_{i\ell}$, where the consumption good has been used as the numeraire; r_ℓ is the rental price of housing in location ℓ; and $W_{i\ell}$ denotes labor earnings of individual i in location ℓ. Individuals know the labor income they would receive in each location and choose where to live by comparing welfare across places. This compar-

[19] For example, Munshi and Rosenzweig (2016) show that caste-based rural insurance networks and the lack of formal insurance alternatives are an important barrier to urban migration in India.

ison depends on characteristics that make locations more or less attractive and individual comparative advantage.

4.2 Human capital and labor income

Labor income is a function of human capital, which depends on individual talent and education. To be specific, I build on the macro-development literature and define individual human capital (efficiency units) as

$$z_{i\ell} = \nu_{i\ell} \exp(e_i \eta_\ell), \tag{3}$$

where $e_i \in \{0, 1, ..., 16\}$ are education years of individual i, which are valued at rate η_ℓ in location ℓ. Parameter η_ℓ governs the elasticity between education years and human capital, and captures differences in the demand for skilled labor in each location. I assume that individual education and schooling returns are exogenous, so the share of individuals in the economy with e years of education completed is denoted by ζ_e. Additionally, every individual is endowed with an idiosyncratic talent draw $\nu_{i\ell}$ for each possible residential location. The idea is that individuals have different talents and the type of jobs that predominate in each location may be different. Most individuals in rural regions work in agriculture and slums dwellers tend to concentrate in elementary occupations such as rag-picking, rickshaw pulling or low-value manufacturing.[20] Similarly, industries in the urban periphery are not the same as those in the main business areas of a city; for example, banking and financial services tend to be located in the CBD of a city.

I follow Bryan and Morten (2018) and assume that talent is drawn from a multivariate Fréchet distribution

$$F(\nu_{cf}, ..., \nu_r) = \exp\left(- \left[\sum_\ell \nu_\ell^{-\frac{\tilde{\theta}}{1-\rho}} \right]^{1-\rho} \right), \tag{4}$$

where the shape parameter $\tilde{\theta} > 0$ governs the dispersion of talent draws, so that a higher value of $\tilde{\theta}$ implies lower variation in individual talent. Parameter $\rho \in [0, 1)$ governs the correlation

[20] In Dharavi, one the biggest slums in world located near the center of Mumbai, there is a large amount of economic activity within the slum related to industries that include leather, textiles, pottery and recycling.

of skills between locations.[21] As ρ get close to one, the distribution approaches the case of unidimensional talent. To characterize the rest of the model it is useful to define a shape parameter adjusted for the correlation between productivity draws: $\theta = \tilde{\theta}/(1-\rho)$. The importance of sorting in the model is stronger when there is high variation in individual talent or when there is a low correlation in talent across locations.

Individuals are endowed with one unit of time to supply inelastically in the labor market they face at their place of residence. There is no commuting across locations, even within the city. This is a simplifying assumption based on the observation that commuting distances are relatively short in India, especially if they are compared to the distance between the city center and the periphery locations where evicted slums dwellers are offered or forced to relocate (see Section 3). Then, individual labor earnings in each location are defined as

$$W_{i\ell} = \omega_\ell \, z_{i\ell}, \tag{5}$$

where ω_ℓ is the wage per efficiency unit in location ℓ.

4.3 Production technologies

There is a final consumption good supplied by competitive producers in urban and rural regions and traded without costs, but regions differ in the technology they use. In urban regions, the final good is produced using efficiency units of labor from every urban location according to

$$Y_u = \Big[\sum_{\ell \neq r} \big(A_\ell Z_\ell \big)^{\frac{\sigma-1}{\sigma}} \Big]^{\frac{\sigma}{\sigma-1}}, \tag{6}$$

where σ is the elasticity of substitution across locations and Z_ℓ is the demand for efficiency units of labor from urban location ℓ. In practice, I will focus on finite values of σ greater than

[21] This is a Gumbel Copula distribution. Its main advantage over other distributions is that it leads to tractable analytical solutions of the model. Lagakos and Waugh (2013) argue that the talent draw from a Fréchet distribution can be thought as the task or occupation, among a large set of options, that maximizes individual labor income in location ℓ. To the extent that the number and types of industries to which an individual has access are different across locations, individuals have a different draw in each place.

one, which implies that labor units from different urban locations are not perfect substitutes but also that none of them is essential. Note that the specification in (6) implies that each urban location produces an intermediate good given by $Y_\ell = A_\ell Z_\ell$. Labor productivity is potentially different in each location and A_ℓ is a parameter that captures spatial differences in industry mix, infrastructure, agglomeration forces, and access to non-tradable goods.[22] In particular, this parameter captures some of the costs of living in slums related to the low provision of infrastructure and public services that are important for individual productivity. The aggregation of labor to produce the final good in the city is the link across all urban locations in the model, and the implicit assumption is that each location produces a differentiated good consumed by individuals in every place of the city. On the other hand, the final good in the rural region is produced using local labor according to

$$Y_r = A_r \, Z_r^{\beta}, \tag{7}$$

where $\beta \in (0,1)1$ governs decreasing returns in rural production and A_r is a parameter of rural labor productivity.

4.4 Housing production and land

In both urban regions, formal housing is produced using land L_ℓ and intermediate inputs M_ℓ (same as consumption good) according to $H_{xf} = (L_{xf})^{\psi} \, (M_{xf})^{1-\psi}$, where $\psi \in (0,1)$ governs the intensity of land in housing production. Formal developers maximize profits taking housing rental prices r_ℓ and residential land prices p_x as given, that is,

$$\max_{M_{xf}, L_{xf}} \quad (1-\tau) \, r_{xf} \, (L_{xf})^{\psi} (M_{xf})^{1-\psi} \; - \; M_{xf} - \; p_x L_{xf}, \tag{8}$$

where $\tau > 0$ is a distortion that developers take as given and captures regulations such such as FAR limits, rent controls, and approval costs. I assume that the fraction of housing output

[22] Section 5.3 relaxes the assumption of exogenous productivity and introduces human capital spillovers in the city.

that is "taxed", $\tau\, r_{xf}\, H_{xf}$, is thrown away.

On the other hand, housing supply in slums can only expand by occupying more land, so that $H_{xs} = B_s L_{sx}$, where B_s is a technology parameter that governs the amount housing production in slums. Then, taking prices as given, slumlords maximize profits solving

$$\max_{L_{xs}} \quad r_{xs}\, B_s\, L_{sx} \;-\; C_x(L_{xs}) \tag{9}$$

where $C_x(L_{xs})$ are the costs of occupying land illegally or informally in region x. I assume these costs are proportional to the value of land in the region and equal to $\phi p_x L_{xs}$, where ϕ governs the costs of informality for slumlords such as bribes, other protections costs, and the risk of evictions; therefore, this parameter also captures government policies and enforcement choices towards the existence of slums.

The difference in housing technologies between slums and formal housing is meant to reflect the fact that production of housing in slums is intensive in the use of land and a fixed amount of housing space can be constructed in a given amount of land: dwellings in slums are usually homogeneous, small one-story houses with one or two rooms at most. Slums expand by covering more land and dwellings tend to be very close tho each other, with little or no open spaces between them. Thus, the relevant decision for slums is the amount of land they occupy given the costs of informal property rights. In comparison, the formal housing sector has the possibility to substitute intermediate inputs for land and produce different amounts of housing space per unit of land (e.g. big houses or tall buildings), plus the amount of land that is covered by housing space in a lot is usually regulated, and formal housing areas tend to have more open spaces and green areas or yards, so this sector is characterized not only by the amount of land that is used but by the variation in the quantity of housing space that is produced with that amount of land.

