

# Slum Upgrading and Long-run Urban Development: Evidence from Indonesia \*

Mariaflavia Harari<sup>†</sup>  
*University of Pennsylvania*

Maisy Wong<sup>‡</sup>  
*University of Pennsylvania and NBER*

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## Abstract

Developing countries face massive urbanization and slum upgrading is a popular policy to improve shelter for many. Yet, preserving slums at the expense of formal developments can raise concerns of misallocation of land. We estimate causal, long-term impacts of the 1969-1984 KIP program, which provided basic upgrades to 5 million residents covering 25% of land in Jakarta, Indonesia. We assemble high-resolution data on program boundaries and 2015 outcomes and address program selection bias through localized comparisons. On average, KIP areas today have lower land values, shorter buildings, and are more informal, per a photographs-based slum index. The negative effects are concentrated within 5km of the CBD. We develop a spatial equilibrium model to characterize the welfare implications of KIP. Counterfactuals suggest that 79% of the welfare effects stem from removing KIP in the center and highlight how to mitigate losses to displaced residents.

**JEL codes: R14, R31, R48**

**Keywords: Cities, urbanization, housing, land markets, informality**

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<sup>†</sup>Corresponding author. Wharton Real Estate. 428 Dinan Hall, 3733 Spruce Street, Philadelphia, PA 19104-6301. Email: harari@wharton.upenn.edu.

<sup>‡</sup>Wharton Real Estate. 425 Dinan Hall, 3733 Spruce Street, Philadelphia, PA 19104-6301. Email: maisy@wharton.upenn.edu.

# 1 Introduction

Developing countries are expected to undergo massive urban expansion to accommodate two billion more people by 2050 (UN-Habitat, 2022). Central to this transformation is the allocation of land, an increasingly scarce resource. This process is complicated by weak property rights and the ensuing politically-charged debate around clearing and redeveloping slums, which host one billion people globally (United Nations, 2020). Yet, there is limited quantitative evidence due to a lack of data and endogeneity challenges associated with studying slums (Field and Kremer, 2008).

We fill this gap by investigating slum upgrading, a popular policy implemented in many cities.<sup>1</sup> The 1969-1984 Kampung Improvement Program (KIP)<sup>2</sup> provided basic public goods and a verbal non- eviction guarantee to 5 million slum dwellers in the city of Jakarta, Indonesia. Upgrades can be a cost-effective way to improve the well-being of many residents without displacing them. However, policy makers are concerned that upgrading can make slums persist longer than they otherwise would. This can entail significant opportunity costs, especially as cities expand and slums occupy centrally located land (Henderson et al., 2020).

This paper deepens our understanding of slum upgrading and the spatial misallocation of land. Our first contribution is to provide long-term causal impacts of KIP, as modern Jakarta grows out of informality. Second, we combine administrative data and an innovative photographic survey of formal *and informal* housing markets. While KIP planners targeted slums in worse conditions in the 1960's, we address program selection bias using credible research designs. Third, we integrate our reduced-form estimates with a spatial equilibrium model to characterize the welfare implications of slum upgrading, highlighting that the opportunity costs from upgrading and preserving slums are concentrated in central areas.

Our research designs leverage high-resolution policy maps and outcomes from 2015, including assessed land values, building heights, and informality from our photos. We begin with a comprehensive sample spanning the entire city and compare KIP and non-KIP locations within the same hamlet (comparable to U.S. census block groups). Our second specification restricts the sample to historical kampungs that existed before KIP and compares treated ones with those that were not, within the same locality (comparable to U.S. census tracts). Finally, we employ a boundary discontinuity design within 200 meters of KIP boundaries. The identifying assumption is that unobserved quality is comparable across KIP boundaries, conditional on our controls and fixed effects.

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<sup>1</sup>Slum upgrading programs have been recently implemented in India and in Indonesia (World Bank, 2018, Government of India, 2016). Other similar programs include the Favela-Barrio project in Brazil, the PRIMED project in Colombia, and programs in Bangladesh, Tanzania, Kenya, and Ghana (UN Habitat, 2011, World Bank, 2017, UN Habitat, 2017).

<sup>2</sup>*Kampung* is a colloquial term used in Indonesia to describe traditional (rural and urban) villages. Unless stated otherwise, we will use the terms slums, informal settlements, and *kampungs* interchangeably.

Our baseline estimates imply that KIP areas have 10% lower land values, -7 percentage points (p.p.) lower likelihood of having tall buildings (more than 3 floors), and buildings with 9% fewer floors. The pattern is robust across all specifications, with effects at least as large as 40% of the control group means. These patterns are consistent with concerns of delayed formalization: while KIP neighborhoods improved after the upgrades ([World Bank, 1995](#)), they persisted as slums while non-KIP areas became formal, leading to a reversal in market outcomes.

We establish that KIP places are indeed more likely to be informal today using multiple metrics. We construct an informality index that ranks photos from 0 (very formal) to 4 (very informal) based on neighborhood appearance. KIP areas are more informal by 0.27 units (relative to a control group mean of 1.12). Moreover, KIP areas are also more likely to have parcels that are not registered and more fragmented land, as measured by parcel density.

Importantly, these negative average impacts mask significant spatial heterogeneity, with the largest effects concentrated in central areas, where KIP is prevalent. Intuitively, the opportunity costs from staying informal are greater close to the city center, where the potential gains from redevelopment are the largest. We leverage the geographic scope of KIP, spanning a quarter of Jakarta's land area, and use distance to the central business district (CBD) to classify the city into center, middle, and peripheral regions. The estimates are the most negative in the center, where 44% of all upgraded areas are, followed by the middle and the periphery (-0.14, -0.10, -0.09 for land values and -0.13, -0.06, -0.04 for heights).

We explore several factors associated with delayed formalization in KIP. A key concern of policy makers is that upgrades can make slums attractive, potentially leading to crowding and land fragmentation. Holdout problems can also arise, complicating land assembly. We lack high resolution, time-series data on population density to test whether KIP caused crowding. From an administrative data of cadastral maps, we estimate that KIP areas have 10.14 more parcels per unit area, relative to a mean of 12.8 in the control group. We also find greater household density in KIP.

Moreover, we consider the role of the physical upgrades. We obtained detailed maps of different types KIP investments, including paved and unpaved roads, number of sanitation facilities, and number of public buildings. To quantify exposure effects, we measure proximity to the upgrades and treatment intensity (length of roads per unit area and number of built facilities). We cannot detect differential impacts on land values. This is in line with the 15-year projected useful life of the basic upgrades ([Darrundono, 1997](#)).

Our results survive a battery of robustness checks. First, we exploit the staggered roll-out of KIP across three waves to assess program selection bias. We first establish a monotonic pattern with more negative impacts for the earliest wave, in line with the selection rule prioritizing kampungs in worse conditions. This pattern disappears in our main specifications, reinforcing our assumption

that the selection bias is adequately accounted for by our granular fixed effects or by restricting the sample to historical kampungs only. Next, we consider persistence in historical conditions. To assess confounding by the generic persistence of slums, we repeat our boundary discontinuity analysis using placebo borders from non-KIP historical kampungs, finding no discontinuity. Pre-KIP population density still affects modern outcomes, but cannot explain away our results (Oster, 2019). We investigate several types of spatial spillovers by examining spatial decay patterns across a range of outcomes. We find suggestive evidence of spillovers across KIP boundaries, but the patterns are not significant enough to change our conclusions and would tend to attenuate our estimates.

To characterize the welfare implications of KIP, we develop a spatial equilibrium model along the lines of (Gechter and Tsivanidis, 2023), featuring two types of residents, high- and low-skilled, and two housing market segments, informal and formal. We assume that markets are well-functioning within each segment, but there are frictions associated with converting land from informal to formal, captured by a formalization “tax”.

Through the lens of the model, wedges in land values and heights between KIP and non KIP arise from differences in amenities and formalization costs. For example, KIP upgrades and enhanced tenure security are captured by better informal amenities in KIP, which will lead to more land allocated to informal land use. As we take the model to the data, for each non-KIP location, we construct a KIP counterpart so that the model-implied wedges in equilibrium prices and quantities match the reduced-form estimates above, with larger effects in the center.

We then implement counterfactuals to quantitatively assess how KIP affects welfare, accounting for general equilibrium effects and spillovers. As a benchmark, we calculate a city-wide welfare effect of 2.9% from removing the KIP shock in the entire city (i.e., all KIP locations inherit the same amenities and formalization costs of their non-KIP counterparts). Lifting KIP, formal housing supply is boosted, the high-skilled gain while the low-skilled lose as they are displaced to less desirable locations. Echoing the reduced-form results, we find that 79% of the gains in the model are associated with KIP locations in the center. This is because the relative profitability of formal land use and the utility gains for formal residents are the largest in these areas.

Additionally, we provide counterfactuals highlighting the equity/efficiency tradeoffs associated with slum upgrading. For example, we consider a zoning reform bundling the removal of KIP in the center and a relaxation of height restrictions, which preserves the gains to the high-skilled while minimizing displacement of low-skilled. We also show that redistributing 5% of the formal land surplus from formalization to the low-skilled will result in both groups gaining.

Beyond Indonesia, our findings deliver lessons for policy makers considering whether and where to implement slum upgrading and, more broadly, how to accommodate urban growth. Our

welfare analysis suggests that spatial misallocation is largely associated with KIP areas that are central. A sizable share of the KIP program area is outside the center and we find limited gains from removing KIP in those areas. This suggests that slum upgrading may offer an attractive cost-benefit balance in cities at earlier stages of development, similar to the middle and peripheral areas on Jakarta, where the opportunity costs of staying informal are low. Additionally, we highlight that urban transformation has major distributional implications as the poor are often displaced without compensation.

Our paper is related to several lines of research. In recent work on urban development under weak property rights, [Henderson et al. \(2020\)](#) and [Gechter and Tsivanidis \(2023\)](#) highlight misallocation and opportunity costs of land use in the context of slums in Kenya and India, respectively. We leverage the wide geographic scope of the KIP program and rich policy variation to characterize where the gains from removing KIP are the largest and how to mitigate losses for the poor.

Second, we relate to the literature on shelter provision and slum policy in developing countries. [Michaels et al. \(2021\)](#) find positive long-term impacts of a “sites and services” program in Tanzania, which provided public goods on vacant land. They also present descriptive evidence on upgraded slums, finding negligible or negative impacts.<sup>3</sup> Relative to other policy approaches, slum upgrading can be suitable for cities with limited vacant land and resources to provide shelter at scale. We contribute policy lessons using one of the world’s largest slum upgrading programs.

Third, we add to the literature on the measurement of urban form through imagery ([Glaeser et al., 2018](#)).<sup>4</sup> Our informality indexes address the notoriously difficult problem of defining and measuring urban informality. Our photos-based index overcomes coverage bias by complementing ground imagery from repositories with photos we took in kampungs inaccessible to cars. We augment this with administrative data on titles and cadastral maps, thus capturing the multidimensional aspects of slums.