The potential inefficiency of slums comes from the fact that the land they occupy is not traded at a competitive price and, thus, the allocation of land across types of urban neighborhoods might not be optimal. Note that this means that the amount of land in slums could be

lower than the optimal, so "expanding" slums could generate welfare gains given the possibility that formal housing might be too expensive due to regulations. That is, slums offer access to urban labor markets to individuals living in the rural area who have a relatively high talent for urban jobs, at lower housing prices than the regulated formal sector; moreover, building slums houses does not require additional intermediate inputs as formal housing, which means that additional land in slums generates housing without taking output from consumption goods. Ultimately, the latter is a quantitative question and the answer depends on the value of the parameters in the model.

Additionally, the available supply of land varies across space in the model. First, I assume there is an infinite supply of land in rural regions and housing supply is perfectly elastic (i.e. there is no land congestion). Therefore, rural housing prices are constant: $r_r \equiv C_r$. Parameter C_r captures the marginal cost of producing a unit of housing in the rural region. Second, the amount of residential land in the urban center is fixed, denoted by $\overline{L}_c$, and owned by landlords who only consume goods in their location.[23] The latter assumption reflects the fact that city centers are geographically constrained and, therefore, land scarcity represents a congestion force in those places.

Finally, the supply of land in the urban periphery is endogenous, owned by residual consumers in the periphery, and denoted by L_p. For simplicity, I assume that the latter is such that, in equilibrium, the rental price of housing in periphery slums is equal to the price of housing in rural regions. The idea is that the relevant margin for urban sprawl are slums that can be formed in semi-urban locations where land is relatively unconstrained, so housing rents in these slums are similar to rural areas.[24] In the model, housing rents in slums are also paid to slumlords or owners who only consume goods in their location.

[23] As noted by Monte et al. (2018), this type of assumption allows the incorporation of general equilibrium effects from changes in the value of land, without introducing an externality in the location choice of individuals from the redistribution of local land rents.

[24] Evidence from urban slums located in the periphery of Mumbai shows that rents in those place are indeed very similar to housing rents in rural India (Baker et al., 2005). This assumption is similar to a model with a monocentric city where housing rents in the periphery are the same as rural areas. See Desmet and Rossi-Hansberg (2013).

4.5 Equilibrium

I now provide a description of allocations and prices in general equilibrium. First, indirect utility of individuals with e years of education and $\nu_{i\ell}$ units of talent in location ℓ is

$$V_{i\ell|e} = \omega_\ell \, \nu_{i\ell} \exp(e\,\eta_\ell) \, {r_\ell}^{-\alpha} \left(1 - \mu \, \mathcal{I}_{[\ell \neq r]}\right). \tag{10}$$

Given the distribution of individual talent and expression (10) for every location, it can be shown that the share of individuals living in location j conditional on education is

$$\pi_{j|e} = \frac{\left(\omega_j \exp(e\,\eta_j) \, {r_j}^{-\alpha} \left(1 - \mu \, \mathcal{I}_{[j \neq r]}\right)\right)^\theta}{\sum_\ell \left(\omega_\ell \exp(e\,\eta_\ell) \, {r_\ell}^{-\alpha} \left(1 - \mu \, \mathcal{I}_{[\ell \neq r]}\right)\right)^\theta}. \tag{11}$$

Equation (11) says that the spatial allocation of talent depends on relative housing costs, local productivity, returns to education, and compensating differentials in urban regions. Particularly, housing prices act as a congestion cost in the urban center due to the limited supply of land. On the other hand, individuals are attracted to more productive locations, and places with higher returns to education, where jobs use skills more intensively, attract individuals with more years of education because the function $\exp(e\,\eta_\ell)$ implies complementarity between e and η_ℓ. In equilibrium, the share of individuals who choose to live in location ℓ is given by $\pi_\ell = \sum_{e=0}^{16} \pi_{k|e} \, \zeta_e$, and market clearing implies $\sum_\ell \pi_\ell = 1$.

Additionally, housing rents must clear the market in every location. That is, supply of housing must be equal to local demand,

$$H_\ell \; = \; \alpha \, \frac{I_\ell}{r_\ell} \tag{12}$$

where $I_\ell = \sum_{e=0}^{16} \left[\int_{i \in \Omega_{\ell|e}} \omega_\ell \, z_{i\ell}(e) \, dF_i \right] \zeta_e$ is total labor income in location ℓ and $\Omega_{\ell|e}$ denotes the set of individuals with e years of education who choose to live in location ℓ. Furthermore, the price of land in each urban region $x \in \{c, p\}$ has to clear the market of land, thus,

$$p_x = \psi \frac{(1-\tau)\, r_{xf}\, H_{xf}}{L_x - L_{xs}}. \tag{13}$$

This expression implies that, holding all else constant, the price of land increases with the amount of land occupied by slums because the amount available for formal development is smaller. Also, attractive locations have a higher demand for housing, which raises the value of land in those places. To see how distortions affect the supply of formal urban housing it is useful to focus on the optimal supply of housing per unit of land: $h_{xf} = H_{xf}/L_{xf}$. In this case, the density of housing production in the formal sector is given by

$$h_{xf} = \left[(1-\tau)\,(1-\psi)\, r_{xf}\,\right]^{\frac{(1-\psi)}{\psi}}. \tag{14}$$

Then, for a given level of housing prices, a higher value of τ implies that a lower amount of formal housing can be developed with the available supply of land. Of course, in general equilibrium housing prices also react if there is a change in τ and individuals move across locations because of this.

In equilibrium, the labor market in each location must clear: $Z_\ell = \sum_{e=0}^{16} \left[\int_{i \in \Omega_{\ell|e}} z_{i\ell}(e)\, dF_i \right] \zeta_e$; and workers are paid a wage per efficiency unit of labor given by

$$\omega_r = A_R \qquad \text{and} \qquad \omega_\ell = \left(A_\ell\right)^{\frac{\sigma-1}{\sigma}} \left(\frac{Y_u}{Z_\ell}\right)^{1/\sigma}, \quad \ell \neq r. \tag{15}$$

Labor demand in a particular urban location has a negative slope and increases with local productivity A_ℓ. Note that ω_ℓ, for $\ell \neq r$, depends on labor demand and local productivity of every urban location through Y_u. The model implies that the gap in average wages between location ℓ and j, conditional on education years, is

$$\overline{W}_{\ell|e} \Big/ \overline{W}_{j|e} = \frac{\omega_\ell}{\omega_j} \frac{\exp(e\,\eta_\ell)}{\exp(e\,\eta_j)} \left(\frac{\pi_{\ell|e}}{\pi_{j|e}}\right)^{-\frac{1}{\theta}}. \tag{16}$$