The rest of the paper proceeds as follows. Section 2 discusses the background, Section 3 describes the data, Section 4 illustrates the empirical strategy, Section 5 presents our main results, Section 6 explores potential channels, Section 7 presents our model and welfare discussion, Section 8 addresses identification threats and robustness, and Section 9 concludes.

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<sup>3</sup>Additionally, [Libertun de Duren and Osorio \(2020\)](#) find limited medium-term impacts associated with the Favela-Barrio slum upgrading program in Brazil. In urban Mexico, [McIntosh et al. \(2018\)](#) and [Gonzalez-Navarro and Quintana-Domeque \(2016\)](#) find that infrastructural improvements increase land prices in the short run for low-income neighborhoods where tenure security is not contentious. The literature has also considered titling ([Field, 2007](#), [Galiani and Schargrodsky, 2010](#)), public or subsidized housing ([Picarelli, 2019](#), [Barnhardt et al., 2017](#), [Franklin, 2019, 2020](#), [Kumar, 2021](#)), housing improvements ([Galiani et al., 2017](#)), and slum clearance ([Rojas-Ampuero and Carrera, 2023](#)). Also see [Brueckner and Lall \(2015\)](#) and [Marx et al. \(2013\)](#) for an overview.

<sup>4</sup>Remotely-sensed imagery has been employed to map slums ([Kuffer et al., 2016](#)), but this approach misses many attributes visible from the ground. Street-level imagery has been utilized in the United States ([Naik et al., 2017](#)), but it can be problematic in developing countries due to coverage bias.

## 2 Background

Indonesia is the fourth most populous country in the world with 274 million inhabitants ([World Bank, 2021](#)). Jakarta, the capital, has close to 11 million residents and is part of the sprawling metropolitan area of Jabodetabek ([Haryanto, 2018](#)),<sup>5</sup> the world's second-largest, home to 35 million inhabitants and over 5 million commuters ([Rukmana, 2015](#)). Below, we describe the history of KIP and discuss how it interacts with urban development in modern Jakarta.

### 2.1 The Kampung Improvement Program

KIP is one of the earliest and largest slum upgrading programs ever. In Jakarta, it covered 110 square kilometers and 5 million beneficiaries, with a total outlay of approximately \$500 million (2015 USD). KIP was later expanded to other cities, eventually covering 500 square kilometers and 15 million beneficiaries in Indonesia (see [World Bank \(1995\)](#), [Darrundono \(1997\)](#), and [Darrundono \(2012\)](#)). We consider the first three waves of KIP, implemented in Jakarta between 1969 and 1984.

The earliest upgrades to traditional settlements began in the 1920's with Dutch interventions. After independence, rapid in-migration raised concerns about floods, fires, and riots in kampungs. At that time, Indonesia was one of the poorest countries in the world (with a GDP per capita below that of India, Bangladesh, and Nigeria). Slum upgrading thus appeared as an affordable policy option to benefit a large number of kampung residents ([Darrundono, 2012](#)).

**Program Details.** The primary objective of KIP was to improve neighborhood conditions in kampungs. Given the limited budget and to avoid attracting high-income groups, the upgrades were basic, with a useful life of 15 years ([Devas, 1981](#)). Residents were not relocated.

To encourage residents to invest in their properties, KIP planners verbally promised not to evict them for 15 years ([Darrundono, 2012](#), p. 50). Given the challenges in establishing property rights, it is common to bundle upgrades in slums with some form of tenure security (verbal guarantees or occupancy certificates) in order to stimulate private investments ([Fox, 2014](#)).

KIP provided three types of physical upgrades. First, the program improved access to kampungs by widening and paving roads, bridges, and footpaths. The second component was sanitation and water management, including public water supply and drainage canals to address flooding. Third, KIP provided community buildings such as primary schools and health clinics.

KIP had a staggered roll-out over three five-year plans (*Pelita*): *Pelita* I (1969-1974) , II (1974-1979) and III (1979-1984), after which it was halted due to budget cuts following the 1986 oil shock. The roll-out prioritized kampungs in worse conditions. Planners created a scoring rule to

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<sup>5</sup>Jabodetabek comprises Jakarta and the adjacent municipalities of Bogor, Depok, Tangerang, and Bekasi.

rank kampungs based on physical characteristics (e.g. sanitation, flood damage, and road quality), kampung age, population density, and estimates of income (KIP, 1969). Given time constraints and limited information, the scoring rule over-weighted physical conditions that were easily observable. Moreover, kampungs had to be distributed evenly across Jakarta's five districts.

**Prior reports on KIP.** KIP is generally considered by practitioners and policy makers as a successful program (Devas, 1981, Taylor, 1987, World Bank, 1995, Darrundono, 2012)). A 1995 World Bank evaluation report concludes that KIP “improved the quality of life of Indonesian urban areas at a low cost of investment” (World Bank, 1995, p. 71). The report highlights improvements in neighborhood conditions, residents’ education and health, and private housing investments. In addition, KIP was considered “crucial to establishing the permanence of the kampungs” (p. 59) and associated with strengthened perceptions of tenure security by residents.<sup>6</sup>

## 2.2 KIP and kampung redevelopment

The World Bank report recognizes that rising demand for urban land would eventually trigger the redevelopment of kampungs. Today's Jakarta provides an ideal setting to study the implications of slum upgrading in the long-run. The city faces an annual population growth rate of 1.7% (World Population Review, 2024) and a severe housing backlog, with an estimated 70,000 additional housing units needed each year (Mardanugraha and Mangunsong, 2014). To address concerns of overpopulation and sprawl, the most recent Master Plan explicitly promotes the redevelopment of central areas (Human Cities Coalition, 2017).

Kampungs are estimated to host a quarter of Jakarta's population (McCarthy, 2003). They are relatively high-quality, with fairly permanent structures and access to basic amenities. According to our survey, most residents (75%) are owners, but only 25% report having a formal title.<sup>7</sup> This reflects the segmentation of Indonesian land markets: a formal one with well-defined property rights, originally established by the colonial administration in Dutch settlements (Harari and Wong, 2024), and an informal one that follows local customary law (*adat*).

Redeveloping kampungs into formal neighborhoods is complex (Leitner and Sheppard, 2018). Formally registering titles entails significant transaction costs, including high fees (8.5%), challenges in verifying tenure status and resolving disputes, and delays due to backlogged courts. Redevelopment also requires negotiations involving developers, residents, government officials, and

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<sup>6</sup>Even though respondents “had no land certificate or document to prove [ownership]” (p. 111), 47% of KIP respondents claimed ownership rights compared to 32% in non-KIP (Table 13).

<sup>7</sup>In 2016 we conducted a field survey with 300 households in eight kampungs, with the local government's permission Wong (2019). 77% of houses had brick or concrete walls, 93% reported having metered electricity, 79% utilized private water supply, and 71% had private toilets. However, only 12% of residents reporting that their street had car access. The average annual household income was US\$3,500 and the annual rental cost US\$1,600.

middlemen. Local governments fear political backlash from slum clearance, as residents contend that they are not compensated adequately, if at all.<sup>8</sup> In addition, assembling many contiguous land parcels in dense kampungs entails holdout problems (Brooks and Lutz, 2016).

Preserving slums is one of the inherent objectives of slum upgrading programs, as these areas give shelter to many residents. This occurs through a number of potential channels. First, higher land values from the upgrades will increase redevelopment costs. Moreover, upgrades and non-eviction guarantees can make slums more attractive and strengthen residents' perceptions of their occupancy rights (Fox, 2014). This encourages them to stay, plausibly leading to greater population density and more fragmented land (as stayers sub-divide land parcels) over time. In turn, this can increase relocation and land assembly costs. Taken together, these factors potentially contributed towards higher perceived formalization costs in KIP areas. Indeed, developers accounted for KIP status as they selected sites for development (World Bank, 1995).

### 3 Data

This Section discusses our primary data sources, including policy maps, land values, building heights, and our measures of informality. More details about data sources and processing are provided in the Data Appendix. Table A1 reports summary statistics.

#### 3.1 Assessed land values

We observe assessed land values from a 2015 digital map available through the Smart City Jakarta initiative. The Indonesian land agency uses a property appraisal valuation model that relies on transactions and market data (e.g. from brokers and notary offices). The estimated property value is decomposed into a building component and a land component, which is what we consider. We have land values in Rupiahs per square meter for nearly 20,000 sub-blocks (the smallest zoning unit), evenly distributed throughout the city (Figure A1). Importantly, in Jakarta, properties are transacted actively in both the formal and informal markets (Leaf, 1994). We verify that KIP areas are not underrepresented in the dataset (see Section 8.4). The average land value is 12 million Rupiahs per square meter (around US\$90 per square foot).

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<sup>8</sup>Evictions without compensation are common (Human Rights Watch, 2006) and carried out by the government for public works or by developers (with the government's cooperation) for residential and commercial projects (Szumer, 2015). The law does not provide any monetary compensation to residents without a title (Obeng-Odoom, 2018). In practice, developers sometimes offer compensation through middlemen, but well below market value (Leitner and Sheppard, 2018). The government will occasionally offer subsidized rental apartments, mostly in peripheral areas, that residents are often unsatisfied with (Wijaya, 2016).



Reliable land value data is challenging to obtain in developing countries. We validate our data in two ways. First, we cross-check our price effects against real quantities by collecting our own data on building heights. Second, we correlate our land values with 4,000 property prices from Indonesia’s largest property website, obtaining a correlation coefficient of 0.56 (see Figure A2).

### 3.2 Building heights

We measure building heights from a photographic survey we collected. The unit of observation is a 75 meter-by-75 meter pixel.<sup>9</sup> We draw a representative sample of 19,515 pixels from the full Jakarta grid of 89,000 pixels, stratifying to ensure broad spatial coverage (details of the sampling procedure are in the Appendix). In each pixel, we obtain four photos from four angles.

The main advantage of our approach is the ability to construct a representative sample including both formal and *informal* areas. We begin by drawing street view images from online image repositories. In some instances, cars cannot access the narrow streets of some kampungs (8% of pixels) or private gated developments (2%). For these areas, we obtained photos from enumerators sent to the field, with the government’s permission. Our approach also overcomes the problem of under-reporting of buildings in administrative records (e.g. due to tax evasion).

Our primary height outcome is an indicator equal to one if the tallest building in the pixel is above three floors. Pixels with no buildings (4% of the sample), corresponding to large roads, parks, or empty lots, were assigned a height of 0 and tagged with a dummy; results are robust to excluding them. We also consider log number of floors of the tallest building, for the (selected) sample of pixels that have at least one building.

### 3.3 Measuring informality

Defining and measuring urban informality is challenging. We consider several metrics to quantify informality through a combination of imagery and administrative data.

**Rank-based index.** We hand-coded a rank-based index that provides a holistic assessment of the neighborhood’s quality based on photographs. The index ranges from 0 (very formal) to 4 (very informal). Examples can be found in Figure A3. We instructed our research assistants to rank photos based on characteristics of the neighborhood (including the density and irregularity of structures, and cleanliness) and of the buildings (such as the durability of materials and the size of windows).

**Titles.** We observe what type of titles land parcels have from a unique digital land map created

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<sup>9</sup>This is the area required for an average high-rise development, based on reports from the Jakarta City Planning Agency.

and made public by the Indonesian National Land Agency in 2020. As a proxy for informality, we compute the area share of each pixel corresponding to unregistered parcels.

**Parcel density.** We consider the number of parcels in each pixel based on digital cadastral maps created by the Jakarta Department of Housing in 2011 (Figure A10).

**Population data.** From the 2010 complete count Population Census, we observe demographics for 10 million individuals in Jakarta, including age, gender, educational attainment, and migration status. For the model, we use this data to predict the likelihood that households in formal and informal locations are high versus low types.

### 3.4 Policy maps and historical kampungs

**KIP boundaries.** We utilize high-resolution (2.5 meters) maps from the Jakarta Department of Housing (DPGP, 2011), indicating the boundaries of KIP upgraded areas and the individual assets provided (e.g. roads, sanitation facilities, and community buildings). An example map is provided in Figure A9. Figure 1 displays KIP treated areas as unshaded polygons.

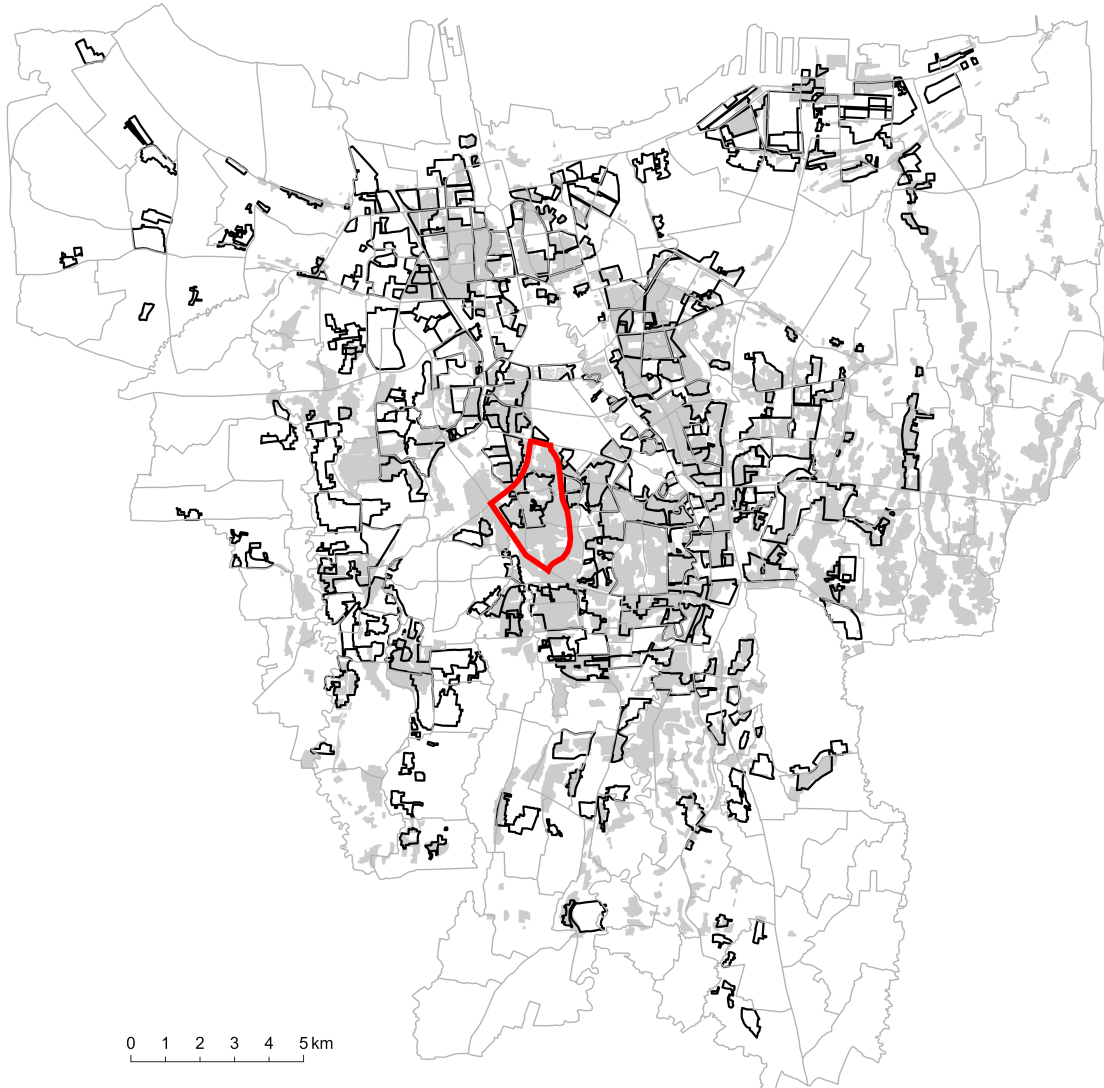
For our boundary discontinuity design, we develop an automated procedure to define KIP boundary segments and treated and (non-contaminated) control areas as follows. We overlay a fishnet of 500 by 500 meter grid cells on KIP boundaries and use it to arbitrarily subdivide them into boundary segments. We then assign a unique boundary identifier to each segment, which we use to define boundary fixed effects. For each observation, we calculate the distances to the nearest and second nearest boundary segment. We assign to the “control” group any observation that is (i) not in a KIP polygon; (ii) within 200 meters of the nearest boundary segment; (iii) at a distance greater than 200 meters from the second nearest boundary segment (to avoid contamination). Figure A4 shows that the resulting boundary segments are evenly distributed across Jakarta. The Appendix discusses additional details on the selection procedure.

**Historical kampungs.** We identify areas that were kampungs before the implementation of KIP through two maps, one from 1959 (U.S. Army Map Service, 1959) (with 25 meters resolution) and one from 1937 (G. Kolff & Co, 1937) (11 meters). We consider as historical kampungs areas that are marked as “kampung” in either the 1937 or the 1959 map. These are the shaded regions in Figure 1.<sup>10</sup> We also use these maps to trace major historical roads.

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<sup>10</sup>KIP areas that do not correspond to historical kampungs are kampungs that were settled post 1959.

**Figure 1: KIP boundaries and historical kampungs**



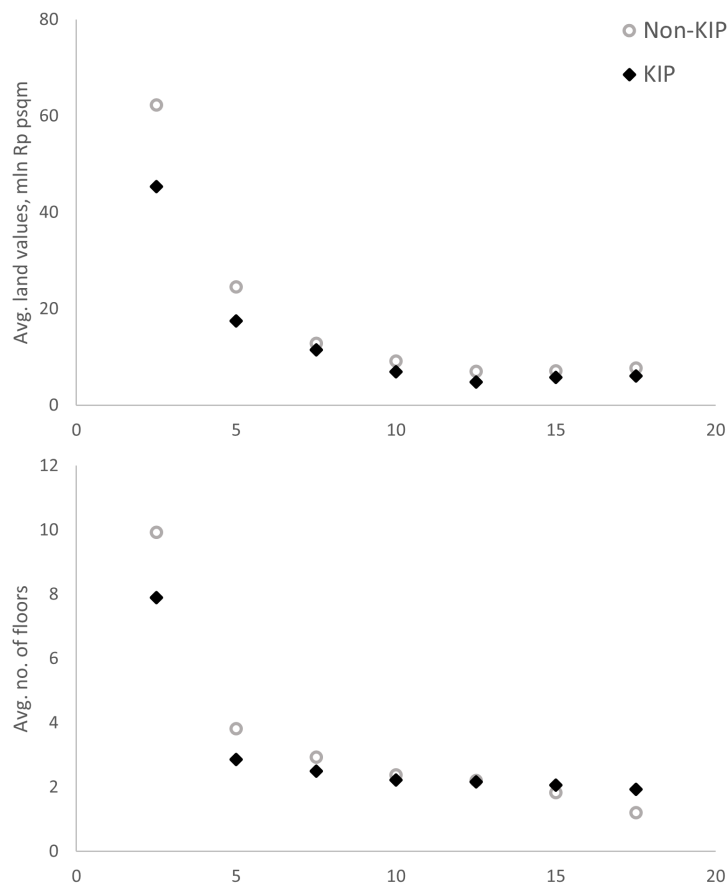
Notes: Map showing KIP boundaries (black border) and historical kampungs that existed before KIP (shaded regions). The grey borders are locality boundaries. The thick red boundary in the middle is the Golden Triangle.

### **3.5 Descriptive analysis by distance to the CBD**

Figure 2 presents scatter plots for the average land values and average number of floors by KIP status. The horizontal axis is distance to the CBD in kilometers. There is clear spatial decay away from the center and a striking pattern of lower land values and building heights in KIP, with wedges that are larger closer to the center.

As CBD, we consider the “Golden Triangle” (red polygon in the map), an approximately 5 squared km area delineated by three road arteries (Bland, 2014). Notably, KIP did not influence

**Figure 2:** Land values and heights by KIP status and distance to the CBD



Notes: Average land values (millions of Rupiahs per squared meter) and average number of floors (inclusive of zeros) by KIP status and distance to the Golden Triangle (in kilometers).

the location of the Golden Triangle. Even though skyscrapers emerged only several decades later, the roads delineating the Triangle were largely established before KIP.

## 4 Empirical framework

We consider the following regression model linking current outcomes ( $Y$ ) to KIP treatment status and an index capturing local unobserved quality ( $\xi$ ):

$$Y_{ij} = \alpha + \beta KIP_{ij} + \xi_{ij} + \varepsilon_{ij} \quad (1)$$

where unit  $i$  is a sub-block (for assessed land values) or 75-meter pixel (for heights) in location  $j$  and  $\varepsilon_{ij}$  is an idiosyncratic error term.

The parameter of interest is  $\beta$ , which captures the long-term impacts of KIP on land values and building heights. The main threat to identification is program selection bias because KIP planners formulated a scoring rule to prioritize low-quality kampungs. To the extent that historical differences are persistent, KIP areas may have worse outcomes today due to selection bias ( $E[\xi_{ij}|KIP = 1] - E[\xi_{ij}|KIP = 0] < 0$ ).

Our thought experiment involves two nearby locations (T and C) within the same neighborhood  $j$ . Unconditionally, T had a lower  $\xi_{ij}$  than C at the time of KIP, and was selected into KIP on the basis of the scoring rule. Over time, massive urbanization introduced large shocks to both T and C. Our identification assumption is that pre-KIP differences between T and C have a muted impact by today and that more recent shocks were common to T and C, so that T and C now have similar quality, conditional on observables and granular fixed effects. We discuss potential confounding due to program selection and persistent pre-KIP differences in Sections 5.3 and 8.2.