According to expression (16), conditional wage gaps between location pairs reflect differences in local productivity captured by ω_ℓ; differences in returns to education given by η_ℓ; and the sorting effect captured by conditional population shares $\pi_{\ell|e}$. The sorting effect refers to the fact that there is a negative relationship between average wage and population share in a given location because the marginal worker has a relatively low productivity in that place. That is, as population increases in a particular location, new dwellers are added from the lower part of the distribution of talent.[25] The strength of the sorting effect on wages depends on the variation of talent draws within locations and the correlation of draws across locations: $\theta = \tilde{\theta}/(1-\rho)$. When the correlation is high, the sorting effect is weaker since individuals tend to have similar levels of talent in every location. Finally, the unconditional wage gap between locations pairs can be written as

$$\overline{W}_\ell \Big/ \overline{W}_j = \frac{\omega_\ell}{\omega_j} \quad \frac{\sum_{e=0}^{16} \exp(e\,\eta_\ell)\, \pi_{\ell|e}^{1-1/\theta}\, \zeta_e}{\sum_{e=0}^{16} \exp(e\,\eta_j)\, \pi_{j|e}^{1-1/\theta}\, \zeta_e} \quad \frac{\pi_{j|e}}{\pi_{\ell|e}}. \tag{17}$$

Thus, differences in average labor earnings across locations depend on the distribution of educational attainment in each place. The latter depends on location choices and is captured by the term $\zeta_e\, \pi_{\ell|e}$. Education returns in the model have a similar role in explaining wage gaps and spatial sorting as differences in skill intensities in Young (2013). That is, a high return in location ℓ attracts more educated individuals to that place, which in turn increases local average earnings. Moreover, selection in unobservable talent is key to explain spatial wage gaps in the model, though, similar to the argument in Bryan and Morten (2018), compensating differentials and housing prices (regulations) introduce possible frictions to the spatial allocation of labor.

5 Quantitative Analysis

This section presents the estimation of the model using the IHDS II and other sources of aggregate data from India. The main parts of the estimation can be summarized as follows. First, I

[25] This implies that absolute and comparative advantage are aligned in the model. See Young (2014) for a thorough discussion applied to structural transformation.

estimate a subset of parameters using informative relationships derived from the model. Then, I implement an internal method of moments to recover unobserved location characteristics using data on wages, housing rents, and population shares. Finally, I validate the model by comparing non-targeted moments in the model and the data. I then use the estimated model to compare the effects of evicting slum dwellers from central urban areas and reallocating the land to the formal sector, with the effects of reducing distortions in urban formal housing.

5.1 Calibration

A subset of parameters is calibrated based on previous literature and aggregate data. First, productivity in the rural region A_r is normalized to one. Next, I follow Allen and Arkolakis (2014) and choose σ equal to 9. This value implies a high level of substitutability between goods of different urban locations. The value of β in rural production is set equal to 0.91 based on the results of Lagakos et al. (2018*b*) for the case of Bangladesh.[26] Moreover, I set the expenditure share on housing α equal to 0.25 following Davis and Ortalo-Magne (2011), and the share of land in housing production ψ equal to 0.25 based on previous literature (e.g. Ahlfeldt et al., 2015 and Combes et al., 2018). I determine the value of distortions in the formal housing sector τ using a report from KPMG (2014) on housing development in India, according to which taxes, fees and approval costs account for approximately 55% of housing development costs. I take this as a measure of distortions in formal housing.

In what follows I focus on Mumbai to get data on population and land in the urban periphery. To be specific, I use information from the Development Plan for Greater Mumbai 2014 - 2034 (DPGM) which provides data on population and residential land in each subdistrict of the city. Then, I define the urban periphery as those subdistricts that are in the outskirts of the city: 20 or more kilometers away from the closest CBD.[27] This cutoff is consistent with the location of resettlements offered to evicted slums dwellers in the main cities of India (see

[26] The findings in Hnatkovska and Lahiri (2014) and Munshi and Rosenzweig (2016) suggest that rural wages do not increase substantially with urban migration in India. This is consistent with weak decreasing returns in rural production.

[27] This is based on subdistricts that are part of Mumbai City and Suburban Mumbai. A map is included in Appendix A.

Dupont, 2008; Diwakar and Peter, 2016).

Lastly, I calculate the population share with e years of education ζ_e using data from the IHDS II. Individuals are assigned to one of 17 possible categories that go from zero years of schooling to graduate education (above bachelors degree or more than 15 years of education). For the latter and every other moment estimated using IHDS II, I restrict the sample to working age male individuals who worked at least part time.

5.1.1 Returns to education

The model implies a relationship between log-wages and education years similar to a Mincer regression:

$$\log(W_{i\ell}) = \log(\omega_\ell) + \eta_\ell e_i + \log(\nu_{i\ell}) \tag{18}$$

Based on this expression, I use data from IHDS II to estimate location-specific returns to education η_ℓ in the same way as Section 2.1, but in this case I distinguish between central and peripheral urban regions. IHDS II does not provide the geographical location of households within cities; however, for rural villages, it reports the distance to the main city in the district. I use this information to define the urban periphery as those villages that are between zero and nine kilometers from the main urban center of their district. This cutoff is determined by the relationship between average wages and distance. Villages within nine kilometers of the urban center have an average wage that is much higher than the rest of the rural areas: around 30% higher. The assumption is that villages located close to main cities have similar characteristics to urban locations in the periphery of the city proper.

Given this definition of urban periphery and following expression (18), I estimate a Mincer regression of log-wages on education years. To do so, I control for location fixed effects to account for local differences in productivity, and a quartic in experience at the place of residence to account for individual comparative advantage. The Mincer return for each location type η_ℓ is reported in Table 4. These results show that returns to education are high for individuals living in formal housing, even if they are located in the periphery. On the other hand, peripheral

Table 4: Location-specific Mincer returns

Location	Mincer return (η_ℓ)
Formal center	6.5%
Slum center	5.1%
Formal periphery	6.3%
Slum periphery	4.4%
Rural	4.2%

Notes: Based on male population (15-65 years) working at least part time. The urban periphery is defined as rural villages that are within 10 km from the main urban center in their district. See text for details.
Source: Author estimates using IHDS II 2012.

slums have similar education returns to rural regions, but returns are higher in central slums and, thus, they attract individuals with higher education to live in such locations.

These estimates suggest important differences in the use or value of skills across locations. However, as noted by Herrendorf and Schoellman (2018), differences in location-specific returns to education could be partially capturing selection. That is, urban returns to education could be higher than rural because individuals with high cognitive talent live in cities. To address this possibility, Section 6 presents a robustness check of the results taking into account this bias. That said, the fact that education has a higher value in urban occupations does not mean that moving to the city necessarily generates large productivity gains because selection partly offsets those gains in the model, though not through returns to schooling. If most individuals with a strong comparative advantage for urban occupations already live in the city, then productivity gains from increasing urban migration would be relatively small.

5.1.2 Distribution of talent parameters

To estimate the parameters that govern the distribution of talent across locations, I use the relationship implied by the model between average wage by location and the share of population

living in that location conditional on education years:

$$\log\left(\frac{\overline{W}_{\ell|e}}{\exp(\eta_\ell\, e)}\right) = \log(\omega_\ell) \; - \; \frac{1}{\theta}\log(\pi_{\ell|e}). \tag{19}$$

First, using data from IHDS II, I compute average wages for each location-education pair, as well as the corresponding population share. The latter results in a total of 84 observations based on $\ell \in \{cf, cs, pf, ps, r\}$ locations and $e \in \{0, 1, ..., 16\}$ education years. Then, following expression (20) and using the Mincer returns estimated in the previous section, I estimate the elasticity between conditional average wages divided by the value of education in human capital and conditional population shares, controlling for location type. The model implies that this conditional elasticity is a measure of spatial sorting: $1/\theta$. The estimated value of θ is 4.13.

Next, properties of the Fréchet distribution imply that the squared coefficient of variation of location wages conditional on education is equal to: $\Gamma\left(1 - \frac{2}{\theta(1-\rho)}\right) \Big/ \Gamma\left(1 - \frac{1}{\theta(1-\rho)}\right)^2 - 1$. I calculate this moment for all the location-education pairs in the data and use the estimate of θ to find the value of ρ that fits the data. I obtain a value ρ equal to 0.29, which is the Kendall rank coefficient and represents a moderately high correlation across talent draws. The linear correlation is equal to 0.58. These estimates imply that the value of the shape parameter $\tilde{\theta} = \theta(1-\rho)$ is equal to 2.92. This value is in the same range of other papers using similar parametrizations in other contexts. For example, Bryan and Morten (2018) estimate values equal to 2.69 and 3.18 across regions in the U.S. and Indonesia, respectively; and Hsieh et al. (2018) find values close to 2 across occupation in the U.S.[28]

5.1.3 Internal calibration

There are eight remaining parameters: A_{cf}, A_{cs}, A_{pf}, A_{ps}, C_r, B_s, ϕ, and μ. These parameters are calibrated jointly to match eight moments: (i-iv) population shares by location; (v) the

[28] A possible issue with this estimation is the potential endogeneity between locations wages and population shares. To the extent that this would lead to mismeasurement of the sorting effect in the model, Section 6 presents robustness checks of the baseline results considering alternative values of θ.

Table 5: Joint Calibration

Parameter		Value	Moment	Model=Data
Urban compensating differentials	μ	0.26	Urban-rural wage gap	1.71
Costs of informality	ϕ	8.27	Share of Land in central slums	0.33
Production cost of rural housing	C_r	0.63	Urban-rural housing rent gap	2.01
Housing techonology in slums	B_s	0.18	Formal-slum housing rent gap	1.60
Productivity formal center	A_{cf}	0.79	Urban population	0.31
Productivity slums center	A_{cs}	0.63	Urban population in slums	0.36
Productivity formal periphery	A_{pf}	0.49	Formal urban population in periphery	0.22
Productivity slums periphery	A_{ps}	0.39	Slums population in periphery	0.26

Notes: This table presents the results of an internal method of moments in the model.

housing rent gap between urban and rural, (vi) the housing rent gap between formal urban and slums, v(ii) the share of land occupied by slums in the urban center, and (viii) the wage gap between urban and rural. Population shares in the periphery are obtained from the DPGM based on subdistricts located in the periphery of Mumbai (see Section 5.1); and differences in housing rents are obtained from reports of the NSS - Housing Conditions Round 58th in 2002. The latter takes into account imputed housing rents of non-rental households based on prevailing rents of similar dwellings in a given locality. Housing rents in the data represent both the price and quantity of housing space consumed by households. To deal with this issue, I match the gap in rental prices of housing in the model to the gap in housing rents for dwellings with a floor area of 30 to 40 sq.m. This range includes the average floor area in both rural and urban regions. The remaining moments are estimated using data from IHDS II.

The results presented in Table 5 show that the large wage gap between urban and rural regions implies that compensating differentials in urban regions are equal to 0.74 ($= 1-\mu$). As mentioned before, this could represent factors that offset the benefits of urban consumption and labor markets such as pollution, risks associated with cities, loss of family networks,

discrimination based on caste, and other barriers to urban migration. This is consistent with the findings of Lagakos et al. (2018*b*) and Munshi and Rosenzweig (2016). In particular, the latter find that caste-based insurance networks in rural India and the lack of formal alternatives are an important barrier to urban migration.

Not surprisingly, the results show that central urban areas are more productive than the periphery and that is why they attract a larger share of the urban population. This could represent differences between the urban center and periphery in industry mix, infrastructure, or access to services that are important for labor productivity.[29] Finally, the high value of ϕ obtained by targeting the share of land occupied by slums in the urban center can be interpreted as the costs of acquiring land illegally or informally such as bribes, protection costs, and overall risks of lacking tenure security.

5.1.4 Model validation

The moments presented in Table 5 are all matched in the baseline economy. To assess the quantitative implications of the model for other relevant moments of the data, Table 6 compares average years of education across locations in the model and the data. The model does very well in matching the levels of educational attainment across locations. The gains from living in locations with high returns to schooling are larger for educated individuals and, thus, formal urban locations have residents with higher educational attainment. I interpret this in the model as the fact that education is more valuable for occupations in those locations.

Additionally, as shown in Table 7, the model generates a ratio of average wages in slums to rural regions equal to 1.52, which is fairly close to the one observed in the data: 1.44; and the ratio of average wages in formal urban to rural regions is equal to 1.82 in the model compared to 1.89 in the data. Moreover, the baseline economy in the model implies that the land in the periphery is equal to 45% of the land in the center of city, which is similar to the 43% in Mumbai, and the share of land occupied by slums in the periphery is equal to 35% in the model

[29] Based on surveys from Mumbai, Baker et al. (2005) find that affordable health care options tend to located near the center of the city. They also find that the best jobs in the city in terms of earnings tend to be located in the center of the city.

Table 6: Educational attainment: model vs. data

Location	Model	Data
Formal center	9.1	9.7
Slum center	7.9	7.8
Formal periphery	9.0	8.9
Slum periphery	7.3	6.7
Rural	7.1	6.8

Notes: Average education years in the data are estimated based on working age male population. Education years were not targeted in the calibration of the model.

Table 7: Average wage gaps: model vs. data

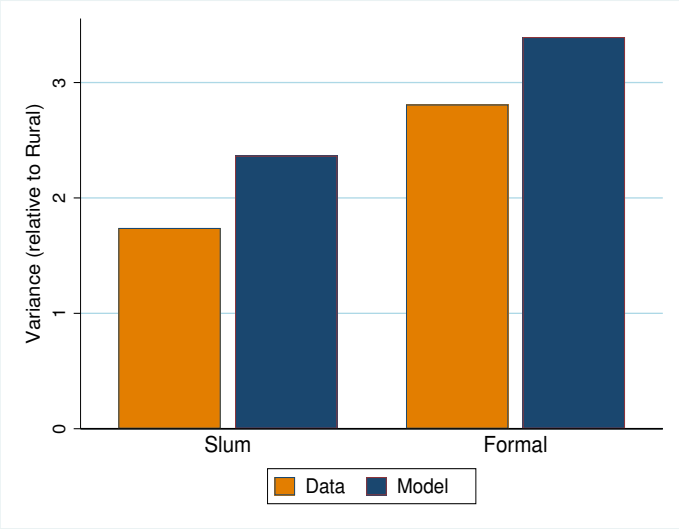
	Model	Data
Targeted		
Urban / Rural	1.71	1.71
Non-targeted		
Formal / Rural	1.82	1.89
Slum / Rural	1.52	1.44

Notes: Average wages in the data are estimated based on working age male population.

compared to 33% in the data. Lastly, Figure 4 presents the variance of wages by type of urban neighborhood relative to the variance in rural regions. The model does well in replicating the fact that wages variance is higher in urban regions, especially in formal locations.

To summarize, the baseline economy in the model replicates the main empirical facts presented in Section 2, namely urban-rural gaps in wages, education levels, and housing rents, plus it is also consistent with additional moments of the data. Next, I use this estimated model to assess the aggregate implications of anti-slum policies and housing distortions in India.