Our first strategy utilizes the full sample spanning the city of Jakarta and includes more than 2000 hamlet fixed effects (comparable in area to U.S. census block groups).<sup>11</sup> Our identifying assumption is that hamlets are subject to common shocks and have uniform potential for redevelopment due to their small geographic area.

Our second strategy restricts the sample to historical kampungs that existed before KIP and includes around 200 locality fixed effects (the smallest jurisdiction where local taxes are collected, comparable in area to U.S. census tracts). This second strategy circumvents the concern that the full sample compares areas that were historically slums with areas that were not.

Third, we implement a boundary discontinuity design (BDD) comparing observations within 200 meters of KIP boundaries.<sup>12</sup> Our BDD specification controls for distance to the boundary interacted with KIP, boundary segment fixed effects, and locality fixed effects to address the fact that some of the boundary segments happen to be near administrative boundaries. Our identifying assumption is that, absent KIP, unobserved quality today would vary smoothly at the program boundaries, within these narrow distance bands.<sup>13</sup>

When estimating average treatment effects, we show all three specifications. For our heterogeneity analyses and sample splits we primarily utilize the full sample due to lack of power in the other two sub-samples.

Standard errors are clustered by locality except in the BDD where we cluster by boundary

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<sup>11</sup>A list of all administrative units along with their area size is reported in Table A13 in the Data Appendix.

<sup>12</sup>As a reference, the optimal bandwidth à la [Calonico et al. \(2014\)](#) is 270 meters and 149 meters for log land values and for the height dummy, respectively. Because KIP polygons are relatively small, most KIP observations are within 500 meters from a KIP boundary. We address robustness to the choice of distance cutoff in Section 8.1.

<sup>13</sup>KIP neighborhood boundaries are pre-determined because they largely depend on hamlet boundaries defined during World War II by the Japanese for security purposes. Thus, they are likely uncorrelated with the potential for formal high-rises.

segment. Results are robust to using [Conley \(1999\)](#) errors to address spatial correlation (see Section 8.4.)

We include eighteen controls capturing distance to historical landmarks, historical infrastructure, and geography. All are predetermined with respect to KIP. Our landmark controls capture historical neighborhood quality and include distance from the National Monument, Old Batavia Castle (the colonial city center), and other colonial landmarks. Our infrastructure controls capture pre-KIP public investments and market access, including distance to historical main roads, railway and tram stations, as well as the presence of wells or pipes. Finally, our topography controls capture natural advantage. An important component is flood proneness, as Jakarta lies on a coastal lowland and is often paralyzed by flooding. Absent pre-KIP data on flood proneness, we proxy for it with predetermined geographic predictors suggested by the hydrology literature.<sup>14</sup> All variables are described in the Data Appendix.

## 5 Main results

In this Section, we discuss average and heterogeneous KIP effects on our primary outcomes, land values and building heights. We also address program selection bias, a key identification threat.

### 5.1 Effect of KIP on land values and building heights

Table 1 presents the effect of KIP on land values (columns 1 to 3). The dependent variable is the log price per square meter in a sub-block, from the assessed land values database. Column 1 reports the full sample specification and columns 2 and 3 present the historical kampung and BDD analyses, respectively. The full set of controls are listed in Table A2.

Across all three specifications, KIP areas have lower land values on average. The full sample estimate of -0.11 in column 1 compares observably identical KIP versus non-KIP observations within hamlets. Column 2 restricts the comparison to historical kampungs within the same locality, with a slightly more negative estimate of -0.14. Column 3 presents our BDD analysis showing a coefficient estimate of -0.18 comparing observations within 200 meters of KIP boundaries. In Section 8.1, we show robustness and discuss threats related to spatial spillovers and confounding by coinciding boundaries. The confidence intervals overlap across all three columns.

Turning to building heights, we consider as dependent variable a dummy indicating whether the tallest building in a pixel has more than three floors. This specification uses the full photographic

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<sup>14</sup>These variables include elevation, slope, distance from the coast and other water bodies, and flow accumulation. We verify that they are good predictors of contemporaneous flooding in Jakarta as measured by OpenStreetMap. For robustness, we also verify that our results are similar controlling for contemporaneous flood proneness.

**Table 1: Effect of KIP on land values and building heights**

Dependent variable:	Log land values			1(Height>3)		
	Full Sample	Historical Kampung	BDD 200m	Full Sample	Historical Kampung	BDD 200m
Sample:	(1)	(2)	(3)	(4)	(5)	(6)
KIP	-0.11*** ( 0.03)	-0.14*** ( 0.05)	-0.18** ( 0.07)	-0.07*** ( 0.02)	-0.12*** ( 0.02)	-0.10*** ( 0.04)
N	19848	3144	4339	19515	5277	4128
R-Squared	0.85	0.73	0.84	0.36	0.29	0.53
Control Group Mean	15.84	15.89	15.80	0.18	0.24	0.21
Infrastructure	Y	Y	Y	Y	Y	Y
Topography	Y	Y	Y	Y	Y	Y
Landmarks	Y	Y	Y	Y	Y	Y
Distance to KIP boundary	N	N	Y	N	N	Y
Geography FE	Hamlet	Locality	KIP Boundary	Hamlet	Locality	KIP Boundary

\* 0.10 \*\* 0.05 \*\*\* 0.01

Notes: This table reports the effect of KIP on land values and building heights. Columns 1, 2, and 3 report the effect of KIP on log assessed land values in a sub-block, where the key regressor is an indicator that is 1 for sub-blocks in KIP. Column 1 includes the full sample with 2058 hamlet fixed effects (303 with KIP variation). Column 2 includes the historical kampung sample with 196 locality fixed effects (87 with KIP variation). Column 3 uses observations within 200 meters from a KIP boundary, controlling for distance to the KIP boundary, and KIP boundary fixed effects (215 with KIP variation). Columns 4, 5, and 6 present the analysis for heights at the pixel level, where the dependent variable is a dummy equal to 1 if the tallest building in the pixel has more than 3 floors. We also control for strata fixed effects from our photographic survey and an indicator for pixels with public parks and roads. All other controls are listed in Table A2. Standard errors are clustered by locality (full and historical specifications), and by KIP boundary (BDD specification).

sample for 19,515 pixels. Below, we also consider log of heights, which conditions on a selected sample of pixels that have buildings. We add sampling strata fixed effects (from our photographic survey) as well as a dummy for pixels with public parks and roads (see Section 3.2). Again, all three specifications indicate KIP areas have fewer tall buildings, with estimates ranging from 7 to 12 percentage points, and overlapping confidence intervals. These estimates are large (40 to 50 % relative to the mean). Figure A5 shows the distribution of building heights by KIP status, highlighting that non-KIP locations have more tall buildings and KIP locations have more short buildings. On the intensive margin, we estimate an average KIP effect of -9% on number of floors (see Table A3).

## 5.2 Heterogeneity by distance to the CBD

Next, we leverage the wide geographic scope of KIP to explore where the effects are the largest. As discussed in [World Bank \(1995\)](#), one concern is that the upgrades can improve land values but also

make slums more permanent than they otherwise would be. Once the gains from formalization are large enough to justify redevelopment, there can be a reversal in market outcomes as non-upgraded slums formalize. Intuitively, the KIP effects are most likely to be negative in areas with greater redevelopment potential, which we capture using proximity to the CBD.

While KIP covered a large area (110 square km), it is disproportionately in the center of modern Jakarta because KIP kampungs were settled early and the city has expanded outwards across the decades. We categorize Jakarta into central (pixels and sub-blocks that are 0 to 5km from the Golden Triangle, inclusive), middle (5km to 10km), and peripheral (10km to 20km) regions.<sup>15</sup> Strikingly, 44% of the program area is in the center, relative to 43% and 13% in the middle and periphery.

We trace out the heterogeneous effects of KIP by distance to the CBD, utilizing the full sample and interacting the KIP dummy with indicators for the central/middle/peripheral regions (the omitted group is the non-KIP region in the periphery). We also add two indicators for the central and middle regions, in addition to hamlet fixed effects and our controls. We do not have enough power to detect heterogeneous effects with the boundary sample and the historical sample is too concentrated in the center. The three interaction coefficients are identified from 303 hamlets that have variation in KIP status and are spread across Jakarta, with 34% of the hamlets in the center, 48% in the middle, and 18% in the periphery. As a reference, this breakdown is similar to the geographic distribution for the full sample of hamlets (31/41/28%), except there is less KIP presence in the periphery.

We find patterns consistent with the scatterplots above (Figure 2). Column 1 of Table 2 presents larger estimated effects for log land values in the center (-0.14), compared to the middle (-0.10) and periphery (-0.09). Columns 2 and 3 present heterogeneous effects for the extensive and intensive margins of building heights. The dependent variables are an indicator for buildings with more than three floors (column 2) and log of the number of floors (column 3, dropping pixels without buildings). Consistent with the plots above, we find taller buildings in non-KIP central locations (0.13 estimate for log heights) relative to the middle (0.06) and periphery (0.04). The estimated effects for buildings above 3 floors are even (7, 7, and 6 p.p., respectively).

These heterogeneity patterns are robust to a variety of approaches to rank neighborhoods by their formalization potential. For example, we constructed a predicted land index using non-KIP observations and hamlet fixed effects. We find qualitatively larger effects in areas in the top quintile of the predicted land index, followed by the next quintile, and so on. We also considered K-means clustering to group sub-blocks using the predicted land index and latitude and longitude.

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<sup>15</sup>We pool the two outermost 5-km bins because only 5% of KIP observations (195 obs) are beyond 15 km. Only 7 hamlets have within-KIP variation in the 15 to 20km band.



**Table 2:** Heterogeneous effects by distance to the CBD

Dependent Variable	Log land values (1)	1(Height>3) (2)	Log height (3)
KIP X Center	-0.14** ( 0.06)	-0.07*** ( 0.02)	-0.13** ( 0.06)
KIP X Middle	-0.10** ( 0.05)	-0.07*** ( 0.02)	-0.06** ( 0.03)
KIP X Periphery	-0.09** ( 0.04)	-0.06*** ( 0.02)	-0.04 ( 0.03)
Center	0.30** ( 0.12)	-0.01 ( 0.05)	-0.04 ( 0.10)
Middle	0.09 ( 0.07)	-0.02 ( 0.02)	-0.04 ( 0.05)
N	19848	19515	17233
R-Squared	0.85	0.36	0.41
Control Group Mean	15.84	0.18	0.92
Infrastructure	Y	Y	Y
Topography	Y	Y	Y
Landmarks	Y	Y	Y
Geography FE	Hamlet	Hamlet	Hamlet

\* 0.10 \*\* 0.05 \*\*\* 0.01

Notes: This table extends the full sample specifications in Table 1 which includes more than 2000 hamlet fixed effects and baseline controls. The key regressors interact the KIP indicator with indicators for central/middle/peripheral regions, defined respectively using 0 to 5km, 5 to 10km, 10 to 20km bands from the CBD. We also include one indicator each for the central and middle regions. In column 1 the dependent variable is log assessed land values for sub-blocks. In column 2, the dependent variable is an indicator for whether the pixel has more than 3 floors, adding strata fixed effects for the photographic sample and an indicator for pixels with public parks and roads. The dependent variable for column 3 is log of building height, restricted for a sample of 17,233 pixels with buildings. Standard errors are clustered by locality.

### 5.3 Program selection bias

Next, we address concerns due to program selection bias ( $E[\xi|KIP = 1] - E[\xi|KIP = 0] < 0$ ). Since the scoring rule formulated by KIP planners prioritized low-quality kampungs first, we use the sequential roll-out of KIP across the three *Pelita* waves (five-year plans) to investigate selection bias. Specifically, we decompose the overall KIP indicator into three dummies corresponding to the three KIP waves and assess whether  $\beta_I < \beta_{II} < \beta_{III}$ .

Critically, we find a monotonic pattern consistent with selection bias, but it disappears once we include our granular fixed effects. In Table 3, column 1 shows a monotonic pattern using the full sample of assessed land values, with estimates for the three waves being -0.44 (wave I), -0.31 (wave II), and -0.18 (wave III). We control for district fixed effects, as the selection rule specified that KIP had to be distributed evenly across the five districts of Jakarta, as well as our controls. Reassuringly, the differences in column 1 are greatly attenuated once we include hamlet fixed effects (column 2) and in the historical kampung specification with locality fixed effects (column 3). We do not have

**Table 3: Heterogeneous effects by KIP waves**

Dependent variable:	Log land values			1(Height>3)		
	Full Sample	Full Sample	Historical Kampung	Full Sample	Full Sample	Historical Kampung
Sample:	(1)	(2)	(3)	(4)	(5)	(6)
KIP I (1969-1974)	-0.44*** (0.08)	-0.03 (0.07)	-0.10 (0.10)	-0.13*** (0.03)	-0.07** (0.03)	-0.10*** (0.03)
KIP II (1974-1979)	-0.31*** (0.07)	-0.13** (0.05)	-0.06 (0.07)	-0.09*** (0.01)	-0.05** (0.02)	-0.10*** (0.02)
KIP III (1979-1984)	-0.18** (0.08)	-0.09** (0.04)	-0.09 (0.08)	-0.07*** (0.02)	-0.04* (0.02)	-0.09*** (0.03)
N	19848	19848	3144	19515	19515	5277
R-Squared	0.57	0.85	0.73	0.16	0.36	0.29
p-val ( $H_0 :  \beta_I  \leq  \beta_{II} $ )	0.06	0.89	0.30	0.12	0.33	0.45
p-val ( $H_0 :  \beta_{II}  \leq  \beta_{III} $ )	0.10	0.28	0.59	0.13	0.35	0.47
Control Group Mean	15.84	15.84	15.89	0.18	0.18	0.24
Infrastructure	Y	Y	Y	Y	Y	Y
Topography	Y	Y	Y	Y	Y	Y
Landmarks	Y	Y	Y	Y	Y	Y
Distance to CBD bins	N	Y	Y	N	Y	Y
KIP investments	N	Y	Y	N	Y	Y
Geography FE	District	Hamlet	Locality	District	Hamlet	Locality

\* 0.10 \*\* 0.05 \*\*\* 0.01

Notes: This table assesses whether there is a monotonic pattern in the effects of the three KIP waves that is consistent with the scoring rule prioritizing worse neighborhoods ( $\beta_I < \beta_{II} < \beta_{III}$ ). Specifically, we estimate heterogeneous effects on land values (columns 1 to 3) and building heights (columns 4 to 6) with the key regressors being dummies for each of the three KIP *Pelita* waves (five-year plans). Column 1 includes the full sample of 19,848 sub-blocks from the assessed land values data and 5 district fixed effects. Column 2 adds hamlet fixed effects and controls for KIP investments and dummies for distance bins from the CBD. Column 3 restricts to the historical kampung sample with 3,144 sub-blocks and includes 196 locality fixed effects. Columns 4 through 6 present the analogous analysis for heights. Column 4 includes the full photographic survey sample corresponding to 19,515 pixels. Standard errors are clustered by locality.

statistical power for this test with the BDD sample, as there are not enough boundaries to separately identify an effect for each wave. In columns 4 through 6, we reach similar conclusions for building heights: there is a slight monotonic pattern but it weakens in the full sample and historical kampung specifications.

**Other differences across waves** One concern with our test is that the three waves may differ in other manners and not just by the selection rule. While it is difficult to separately identify negative selection across waves using a single cross-section of data, it is reassuring that our conclusions are robust to accounting for differences in program design across waves. Earlier KIP waves were implemented in older and more central parts of the city (see Figure A7). We address this by controlling for distance from the CBD, in addition to our granular fixed effects. Moreover, the investments provided by each of the three waves were not identical: for example, the first wave

focused on sanitation and paving footpaths. We account for this by controlling for the intensity of KIP-provided investments. For each pixel, we code the presence of KIP investments (paved roads, sanitation facilities, and public buildings) within 500 meters, from our policy maps. Reassuringly, once we include our fixed effects, neither the distance nor the investments controls materially change the estimates of our coefficients of interest.

In addition, we note that there should be little heterogeneity associated with the timing of the physical upgrades for different waves as they have all likely depreciated by 2015, as discussed in Section 6.3. Finally, another concern is that the earlier waves had more time to be redeveloped. We note that development activity would only take off in the 2000's, well after KIP ended, suggesting that the gap between the first and last waves did not lead to a meaningful difference in redevelopment potential.

Overall, while we observe differences indicative of program selection bias, it is reassuring that these differences are greatly attenuated in the historical kampung and full sample specifications. These results are in line with descriptions of the convergence of KIP and non-KIP kampungs documented in [World Bank \(1995\)](#). Section 8.2 below further probes whether historical differences between KIP and non-KIP can explain our results, reaching similar conclusions.

## **6 Why do upgraded areas have low land values and heights?**

We now examine potential factors associated with lower land values and building heights in KIP. In line with the policy makers' perception that upgrading makes slums more persistent, we consistently find that KIP areas are more likely to be informal across all proxies of informality. Several aspects can contribute to delayed formalization: upgraded slums could be less likely to be redeveloped because they are more crowded, because they have higher neighborhood quality, or because of more established perceived ownership rights by residents. Below, we consider household density and amenities.

### **6.1 Informality**

We measure informality by the appearance of the neighborhood on photos and the legal status of land parcels. Figure A6 shows that KIP areas are more likely to be informal today, using the full photos sample and our rank-based informality index for treated and control pixels. Here, 0 indicates very formal areas and 4 indicates very informal areas. There is a continuum across the index values, reflecting the varying degrees of informality in a city undergoing urban transformation.

Table 4 considers two measures of informality. Columns 1 through 3 indicate that KIP neighborhoods are more likely to be informal using the photo rankings. The magnitudes range from 0.27 to 0.31, relative to a control group mean of 1. Columns 4 to 6 show the share of a pixel with unregistered titles is higher by 2 to 3 p.p. in the full and historical samples. The effects are insignificant for the BDD specification.

**Table 4:** Effect of KIP on informality

Dependent variable:	Rank-based index			Unregistered parcels (shares)		
	Full Sample	Historical Kampung	BDD 200m	Full Sample	Historical Kampung	BDD 200m
Sample:	(1)	(2)	(3)	(4)	(5)	(6)
KIP	0.27*** (0.03)	0.31*** (0.06)	0.27*** (0.08)	0.02** (0.01)	0.03*** (0.01)	-0.01 (0.03)
N	19515	5277	4128	19515	5277	4128
R-Squared	0.54	0.25	0.47	0.47	0.35	0.57
Control Group Mean	1.12	0.96	1.13	0.13	0.18	0.15
Infrastructure	Y	Y	Y	Y	Y	Y
Topography	Y	Y	Y	Y	Y	Y
Landmarks	Y	Y	Y	Y	Y	Y
Distance to KIP boundary	N	N	Y	N	N	Y
Geography FE	Hamlet	Locality	KIP boundary	Hamlet	Locality	KIP boundary

\* 0.10 \*\* 0.05 \*\*\* 0.01

Notes: This table reports the effect of KIP on informality, using pixel-level specifications similar to those of Table 1, columns 4, 5, and 6. The dependent variables include the rank-based informality index (columns 1, 2, and 3; higher values correspond to more informal) and area share of a pixel with unregistered titles (columns 4, 5, and 6). Standard errors are clustered by locality (full sample and historical specifications), and by KIP boundary (BDD specification).

## 6.2 Density

Next, we consider parcel and household density. All else equal, both are proximate factors that could contribute towards delaying formalization. Relocation costs are likely higher in dense neighborhoods. Additionally, land assembly costs increase with parcel density, as more claimants exacerbate ownership disputes and holdout problems. Columns 1 through 3 of Table 5 show that KIP areas have 9 to 13 more parcels per pixel, with an average of 13 to 19 parcels per pixel in non-KIP areas. Besides our standard controls, we also include the log length of roads in the pixel, as the presence of road intersections may mechanically increase observed land fragmentation.

In a similar vein, columns 4 and 5 show that household density in KIP is higher. Applying the 0.48 coefficient for the full sample to the corresponding control group mean, we find an effect of 13 households per pixel, in line with the parcel density estimates.<sup>16</sup> Our data is not granular enough

<sup>16</sup>Assuming one to two households per parcel, 10 more parcels per pixel (from column 1) implies 10 to 20 more

**Table 5:** Effect of KIP on parcel and household density

Dependent variable:	Parcel density			Log household density	
	Full Sample (1)	Historical Kampung (2)	BDD 200m (3)	Full Sample (4)	Historical Kampung (5)
KIP	10.14*** ( 0.55)	8.59*** ( 1.06)	12.61*** ( 1.04)	0.48*** ( 0.06)	0.32*** ( 0.07)
N	88832	11002	14951	2581	1202
R-Squared	0.52	0.51	0.61	0.46	0.57
Control Group Mean	12.84	18.79	13.88	8.03	8.24
Infrastructure	Y	Y	Y	Y	Y
Topography	Y	Y	Y	Y	Y
Landmarks	Y	Y	Y	Y	Y
Distance to KIP boundary	N	N	Y	N	N
Geography FE	Hamlet	Locality	KIP Boundary	Locality	Locality

\* 0.10 \*\* 0.05 \*\*\* 0.01

Notes: This table reports the effects of KIP on the number of parcels in a pixel (columns 1 to 3) and log household density (columns 4 and 5). Columns 1 to 3 repeat the pixel-level specifications of Table 1, adding the log length of roads in a pixel as a control. Columns 4 and 5 report effects for household density in a hamlet, logged. Standard errors are clustered by locality.

to decompose these effects in a definitive way, but we find no evidence of differential in-migration, fertility, or mortality, consistent with KIP residents being more likely to stay in the neighborhood. This is also in line with greater land fragmentation associated with stayers subdividing land over time. We provide suggestive tests in Section 8.2.