Figure 4: Baseline economy: urban wages variance



Notes: Sample in the data is restricted to working age male population.

5.2 Counterfactual Policies

In this section I analyze two types of counterfactual policies: (i) demolition of central slums, and (ii) reduction of distortions in formal urban housing. The forced eviction of slums dwellers is a common policy to modernize or sanitize cities by recovering land occupied by squatters and use it for alternative projects, such as commercial development or construction of high-value real estate.[30] I compare the effects of this type of policy with an alternative supported by the model, which is reducing housing distortions in the formal housing sector. The model implies that reducing distortions could increase the density of formal housing production, which in turn could decrease the rental price of housing in this sector. To assess the aggregate implications, I focus on changes in urban population; total output, which takes into account individual consumption plus income of landlords and slumlords (payments to land in formal sector and slums rents); and individual welfare $\mathcal{W}$ computed by aggregating equation (10),

$$\mathcal{W} = \sum_{\ell} \omega_{\ell} \, Z_{\ell} \, r_{\ell}^{-\alpha} \left(1 - \mu \, \mathcal{I}_{[\ell \neq r]}\right). \tag{20}$$

[30] See Marx et al. (2013). Other countries with recent cases of massive forced evictions in slums are Zimbabwe, Nigeria and Kenya.

Table 8: Aggregate effects of reducing central slums population

	Percentage change from a		
Variable	10% reduction	30% reduction	50% reduction
Urban population share	-1.66	-5.32	-9.44
Total Output	-0.18	-0.69	-1.45
Individual Welfare	-0.23	-0.74	-1.30

Notes: This table presents the results from reducing the share of the population living in central slums by exogenously increasing their cost of occupying land in the urban center.

Furthermore, I also quantify the effects of these policies on different population groups.

5.2.1 Demolition of central slums

First, I estimate the quantitative effects of demolishing central slums. In the model, this can be introduced as an exogenous shock D that increases the costs of occupying land informally in the city center: $C_c(L_{cs}) = D\phi p_c L_{cs}$, with $D > 1$. To be clear, these experiments are meant to represent cases in which slums are destroyed, the land becomes available to be used in the formal sector, and the market determines who can afford the new formal housing.[31] The potential benefits of this policy comes from the fact that it can increase the supply of formal housing in the urban center, which is the most productive location in the city. To assess the impact of empirically reasonable cases, I choose values of D to induce an equilibrium reduction in the share of population living in central slums of 10%, 30%, and 50%.

Table 8 presents the results of these experiments. If 50% of slum dwellers in the central slums are evicted, the share of urban population decreases by 9%, total output goes down by 1.4%, and individuals experience an average welfare loss of 1.3%. These aggregate outcomes seem small, but they are non-trivial considering the fact that the share of total population living in central slums is only 8.2%.

[31] This is different to other policies regarding slums such as land redevelopment, housing upgrade, or land titling programs in which slum dwellers get some type of support or compensation.

To further understand these results, I simulate data and look at the effects on particular groups of the population. I focus on the case in which the share of population living in central slums is 50% lower. First, Table 9 presents the new location, welfare change, and average education years of evicted dwellers. These are individuals who choose to live in central slums in the baseline economy and change location when $C_c(L_{cs})$ increases. Over 74% of them move to the rural region, 19% move to formal housing in the urban center, 4% move to formal housing in the periphery, and close to 3% moves to peripheral slums. One way to interpret these results is that individuals have to relocate so far from the main areas of the city that they effectively lose access to urban markets. The reason most of the evicted dwellers relocate to the rural region is that formal housing in the center is expensive and the periphery has lower rents but also lower productivity. In contrast, the rural region attracts more individuals because housing rents are low and compensating differentials make urban regions less attractive; however, having more population in the rural region lowers rural wages due to decreasing returns. The negative outcomes of destroying slums are consistent with the findings of Jedwab and Vollrath (2019) regarding policies that limit urban migration into informal areas

In addition, Column 3 of Table 9 presents the welfare change of evicted dwellers in their new location. Those who move to formal housing in the center have access to more productive and skill-intensive jobs, but they are forced to pay a higher price for housing. Even if the newly available land puts a downward pressure on the price of formal housing in the center, distortions limit the capacity to accommodate more population and congestion partially offsets the reduction in rents. Additionally, those who move to locations in the urban periphery have the highest welfare loss because productivity is lower in those places, even if this is partially compensated by lower rents. Note that the welfare loss of evicted dwellers is more than six times higher than the aggregate welfare loss.

The last column in Table 9 shows that the evicted dwellers with lowest level of education move to the rural region and only the most educated ones move to the formal urban sector. The latter would be consistent with the story that a small fraction of slums dwellers are relatively high-skill individuals who choose to live there because the price of housing is low. That said,

Table 9: Relocation, welfare and education of evicted slums dwellers

New Location	Location % share	Welfare % change	Education years
Rural	74.3	-8.0	7.5
Formal Center	18.5	-7.7	9.4
Formal Periphery	4.4	-8.4	9.2
Slum Periphery	2.8	-8.3	7.7

Notes: This table presents the new location, average welfare change, and average education years of evicted slum dwellers after a change in their cost of occupying land induces a 50% reduction in the population living in central slums.

Table 10: Welfare of infra-marginal individuals:
Reducing population in central slums by 50%

Location	% Change
Formal Center	0.33
Slum Center	-16.53
Formal Periphery	-0.95
Slum Periphery	-0.94

Notes: This table presents the average welfare change of infra-marginal individuals (those who do not relocate) after a change in their cost of occupying land induces a 50% reduction in the population living in central slums.

given that most individuals in India have a low education level, these results suggest that the relevant welfare margin in terms of spatial allocation of labor is between keeping a high concentration of population in rural areas or allowing individuals to move to urban slums, even if they occupy land illegally.

Next, Table 10 presents the welfare effects of this policy experiment on infra-marginal individuals, those who do not move from their original location in the baseline economy. Not surprisingly, the welfare loss is very high for those who remain in central slums because housing rents increase. This could be interpreted as increasing expenditures on protection costs when

governments are cracking down on slums. In contrast, those who live in the formal center have a welfare gain because having additional land for formal development reduces the rental price of housing in this sector, though the fall in urban output partially offsets these gains. Finally, the welfare loss of infra-individuals in the periphery is primarily explained by the fall in urban production that is caused by displacing workers from the urban center.

Now, so far I have not isolated the impact of slums demolitions on formal housing landlords and slumlords, whose residual consumption in their location is part of total output. In the case where half of the dwellers are evicted from central slums, the income of landlords in the urban center ($p_c L_{cf}$) goes up by 3.9%, while income of slumlords ($r_{cs} H_{cs}$) goes down by 37.8%. Therefore, the results imply that anti-slum policies in the urban center increase the total value of land traded in the formal sector and benefit the owners of that land.

To summarize, demolishing central slums leads to a fall in the urban population share, total output, and individual welfare. On average, only formal landlords in the urban center and individuals who were living there before the policy change have positive welfare effects. Allocating more land to the formal housing sector in the urban center attracts individuals who were previously on the margin of living in this location or other place; however, given that most evicted dwellers from central slums are displaced from the city, the urban labor market loses individuals working in relatively productive locations and, thus, urban output goes down. Individuals do not stay in the periphery because productivity is low in those locations and formal housing rents would increase if a large share of individuals moves there. Furthermore, selection plays an important role in these quantitative results, that is, individuals who remain in the city tend to have a relatively high talent, which limits the loss in average productivity from demolishing central slums.