### 6.3 Amenities

Below, we explore the role of amenities by considering initial KIP investments and access to current public amenities.

**Initial KIP investments.** The physical upgrades can have persistent impacts on land values through the direct effects of durable investments or by encouraging private investments. Table 6 investigates heterogeneity by the intensity and type of original KIP investments. Specifically, we examine four primary KIP policy components - vehicular roads, pedestrian roads, sanitation facilities, and public buildings (health centers and schools). We observe the location and type of KIP investments from the policy maps.

For each sub-block, we quantify the intensity of investments located within a 500 meter buffer as total length of vehicular and pedestrian KIP-provided roads and number of sanitation facilities and public buildings. We do so for observations in KIP and non-KIP areas, allowing for the possi-

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households per pixel, inclusive of 13.

**Table 6: Heterogeneous effects by KIP components**

Dependent variable:	Log land values	
	Full Sample (1)	Historical Kampung (2)
Sample:		
KIP	-0.11*** ( 0.04)	-0.09* ( 0.05)
Length of Vehicular Roads (in km)	-0.02 ( 0.02)	-0.03 ( 0.03)
Length of Pedestrian Roads (in km)	0.01 ( 0.02)	-0.01 ( 0.02)
Number of Sanitation Facilities	0.003 ( 0.01)	0.01 ( 0.01)
Number of Public Buildings	0.01 ( 0.02)	0.01 ( 0.03)
KIP X Length of Vehicular Roads	0.004 ( 0.02)	-0.001 ( 0.03)
KIP X Length of Pedestrian Roads	-0.01 ( 0.02)	-0.01 ( 0.02)
KIP X Number of Sanitation Facilities	-0.004 ( 0.01)	0.002 ( 0.01)
KIP X Number of Public Buildings	0.02 ( 0.02)	-0.02 ( 0.03)
N	19848	3144
R-Squared	0.85	0.73
Control Group Mean	15.84	15.89
Infrastructure	Y	Y
Topography	Y	Y
Landmarks	Y	Y
Geography FE	Hamlet	Locality

\* 0.10 \*\* 0.05 \*\*\* 0.01

Notes: This table reports heterogeneous effects on land values by four policy components (vehicular roads, pedestrian roads, sanitation, public buildings). Column 1 presents the full sample specification with hamlet fixed effects. Column 2 presents historical kampungs with locality fixed effects. The intensity of KIP investments is measured by length of vehicular and paved roads, number of sanitation facilities, and number of public buildings within a 500 meter buffer around each observation. The KIP intensity variables have been demeaned so that the coefficient on the KIP indicator reflects the effects when evaluated at average intensity levels. The omitted category is non-KIP areas. Standard errors are clustered by locality.

bility that residents in non-KIP areas were also able to access these investments. The four investment intensity measures are demeaned so that the coefficient on the treatment indicator corresponds to the average treatment effect (i.e. evaluated at the average prevalence of KIP investments).

Columns 1 and 2 report the results for the full and historical samples, respectively. We do not find differential treatment effects by type of investment on current land values. This suggests that differences in initial public investments may have equalized across KIP and non-KIP areas by now.

Given that planners assumed a useful life of 15 years, it is plausible that the initial KIP investments have significantly depreciated after four decades.

**Current amenities.** Next, we consider current amenities of two types. First, we observe public amenities in 2016 from OpenStreetMap. We measure distance of each pixel to the closest school, hospital, police station, and bus stop. Second, as a proxy for amenities associated with formalization, we compute the land share of each pixel corresponding to retail and office buildings respectively, based on a 2014 administrative land use map from the Jakarta Government website.

Table A4 shows that KIP areas today have similar access to public amenities (columns 1 through 4), but fewer formal amenities. Differences in access to the nearest school, hospital, police station, and bus stop are not large enough to explain our results. This corroborates the discussion in [World Bank \(1995\)](#) that KIP accelerated the provision of amenities in treated neighborhoods, but that non-KIP kampungs “caught up” (p. 6) as a result of broader economic growth in Jakarta. Columns 5 and 6 show that KIP areas have 1 p.p. lower retail density and 2 through 4 p.p. lower office density, in line with our findings of lower land values, lower heights, and more informality.

Taken together, KIP neighborhoods today are more informal, with more fragmented land, and greater density. These patterns are consistent with KIP being attractive to informal residents through strengthened perceptions of tenure security and greater land assembly costs deterring re-development. The land value effects are not associated with differences in physical KIP upgrades and access to modern amenities in non-KIP places also appears comparable by now.

## 7 Model

So far, we have documented lower land values and heights in KIP neighborhoods. Mapping land values to welfare is complicated in our setting because the losses of displaced slum residents may not be readily captured. What are the sources of societal gains in a counterfactual without KIP, where are the gains largest, and how can we mitigate losses to the poor? In this Section, we develop and estimate a spatial equilibrium model to shed light on the welfare implications of KIP. The model includes key characteristics of developing country cities by featuring heterogeneous households and formal and informal housing markets ([Gechter and Tsivanidis, 2023](#)).

Below we outline the residents’ and the developers’ problem, and define the equilibrium conditions. We then discuss how we estimate key parameters in the model to match the reduced-form moments. The full derivation is provided in the Appendix. Our reduced-form estimates above identify the local, direct effects of KIP but do not account for spatial linkages and spillovers with the rest of the city that will be important in spatial equilibrium. The model allows us to consider

policy counterfactuals that account for these forces and assess the aggregate and heterogeneous impacts of lifting KIP restrictions in the city as a whole and in different regions. We conclude with robustness and a discussion of caveats and extensions.

## 7.1 Residents

There is an open city, embedded in a broader economy, comprising a discrete set of locations  $i \in \{1, \dots, N\}$ . It is populated by a continuum of workers of type  $g \in \{H, L\}$ , representing high- and low-skilled. Conditional on moving to the city, residents choose where to live ( $i$ ), where to work ( $j$ ), and how much housing to consume. The indirect utility of individual  $\omega$  of type  $g$  living in  $i$  and working in  $j$  is:

$$U_{ij\omega}^g = (u_i^g)^{\rho^g} Y_{ij}^g (r_i^g)^{(\beta^g-1)} \varepsilon_{i\omega}^g v_{j\omega}^g \quad (2)$$

which depends on amenities, rents, and housing consumption. We assume the housing market to be segmented into two types of housing, also indexed by  $g$ , each of which is consumed by group  $g$  residents only. Preferences are Cobb-Douglas over a numéraire consumption good and housing, reflected in the term  $Y_{ij}^g (r_i^g)^{(\beta^g-1)}$ , where  $r_i^g$  denotes housing rents per square meter of built-up space and  $(1-\beta^g)$  is the budget share spent on housing. Resident  $\omega$ 's income  $Y_{ij}^g$  includes a workplace-specific wage  $w_j^g$  that is discounted by commuting costs  $d_{ij}$ . The two idiosyncratic taste shocks, for residence ( $v_i^g$ ) and workplace ( $\varepsilon_j^g$ ), are drawn independently and sequentially from a Fréchet distribution with shape parameter  $\theta > 1$ . This is robust to assuming simultaneous draws (Tsivanidis, forthcoming).

Locations are differentiated by amenities and rents. The term  $u_i^g$  is a bundle of local amenities, with  $\rho^g$  governing type- $g$  preference weight. It includes an exogenous component  $\bar{u}_i^g$  and an endogenous one that depends on the share of type- $H$  residents:  $u_i^g = \bar{u}_i^g \cdot (Sh_i^H)^{\mu^g}$ . Exogenous amenities  $\bar{u}_i^L$  include basic public goods and tenure security, which are plausibly higher in KIP locations, whereas  $\bar{u}_i^H$  may include public space and landscape amenities. Both types benefit from  $(Sh_i^H)^{\mu^g}$ , which captures positive spillovers (e.g. through agglomeration and job access) from having many  $H$ -type neighbors. In line with the literature (Diamond, 2016, Su, 2022), we assume that the low-skilled benefit less from these spillovers ( $\mu^H > \mu^L > 0$ ).

Solving the residents' problem by backward induction, the share of group  $g$  residents choosing to live in  $i$  is:

$$p_i^g = \frac{(\Phi_i^g)^\theta}{\sum_i (\Phi_i^g)^\theta} \quad (3)$$

where  $\Phi_i^g \equiv (u_i^g)^{\rho^g} (\bar{Y}_i^g) (r_i^g)^{(\beta^g-1)}$ . The term  $\bar{Y}_i^g$  denotes the expected income of location  $i$  residents



given their optimal workplace choice. It is a function of the wages paid by jobs accessible from location  $i$ , as summarized by residential commuter market access ( $RCMA_i$ ) (Tsivanidis, forthcoming). We focus on the choice of where to live and relegate details about workplace choices to the Appendix (Section B.1.1).

The expected utility of group  $g$  residents in the city (our welfare metric) is:

$$\bar{U}^g \propto \left( \sum_i (\Phi_i^g)^\theta \right)^{1/\theta}. \quad (4)$$

The total measure of residents of each type choosing to live in the city,  $\bar{L}^g$ , is pinned down by the expected utility in the city  $\bar{U}^g$  vis-à-vis the outer economy.<sup>17</sup>

## 7.2 Developers

The supply side is similar to Gechter and Tsivanidis (2023) and Sturm et al. (2023). Each location  $i$  comprises a continuum of plots. In each plot, an atomistic landowner chooses (i) whether to develop the plot to provide formal ( $g = H$ ) or informal ( $g = L$ ) housing and (ii) how many floors to build, denoted by  $h_i^g$ .<sup>18</sup>

In the formal sector, heights are elastic with convex construction costs per unit land equal to  $c^H(h_i^H) = k_i(h_i^H)^\nu$ , with  $\nu > 1$  and  $k_i$  denoting a local cost shifter (Sturm et al., 2023).<sup>19</sup> At baseline, we assume that the informal technology only allows buildings of one floor ( $h_i^L = 1$ ) at a fixed cost  $\bar{c}^L$  per unit land, but we relax this assumption in a robustness exercise.

Only a share  $\phi^g$  of each plot is buildable, with  $\phi^H \leq \phi^L$  reflecting greater horizontal coverage in slums (Henderson et al., 2020).

Profits per unit land for each land use type are:

$$\pi^L = (r_i^L - \bar{c}^L) \cdot \phi^L \quad (5)$$

$$\pi^H = (r_i^H - c^H(h_i^H)) \cdot h_i^H \cdot \phi^H. \quad (6)$$

Formal profits are further subject to formalization costs  $\tau_i$ , reflecting land market frictions. Additionally, each plot is subject to idiosyncratic profits shocks ( $\zeta_H, \zeta_L$ ) for each type of land use,

<sup>17</sup>The following mobility condition holds:  $\bar{L}^g = \bar{L}_{econ}^g \frac{\bar{U}^g}{\bar{U}^g + \bar{U}^g}$  where the constant  $\bar{L}_{econ}^g$  denotes the total measure of residents in the economy and  $\bar{U}^g$  is the (fixed) expected utility in the outer economy.

<sup>18</sup>We assume all land is residential, abstracting from the trade-off between commercial and residential land use, and adjust the areas accordingly when taking the model to the data.

<sup>19</sup>This functional form can be derived from a Cobb-Douglas production function in land and capital, which is supported empirically in Combes et al. (2011).

jointly drawn from a Fréchet distribution with shape parameter  $\gamma > 1$ . Each plot owner thus chooses land use type  $g$  to maximize  $\{(1 - \tau_i)\pi^H \zeta^H, \pi^L \zeta^L\}$ .

The resulting share of plots in location  $i$  allocated to formal land use is:

$$\lambda_i^H = \frac{((1 - \tau_i)\pi_i^H)^\gamma}{((1 - \tau_i)\pi_i^H)^\gamma + (\pi_i^L)^\gamma} \quad (7)$$

with the corresponding informal share being  $\lambda_i^L = 1 - \lambda_i^H$ .

The total supply of housing floorspace of type  $g$  in location  $i$  is

$$H_i^g = \lambda_i^g \cdot T_i^g \cdot h_i^g \cdot \phi^g \quad (8)$$

where  $T_i^g$  represents a local zoning tax (Sturm et al., 2023).

We assume that all land is owned by residents, consistent with the majority (75%) of kampung dwellers reporting to be owners (see Section 2.2). Land rents are redistributed equally to all residents within each group through lump-sum payment  $\bar{r}^g$ .<sup>20</sup> This ensures that all the gains (producer and consumer surplus) are included in our welfare metric without having to separately account for absentee landlords.

### 7.3 General Equilibrium

An equilibrium is defined as a vector of endogenous objects  $(L_i^g, \lambda_i^g, h_i^g, r_i^g)$  such that the following conditions hold for all  $i$ :

- (i) **Location Choice:** The number of group  $g$  residents in each location,  $L_i^g$ , is consistent with location choice optimization (3):

$$L_i^g = p_i^g \bar{L}^g. \quad (9)$$

- (ii) **Land Use:** The share of land allocated to formal land use is consistent with developer optimization as per (7).

- (iii) **Profit Maximization:** Building heights  $h_i^H$  are consistent with profit maximization:

$$r_i^H = k_i \nu h_i^H (\nu - 1). \quad (10)$$

<sup>20</sup>Specifically we have:  $\bar{r}^g = \frac{\sum_i (1 - \tau_i^g) \pi_i^g \lambda_i^g T_i^g}{\bar{L}^g}$  with  $\tau_i^H = \tau_i$  and  $\tau_i^L = 0$ . Total income is thus  $Y_{ij}^g = (w_j^g / d_{ij}) + \bar{r}^g$ .

- (iv) **Floorspace Market Clearing:** Aggregate floorspace demand equates floorspace supply in each location:

$$\frac{L_i^s(1-\beta^s)\bar{Y}_i^s}{r_i^s} = \lambda_i^s \cdot T_i^s \cdot h_i^s \cdot \phi^s. \quad (11)$$

## 7.4 Calibration

To highlight the gains from lifting KIP at different distances from the CBD, similar to [Henderson et al. \(2020\)](#), we categorize Jakarta into 5 km-wide distance bands (indexed by  $I$ ). In each of the three innermost regions we have a non-KIP and a KIP counterpart and we use the outermost, non-KIP-only region for normalization, resulting in seven locations in total. We address robustness to the choice of spatial units in Section 7.6. Below, we outline the main data preparation steps, our approach to construct KIP counterparts, and key model parameters and assumptions. Further details are provided in the Appendix.

**Data preparation.** To take the model to the data, we need to observe formal *and* informal rents ( $r_i^s$ ), population, ( $L_i^s$ ), building heights ( $h_i^s$ ), and land shares ( $\lambda_i^s$ ) in non-KIP locations. We classify pixels as informal if the parcel density is in the top quartile (over 24 parcels per pixel) and define the informal land share  $\lambda_i^L$  accordingly. Similarly, we classify land values and heights observations to  $H$  or  $L$  based on parcel density. We then calculate rents ( $r_i^s$ ) using land values and heights to infer the value of the structure (see Section B.2.1). In order to disaggregate population by  $H$  and  $L$ , we predict the likelihood of living in an informal area using a battery of household characteristics from the Census, such as age, gender, education, marital status, migrant status, and being economically active. We define endogenous amenities  $Sh_i^H$  as the share of  $H$  types in each region, allowing for amenity spillovers to be common across the KIP and non-KIP portion in each region.

**Constructing KIP counterparts.** We construct KIP counterparts to match the reduced-form KIP effects for the center/middle/peripheral regions. This approach integrates the identifying assumption of the reduced-form that the estimated wedges between KIP and non-KIP are due to the policy and not to other differences. We interpret the KIP estimates as reflecting direct KIP effects on the own-region, without allowing for indirect effects such as sorting and spillovers involving the broader economy. For the sake of illustration, consider region  $I = Center$ . We take  $(L_i^s, \lambda_i^s, h_i^s, r_i^s)$  for  $i = (Center, NonKIP)$  from the data. For the KIP counterpart, we search for values of  $(L_{i'}^s, \lambda_{i'}^s, h_{i'}^s, r_{i'}^s)$  for  $i' = (Center, KIP)$  that satisfy equations (7), (9), (10), (11) in the Center, taking the endogenous variables in all other locations as given, and that generate the reduced-form wedges in log land values (column 1) and log heights (column 3) estimated in Table 2 for the

Center.

**Model-implied wedges.** Through the lens of the model, wedges in land values and building heights between KIP and non-KIP locations arise from differences in amenities ( $\bar{u}_i^g$ ) and formalization costs ( $\tau_i$ ). From the non-KIP data and the equilibrium conditions, we can infer how large the model-implied wedges in amenities and formalization costs have to be to rationalize the estimated KIP wedges in land values and heights. Following [Ahlfeldt et al. \(2015\)](#), amenities are identified (up to a group-specific constant) from the location choice condition, leveraging population and rents. We recover  $H$  ( $L$ )-type amenities to be high in locations we observe a high  $H$  ( $L$ )-type population density relative to local formal (informal) rents. We normalize amenities in the outermost region as 1. Formalization costs  $\tau_i$  are pinned down by relative formal and informal profits and land shares, rearranging equation (7). We discuss the recovered values for  $\bar{u}_i^g$  and  $\tau_i$  in Table B.1 in the Appendix.

**Parameters.** Table 7 describes the parameters. We set the commuting elasticity to  $\theta = 3$  ([Tsivanidis, forthcoming](#)). We match housing budget shares to those in the SUSENAS household survey for Indonesia. The values are comparable to other developing countries ([Balboni et al., 2020](#)). At baseline, we set the amenity spillover parameter  $\mu^H = 0.88$  ([Gechter and Tsivanidis, 2023](#))’s estimates for Mumbai and  $\mu^L = 0.3\mu^L$  in line with the gentrification literature (e.g. [Diamond \(2016\)](#), [Su \(2022\)](#).) We discuss robustness to these parameters in Section 7.6 and Table B.2. We set the amenity multiplier  $\rho_L = 1$  to normalize and  $\rho^H = 1.034$  ([Gechter and Tsivanidis, 2023](#)). Our results are robust to setting both to 1.

On the supply side, we set the cost elasticity with respect to heights as  $\nu = 1.69$  ([Sturm et al., 2023](#)), which implies a housing supply elasticity of  $\frac{1}{(\nu-1)} = 1.45$ . This closely aligns with [Henderson et al. \(2020\)](#) for Nairobi and is in the ballpark of other estimates (e.g. [Saiz \(2010\)](#), [Hebllich et al. \(2020\)](#)). For built-up coverage shares, we set  $\phi^H = 0.3$  throughout the city and  $\phi^L = 0.5$  (center and middle) and 0.3 (periphery). The values are consistent with [Henderson et al. \(2020\)](#) and our data. Our conclusions remain if  $\phi_i^L$  is constant. The profit shock dispersion  $\gamma$  governs how sensitive the land use choice is to relative profits, under a functional form assumption similar to [Gechter and Tsivanidis \(2023\)](#). We estimate it using the cross-elasticity of informal land shares to formal rents, from regression estimates with fixed effects and controls (see Section B.2.2). We recover  $\gamma = 1.91$ . Additional details and robustness are discussed in the Appendix.

**Data calibration.** We calibrate several parameters to match Indonesian/Jakarta moments. We set informal building costs  $\bar{c}^L$  at 200,000 Rupiahs (USD 12) per square meters from industry reports ([Nurdini et al., 2017](#)), but our results are robust to considering alternative values (see Section B.2.2 in the Appendix) and to assuming elastic heights in the informal sector, which does not rely on this

value. We recover model-implied wages  $w_i^g$  from population and employment using a commuting survey for Jakarta ([Gaduh et al., 2022](#)).

**Table 7:** List of parameters, estimation methods, and sources

Parameter	Description	Value	Source
$\theta$	Commuting elasticity	3	<a href="#">Tsivanidis (forthcoming)</a>
$\beta^H$	Housing budget shares	0.17	SUSENAS household survey ( <a href="#">Badan Pusat Statistik, 2008</a> )
$\beta^L$		0.13	
$\mu^H$	Amenity spillovers	0.88	<a href="#">Gechter and Tsivanidis (2023)</a> <a href="#">Diamond (2016)</a>
$\mu^L/\mu^H$		0.30	
$\rho^H$	Amenity multiplier	1.03	<a href="#">Gechter and Tsivanidis (2023)</a>
$\rho^L$		1	
$\frac{1}{(v-1)}$	Floorspace supply elasticity	1.45	<a href="#">Sturm et al. (2023)</a>
$\phi^H$	Built-up coverage shares	0.3	<a href="#">Henderson et al. (2020)</a>
$\phi^L$		0.5 (0.3 in Periphery)	
$\gamma$	Profit shock dispersion	1.91	Estimated from cross-elasticities of land shares to rents.

## 7.5 Counterfactuals

We now conduct counterfactual exercises to shed light on (i) what are the general equilibrium effects of lifting KIP today (ii) where the welfare gains are the largest and (iii) how to minimize losses for the  $L$  types.