5.2.2 Reducing distortions in formal housing

In this section I assess the quantitative effects of reducing distortions in the formal housing sector. I do this by decreasing τ to a level that is consistent with the U.S.. As described in Section 5.1, I set τ equal to 0.55 based on the costs of taxes, fees and approval procedures for

Table 11: Aggregate effects of reducing formal housing distortions to U.S. level

Variable	Percentage change from a 56% reduction in τ
Urban population share	13.06
Slum population (urban share)	-33.74
Total Output	1.76
Individual Welfare	2.14

Note: This table presents the results from increasing formal housing supply in urban regions by reducing τ to 0.24. The baseline value was equal to 0.55.

housing development in India. A study from the National Association of Home Builders done by Emrath (2016) finds that regulations imposed by government at all levels account for 24% of the final price of a new home in the U.S.. I take this value as the equivalent comparison to India, which implies a reduction in τ of 31 percentage points. Even if housing regulations are costly in the U.S., this seems a reasonable comparison given that housing markets in India are highly distorted.

The results presented in Table 11 show that the urban population increases by 13% and the share of the urban population living in slums decreases by 34%. Furthermore, total output and individual welfare increase by 1.8% and 2.1%, respectively. These results imply that distortions in India's formal housing sector represent an important barrier to urban migration and keep a large share of the urban population living in slums. Eliminating burdensome regulations would not only increase the urbanization rate and the access to formal housing, but would also raise aggregate labor productivity and welfare. It is worth mentioning that as more workers move to the city, rural wages increase because there are decreasing returns to labor in rural production, which tends to offset the movement to urban areas.

The reason productivity gains are small, in comparison to the wage gaps across locations observed in the data, is because selection plays an important quantitative role in the model.

Table 12: Welfare gains of new dwellers and infra-marginal individuals: Reducing formal housing distortions to U.S. level

Urban housing	New Dwellers	Infra-marginal
Formal Center	3.9	9.2
Slum Center	N/A	-7.4
Formal Periphery	5.3	11.7
Slum Periphery	-1.2	1.3

Notes: This table presents the average welfare change (%) of new dwellers and infra-marginal individuals (those who do not relocate) after reducing τ to 0.24. The baseline value was equal to 0.55.

That is, while individual productivity increases in cities because education has higher returns, new urban migrants have a relatively low level of urban talent. If individuals with a strong comparative advantage for urban occupations already live in the city, then productivity gains from urban migration should not be huge. This is consistent with papers that find limited welfare gains from encouraging urban migration (e.g. Lagakos et al., 2018*b*).

In this counterfactual case there are large endogenous changes in the market of land. Slums now occupy only 15% and 19% of the land in the center and periphery, compared to 33% and 35% in the baseline economy, and this policy change generates a 76% increase in the supply of land in the urban periphery. Thus, relaxing housing regulations increases the size of the city in terms of both population and land. This is because reducing distortions raises the demand for land in the formal sector but, unlike the center of the city where land is scarce, the urban periphery can expand and the new land is mostly used for formal housing production. This would be equivalent to a case in which urban sprawl is generated by an increased supply of formal housing and not by slums settlements in the outskirts of cities, which is common in poor countries.

To analyze the effects of this counterfactual policy on particular groups of the population, Table 12 presents the welfare gains of new dwellers and infra-marginal individuals. Those

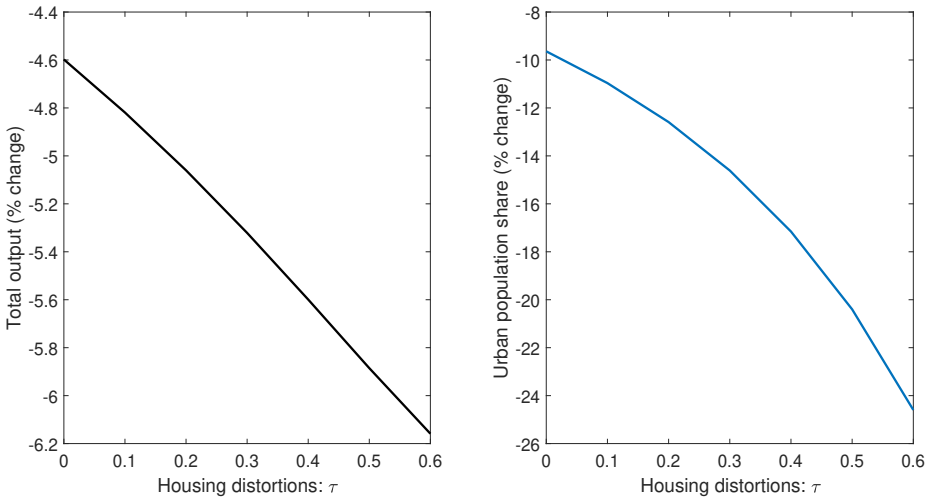
individuals who are now living in formal urban housing experience a welfare gain of 3.9% and 5.3% in the center and periphery, respectively. More surprising is the fact that there are no new dwellers in central slums, despite the fact that urban output increases. That is because land supply is fixed in the urban center and creating slums is not as attractive given that formal housing is less distorted and more affordable. In contrast, because there is more supply of land in the periphery, there are new dwellers in peripheral slums who on average experience a welfare loss. The latter is due to the relatively large welfare loss of individuals who were living central slums before the policy change and cannot afford to live in formal housing even when distortions are lower. This means that some individuals benefit from having more land occupied by central slums when formal housing distortions are high.

On the other hand, the welfare gain of infra-marginal dwellers is over two times higher in formal urban housing. These gains are due to lower rents in that sector and the growth of urban output. The fact that a larger share of the urban population is living in formal housing implies that labor productivity increases through higher education returns and local productivity. In contrast, infra-marginal dwellers in central slums have a welfare loss because housing rents are much higher now. This could be interpreted as central slums facing much higher informality costs when formal housing is a more attractive alternative. Lastly, infra-marginal dwellers in peripheral slums benefit from the fact that rents don't change in equilibrium (by construction) but wages increase due to the higher urban production.

Lastly, to close the comparison with anti-slum policies, income of formal landlords in the center goes up by 104.7% and income of slumlords in the center decreases by 23.1%. Therefore, these results imply that the gains of formal landlords are much higher if distortions are reduced than if slums dwellers are evicted from the center of the city; moreover, the loss in income of slumlords is also lower which means they would need a lower compensation in this case.

A key motivation to focus on the case of India was the interaction of inefficient urban policies and anti-slum policies. To analyze this, Figure 5 presents the effects of destroying central slums (i.e., $C_c(L_{cs}) = D\phi p_c L_{cs}$ with $D \to \infty$) on total output and urban population for different values of housing distortions τ. It is worth mentioning that in the case with zero

Figure 5: Interaction of destroying central slums and housing distortions



Notes: This figure presents the effects of eliminating central slums in the model for different values of τ, holding all else constant.

distortions and no demolitions ($D = 1$), the share of the urban population living in slums decreases by almost 50%, which means that there is still a sizable portion of the population who prefers to live in slums than rural areas.

That said, the results show that housing distortions substantially amplify the effects of destroying central slums. The fall in urban population is more than two times higher when distortions are similar to the level in India ($\tau = 0.55$) than in the case with no distortions ($\tau = 0$). Similarly, the loss in total output is significantly lower when there are no distortions in the formal housing sector. The effects on total output are not as dramatic as the effect on the allocation of workers because the city becomes "exclusive" when central slums are destroyed, and only those individuals with a strong comparative advantage remain in urban regions. These results imply that policies aiming to sanitize cities by demolishing slums located in the most valuable locations are more likely to deter urban migration and produce negative welfare effects in the presence of restrictive building regulations.

5.2.3 Implications for India's urbanization

India has a relatively low urbanization rate for its level of economic development (see Figure 1). The model was calibrated to match an urban population share equal to 31% and a share of

the urban population in slums equal to 36%. Countries with similar level of GDP per capita have an average urban population share of 46% and an average share of the urban population in slums equal to 43%.[32]

I use the model to see how much of the gap in urban population share between India and countries with similar development can be explained by housing distortions. I compare these results to a case in which the costs of occupying land by slums in the urban center is reduced to match the share of the urban population living in slums in those same countries (this is equivalent to a more lenient policy towards slums). The results presented in Table 13 show that eliminating distortions raises the share of urban population by 22%, which implies increasing the share from 31% to almost 38% (half of the gap with similar countries). Thus, holding all else constant, housing distortions alone can account for a high share of the relatively low urbanization rate in India. Moreover, output and welfare gains are substantially larger in the case where the share of urban population raises by decreasing housing distortions. In the case where is less costly for central slums to occupy land, the share of urban population increases by just 4%. These results suggest that eliminating distortions in housing markets is a more effective policy to boost urbanization. Allowing slums to occupy more land increases the access to urban markets where labor productivity is higher, but it raises the price of formal housing because there is less land available for that sector.

One question suggested by the previous results is the following. Given the level of distortions and value of location fundamentals, is there an optimal level of land that should be occupied by central slums? To answer this, I look at the effects on total output, which takes into account individual consumption plus income of landlords and slumlords, of increasing the share of land in central slums by exogenously reducing $C_c(L_{cs}) = \phi p_c L_{cs}$. The results suggest that there is an optimal level. Starting from the baseline economy, increasing the share of land in central slums has small but positive effects on output and urban population. The amount of land occupied by central slums that maximizes output is close to 50%, which is significantly

[32]This is based on World Bank data from 2014. GDP per capita (PPP) in India was $5,678 and the comparison is made with respect to countries with a GDP per capita between $4,000 and $7,000, which had available data on both urban and slums population.

Table 13: Two ways of increasing urbanization in India

Variable (% change)	$\tau = 0$	$\downarrow \phi$
Total Output	2.5	0.2
Individual Welfare	3.6	0.6
Urban population	21.7	4.1
Slum population (urban share)	-48.0	19.5

Note: This table presents the effects (% change) of eliminating housing distortions (τ=0) and increasing the amount of land in central slums (reducing ϕ), independently. The amount of land is increased to match a share of the urban population living in slums equal to 43%. See text for details.

higher than the 33% in the baseline. In such case, total output and urban population increase by just 0.2% and 3.2%, respectively.

These results should be taken with caution since the main goal of the framework in this paper is not determining the optimal size of slums in a city. That said, the fact that total output and urban population display an inverted U-shaped relationship with the share of land occupied by central slums is due to fact that, as land occupied by central slums increases, the cheap housing sector is expanding in the most productive urban region and workers with a low productivity in rural areas are moving to the city. The latter also increases wages in the rural region given that there are decreasing returns to labor. Moreover, the formal housing sector can substitute intermediate inputs for land so the population size in this sector is not affected greatly at first; however, as more land is allocated to slums, substituting intermediate inputs for land becomes increasingly costly and the formal housing sector starts collapsing, causing negative effects on total output and urban population. The main lesson from this exercise is that central slums represent a viable option to live in urban regions in a country where most people live in rural areas due to high rents in cities (related to housing distortions) and other barriers or compensating differentials.

Table 14: Demolition of central slums and affordable housing in periphery

Variable (% change)	Baseline	Expanding formal housing in periphery
Total Output	-1.45	-0.42
Welfare	-1.30	0.09

Notes: This table presents the results of reducing the population share in central slums by 50% and, at the same time, relaxing formal housing distortions in the periphery to keep the urban population share constant.

5.2.4 Demolition of central slums and housing compensation

This section considers an experiment where demolishing central slums is combined with additional formal housing in the periphery. This would be similar to a case in which the government compensates evictions by offering affordable housing in areas of the cities where land is less valuable. To analyze the latter in the model, I increase the amount of formal housing in the urban periphery by relaxing distortions τ in this region, so that in equilibrium the share of urban population remains constant after 50% of dwellers are evicted from central slums (by increasing the costs of occupying land as before). The purpose of this experiment is to avoid the fall in urban population caused by the displacement of individuals from central slums, and focus on the effects of allowing individuals to move to or stay in the city but in less productive, peripheral locations.

The comparison of results presented in Table 14 shows that the loss in total output is lower than in the baseline case, and there is even a small welfare gain in the case with affordable housing in the periphery. The reason for the welfare gain is that a large increase in peripheral land is required to keep urban population constant (more than two times the baseline value) which makes formal housing very cheap in the periphery. In fact, the amount of population living in the periphery increases by 46%. Therefore, this is equivalent to a situation in which central slums population is replaced by more population living in semi-urban peripheral locations where land does not have a high value and better housing is cheap. In the case of

India, only a small share of evicted slum dwellers is offered some type of relocation, usually in peripheral areas that are not very attractive for them. These results imply that if all evictions are fully compensated by making sure that urban population does not decrease, then welfare might not go down; however, they also show that urban periphery locations are not ideal as long as productivity remains low in those places (e.g. slum policies should be complemented with better urban infrastructure in peripheral locations).

5.3 Human capital externalities

Finally, the baseline model assumes exogenous location productivities in urban locations. This section relaxes this assumption and introduces endogenous agglomeration to urban regions in the model. In contrast to rural areas, cities feature agglomeration economies that come from firms and workers locating close to each other; moreover, knowledge and ideas spread across space as educated individuals interact with each other. Human capital externalities are particularly important in this context given the differences in educational attainment of slum dwellers and formal housing residents. Thus, I modify the model and define location productivities in urban locations $\ell \in \{cf, cs, pf, ps\}$ as

$$A_\ell = \overline{A}_\ell \exp(\lambda \pi_{college}), \tag{21}$$

where $\overline{A}_\ell$ represents the exogenous component of productivity in each location and $\pi_{college}$ is the share of the urban population that has a bachelor degree or more, which is endogenous in the model. Thus, location productivity raises with the amount of residents in the city that a have post-secondary degree and the strength of this agglomeration is governed by λ. I use this specification to use estimates of human capital externalities in the literature that can be readily applied to this framework. To be specific, I set the value of λ equal to 2.1 based on the estimates from Chauvin et al. (2017) for India.

To asses the quantitative importance of human capital spillovers, I repeat the joint calibration with the extended model. Table 15 compares the aggregate effects of destroying central

Table 15: Aggregate effects of destroying central slums:
With human capital externalities

Variable (% change)	Baseline	Human capital spillovers
Urban population share	-22.4	-18.1
Total Output	-6.0	-4.7
Individual Welfare	-3.0	-2.4

Notes This table presents the effects (% change) of eliminating central slums in the model. Human capital spillovers in urban locations are defined as the relationship between local productivity and the population share with a college degree in the city.

slums with and without human capital spillovers. In the model with externalities, the fall in urban population is smaller, as well as the output and welfare loss. The difference in these results can be explained by the fact that destroying central slums allows some relatively educated individuals to move to the formal housing sector where labor productivity and returns to education are higher. Also, we saw before that the evicted dwellers that leave the city tend to be the ones with the lowest education. The latter makes the city more attractive in terms of productivity by increasing the share of the urban population with higher education ($\pi_{college}$ increases from 13.7% to 14.9%), which partially offsets the negative effects of evicting slums dwellers.[33]

Therefore, these results imply that gains in human capital spillovers are a potential benefit of reducing the share of the urban population living in slums. Furthermore, these externalities are not easy to measure, so to the extent that they might be larger in a country like India, the quantitative implications could change. That said, these results imply that even with fairly large human capital spillovers it is still the case that destroying central slums has negative welfare effects in the aggregate and reduces the level of urbanization in the economy.

[33]In this model the share of urban population with a college degree changes with the location choice of educated individuals. It is not obvious what the aggregate net effect would be in a model with education choice. Destroying slums might imply that more individuals can have higher and better education in formal neighborhoods, but if the level of urbanization goes down, as my results suggest, then the level of education and human capital could be lower in the economy.

Table 16: Robustness: destroying central slums

Variable		Elasticity Substitution		Shape parameter		Talent correlation	
(% change)	Baseline	$\sigma = 3$	$\sigma = 6$	$\theta = 3$	$\theta = 12$	$\rho = 0.1$	$\rho = 0.8$
Urban population	-22.4	-35.6	-25.8	-21.3	-24.2	-21.6	-24.3
Total Output	-6.0	-9.0	-6.9	-6.1	-4.7	-6.1	-4.4

Notes: This table presents the effects of eliminating central slums in the model. Baseline values are $\sigma = 9$, $\theta = 4.13$, and $\rho = 0.29$. The values of θ in columns five and six are obtained by changing the value of the underlying shape parameter $\tilde{\theta}$.

6 Robustness

This section evaluates the robustness of my findings to different parameter values. For each of the cases presented below, I repeat the joint calibration to match the moments presented in Table 5. Also, to facilitate the comparison with the baseline, I focus on the case where all slums in the center are destroyed.

First, columns three and four in Table 16 present the results of demolishing central slums with lower values of the elasticity of substitution across urban locations. The change in urban population is quite sensitive to the level of substitutability between labor from different urban locations. Furthermore, when the elasticity of substitution is lower and, therefore, the complementarity is stronger, the fall in urban output is larger as workers from central slums are displaced. This explains why the loss in labor productivity is larger compared to the baseline.

Additionally, columns five through eight present the counterfactual results using alternative values of the adjusted shape parameter in the distribution of talent: $\theta = \tilde{\theta}/(1-\rho)$. There are two ways to modify this parameter: changing the underlying share parameter of the distribution $\tilde{\theta}$ or the (rank) correlation between draws ρ. According to these results the aggregate effects of destroying central slums are less sensitive to changes in the adjusted shape parameter. A larger value of θ implies a higher correlation across location-specific talent or a lower variation in individual productivity. Thus, with a large value of θ there is less scope for comparative advantage and the sorting effect on productivity is weaker. This explains why

Table 17: Robustness: destroying central slums
Accounting for unobserved ability in returns to education

Variable (% change)	Baseline	Selection in schooling returns
Urban population	-22.4	-22.6
Total Output	-6.0	-6.3

Notes: This table presents the effects of eliminating central slums in the model. To account for selection in unobserved cognitive ability, I reduce urban returns by 50% of their difference with respect to the return in rural regions. See text for details.

the loss in output is somewhat lower in comparison to the baseline; however, the fall in urban population is higher because individuals are more sensitive to location-specific characteristics such as the rental price of housing.

Finally, in the baseline case, location-specific Mincer returns were estimated assuming that they represent technological differences in the value of skills across locations. However, these differences in returns to education could also represent selection of talented workers. That is, returns to education could be higher in urban regions because workers with more cognitive talent choose to live there. To assess the implications of overestimating the importance of technological differences in the use of education across locations, I reduce the value of Mincer returns in urban locations by 50% of their difference with respect to the rural region (i.e. assuming half of the differences in education returns are due to differences in unobserved cognitive ability). This implies that the model will underestimate differences in educational attainment between urban and rural areas because the complementarity between individual education and schooling returns is weaker.

The results in Table 17 show that the main qualitative implications regarding anti-slum policies do not change after accounting for selection in returns to education. The effects are slightly larger in this case because, in order to match the moments of data, other location fundamentals must adjust; particularly, the value of productivity in urban locations needs to be higher to be consistent with the share of population living there. Moreover, in the baseline

economy there is more complementarity between education and schooling returns, so the loss in output is smaller when the least educated individuals leave the city than the case where individuals with similar levels of education leave. In other words, as differences in returns to education disappear in the model, there is less selection on education across location choices.

7 Conclusion

Slums are a prevalent urban phenomenon in developing countries. Policy responses to their formation vary from upgrading programs to forced evictions of dwellers. India is a case in which slums have been demolished in central urban areas with the idea that displaced dwellers relocate to peripheral regions where land is less valuable. This type of anti-slum policies have been common in other developing countries, and recent cases also include Zimbabwe and Nigeria. However, slums are formed in urban centers because workers want to live close to the best jobs in a city.

This paper develops a spatial general equilibrium framework to assess the quantitative impact of anti-slum policies in a context where formal housing markets are highly distorted. The model takes into account individual selection and differences in local productivity, returns to education, and housing rents. The findings imply that demolishing central slums reduces the level of urbanization because only a small share of evicted dwellers can afford to stay in formal housing and the urban periphery is not attractive. Even if valuable land becomes available for formal development when slums are destroyed, most of the evicted dwellers lose access to the labor market opportunities they had in central urban regions. This is consistent with the fact that India has a small urban population share compared to countries with similar and lower levels of development. The losses in welfare and labor productivity are significant considering the fact that only a small fraction of the total population lives in central slums.

In addition, I use the model to assess the effects of reducing formal housing distortions in India to the U.S. level. The results imply that these distortions account for a large share of the low urbanization rate in India and keep a high fraction of the urban population living in

slums. Moreover, reducing housing distortions raises total output because individuals with low talent for rural activities move to the city and gain access to locations where productivity and returns to education are high. Thus, eliminating distortions in formal housing markets, such as restrictive FARs or large construction approval costs, could have substantial effects on the spatial allocation of talent and aggregate labor productivity.

A possible direction for future research is exploring the political economy of slums and the aggregate implications. It is crucial to understand when do governments find it profitable to increase the provision of urban infrastructure and public services in slums, and under what conditions they choose forced evictions. Research could aim to understand the role of interest groups in policies regarding slums. Rent seeking behaviors can have a great impact on the allocation of land in urban regions and, therefore, on the allocation of workers across space.

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A Urban division in Mumbai

The following map shows the classification of Mumbai sub-districts into urban center or periphery used in the calibration of the model described in Section 5.1. The periphery are those sub-districts which are located approximately 20 or more kilometers away from the closest CBD. The distances were obtained using Google Maps. Bandra Kurla Complex is the main CBD of the city today. Previously, the main CBD was Nariman Point, which is located in the south of the city.

Figure 6: Mumbai Sub-districts (Wards) Division