### 7.5.1 Effects of lifting KIP everywhere

As a benchmark, we begin by considering a counterfactual where we lift KIP everywhere in the city. This amounts to setting  $(\bar{u}_i^g, \tau_i)$  in each KIP region to match the values in the corresponding non-KIP region. We present the results in Table 8, Panel A. We report percentage changes in  $\bar{U}^g$  by groups in columns 1 and 2 and a weighted average of the two in column 3. Overall,  $H$  types gain 4.4% and  $L$  types lose 1.4%, with the city as a whole experiencing welfare gains of 2.9% and a 2.4% population increase. Qualitatively, our findings are similar to those in [Gechter and Tsivanidis \(2023\)](#), who show that formal workers benefit from redevelopment whereas displaced informal residents are hurt. Our finding of city-wide gains associated with formalization also echo those in [Henderson et al. \(2020\)](#) for Nairobi.

Next, we assess the role of direct versus general equilibrium effects in explaining the welfare result. Considering direct effects, as KIP is lifted, the formal land share increases, formal rents fall and informal rents increase, benefiting  $H$  types and harming  $L$  types. Additionally,  $L$  types are displaced away from KIP regions to lower-amenity locations. Lifting KIP also entails reducing the

**Table 8: Effects of lifting KIP**

	H	L	All
<b>Panel A: City-wide</b>			
Welfare %	4.4%	-1.4%	2.9%
Population %	4.8%	-3.5%	2.4%
<b>Panel B: By Region</b>			
Welfare %			
Center	3.7%	-1.6%	2.3%
Middle	0.6%	-0.1%	0.4%
Periphery	0.1%	0.1%	0.1%

*L*-type exogenous amenities and enhancing *H*-type amenities, which exacerbates the effects above. We find that the direct welfare impacts of lifting KIP are 3.9% for the *H* types and  $-2.1\%$  for the *L* types, qualitatively and quantitatively close to the general equilibrium ones.

In general equilibrium, three additional forces come into play: residents resort across the city, from residence and workplace choice, and as a result end up facing different rents and employment income; prices in other regions respond as governed by the elasticity of housing supply; there will be in- and out-migration, with more *H* types moving into the city and *L* types leaving; and endogenous amenity spillovers will manifest, resulting in additional resorting and price effects. Put together, the direct effects are driving the overall welfare impacts.

### 7.5.2 Where to formalize

In Panel B of Table 8 we show that 79% of the gains stem from lifting KIP in the center. We consider three distinct counterfactuals whereby we lift KIP only in one region at a time. In the Center, the gains for the *H* types are the largest (3.7%) but so are the losses for the *L* types (-1.6%). On net, the city-wide effects from lifting KIP in the center (2.4%) are 79% of the effects from lifting KIP in the entire city. The key source of misallocation associated with KIP today is that the program is prevalent precisely in this part of the city.

The finding of greater formal gains and informal losses from lifting KIP in the center lines up with the monotonic pattern of larger reduced-form KIP estimates for the center, followed by the middle, then the periphery (see Table 2). In the model, the Center is where the wedge between formal and informal profits is the largest, resulting in larger gains from formalization. This is also where the *H* types receive the largest amenity boost from lifting KIP and the *L* types suffer the largest amenity drop. To corroborate this, we perform a placebo exercise in which we assume that the reduced-form wedges in land values and heights are the same across the three regions, as

opposed to monotonic. We set each to be equal to the area-weighted average of the three heterogeneous effects coefficients. We re-estimate the model and find that the gains from lifting KIP in the center are only 14% of the overall gains, instead of 79%. We also confirm that our baseline result of largest gains in the center is not mechanically generated by differences in the area sizes of the different regions.<sup>21</sup> Outside of the center, we find small city-wide effects from lifting KIP (0.4% and 0.1% respectively from lifting KIP in the middle or the periphery). This is notable since around half of the program area is in the middle and periphery and our calculations suggest minimal inefficiencies associated with slum upgrading in these areas.

### 7.5.3 How to formalize

Finally, we turn to the question of how to formalize in a way that balances equity and efficiency. In Table 9 we consider counterfactuals where we lift KIP from a smaller portion of the city and consider ways to minimize losses for low-income residents. In this context, lifting the KIP bundle can be thought of as the government easing restrictions to redevelopment associated with KIP, mediating with developers to facilitate land assembly. We provide two examples of policies that can be bundled with formalization to alleviate the losses of the  $L$  types while preserving sizable gains for the  $H$  types: one is to promote taller formal buildings, thus reducing the extent of displacement of the  $L$  types; the other is to redistribute land rents from  $H$  to  $L$  types.

Consider a scenario in which a quarter of KIP's land area in the center can be formalized (12 squared km). Lifting KIP restrictions would entail a loss for the  $L$  types. If this is bundled with a zoning policy allowing for taller formal buildings (which we implement in the model by boosting  $v$  by 25% or 35%), the  $L$ -type losses are attenuated and reversed, while the gains of the  $H$  types are also enhanced. Taller buildings allow total formal floorspace to increase and  $H$  share spillovers to be realized without displacing as many informal households.

An alternative way to alleviate the losses is to redistribute part of the land rents across groups. If the  $H$  types give up 5% of their lump sum  $\bar{r}^H$  and this is transferred to the  $L$  types, both groups gain. This abstracts from the institutional challenges and political economy considerations that make the implementation of these transfers difficult in practice.

## 7.6 Robustness

**Model parameters.** We perform several sensitivity and robustness exercises. In Table B.2 we present the welfare gains from lifting KIP everywhere under different assumptions concerning

<sup>21</sup>We do so by performing another placebo exercise in which we set the land area in each region to be the same. We continue to find that the majority of the gains stem from lifting KIP in the center.

**Table 9:** Balancing equity and efficiency

	H	L	All
Lift KIP	1.09%	-0.06%	0.77%
Lift KIP + zoning height boost ( $\Delta u = 25\%$ )	1.26%	0.00%	0.91%
Lift KIP + zoning height boost ( $\Delta u = 35\%$ )	1.32%	0.02%	0.96%
Lift KIP + redistribute 5% H rents	0.95%	0.15%	0.73%
Lift KIP + redistribute 10% H rents	0.81%	0.36%	0.68%

open versus closed city and endogenous amenity spillovers.

Assuming a closed city the results are qualitatively similar to baseline, but the gains are more muted as we do not allow  $H$  types to move in. Endogenous spillovers from  $H$  types appear to be important, in line with the findings of the literature (e.g. [Diamond \(2016\)](#)). Assuming no spillovers preserves the qualitative patterns but reduces the magnitudes of the gains for both types. This suggests that the strength of the spillovers from formal areas, in the form of non-excludable public goods or access to employment opportunities, is important to determine the effects of formalization on the poor. Naturally, the relative strength of the amenity spillover parameter for  $L$  types drives the magnitude of the  $L$ -type effects, with  $L$  types losing less if they benefit more from being close to  $H$  types.

**Variation from heights only.** We verified that our welfare conclusions are not driven purely by the wedges in land values, which could be measured with error. If we repeat our estimation assuming that the wedges in land values are flat across the three regions, whilst retaining the monotonic wedges in heights from center to periphery, we obtain a similar result that the majority of the gains stem from lifting KIP in the center.

**Elastic informal supply.** A concern with our findings is that the price response of the informal sector may be artificially large because of our assumption of fixed heights. In practice, in the informal sector quantity can respond ([Henderson et al., 2020](#)). We probe this by considering elastic informal supply, with a production function similar to that of the formal sector, but with a lower elasticity of  $\frac{1}{(v_L-1)} = 1.3$ , reflecting the estimates for the formal and informal sector in [Henderson et al. \(2020\)](#). Reassuringly, our estimated gains are similar to our baseline (3.4% city-wide gains from lifting KIP everywhere, with 85% of the gains coming from the center).

**Finer spatial units.** Our conclusion that the majority of the gains stem from the center is robust to considering sub-districts as our spatial units  $i$ . We include 21 that (i) have both a KIP and a non-KIP portion and (ii) have both formal and informal observations for land values and heights in each portion. We lose half of Jakarta’s sub-districts due to the sparseness of the data. Our key patterns of larger gains in the center are preserved and we also continue to find that the majority of



the gains are driven by direct effects.

## 7.7 Discussion

Put together, our welfare conclusions are suggestive that spatial misallocation is largely associated with KIP areas that are central. Indeed, a sizable share of the KIP program area is outside the center and we find limited gains from removing KIP in those areas. Below we discuss a number of caveats to our model.

First, our model does not feature a production sector where firms use land for commercial purposes. Second, our model assumes segmented housing markets and does not allow the  $L$  types to consume  $H$ -type housing. Relaxing this assumption would allow some of the  $L$ -types to share the formal gains by upgrading to formal housing and would plausibly lead to lower welfare losses for the  $L$  types. One way in which our model approximates these effects is in our counterfactual exercise where we share some of the formal land surplus with the  $L$  types. Future research could consider intergenerational effects on slum residents who become formal. To the extent that formalization continues to benefit the  $H$  types more in the center, our welfare conclusions would continue to hold in a richer model.

Finally, the model is static and our efficiency claims may not carry through to a dynamic setting. As long as the relative gains from formalizing the center will continue to be large, the presence of KIP in the center going forward will be inefficient in a dynamic sense as well. However, there could be a reversal if the center of Jakarta loses its primacy, for example as a result of natural disasters (e.g. flooding). Additionally, we note that our welfare exercise speaks to potential efficiency gains from lifting KIP today but cannot speak to the cumulative welfare effects of the KIP program overall. In order to assess whether it was *ex ante* dynamically inefficient, we would need to calculate the expected present discounted value of the flow of short-run KIP benefits on residents vis à vis the long-run gains from formalizing, which we cannot do without historical data on displaced residents.

## 8 Threats to identification and robustness

This Section discusses threats to the identification of our reduced-form estimates. We discuss potential confounding due to spatial spillovers, persistence, and endogenous sorting, and describe additional robustness checks.

## 8.1 Spillovers and BDD robustness

Below, we empirically assess the role of spillovers. Overall, there is suggestive evidence of spillovers but the patterns are not significant enough to change our conclusions.

Our setting is likely to feature spatial spillovers between treated and control areas. For example, our local KIP estimates may be biased by spillovers *from KIP to non-KIP* areas. These could take the form of negative externalities from slums (e.g. from unsanitary living conditions or crime), leading to underestimating the KIP effects, or positive externalities from the KIP upgrades, leading to overestimates. The latter seem unlikely given our findings from Section 6.3 above, where we show no differential KIP effects by access to the initial KIP upgrades (Table 6). Additionally, there could be spillovers *from non-KIP to KIP*, in the form of positive externalities from gentrified areas (e.g. from access to jobs or public goods), also leading to underestimating the KIP effect.

**Spatial decay on both sides of KIP boundaries.** Figure 3 investigates the extent of spillovers by analyzing patterns of spatial decay, under the premise that localized exposure effects should decline with distance (Turner et al., 2014, Anagol et al., forthcoming). We focus on distance bands of up to 500 meters.<sup>22</sup> We employ a similar specification as our BDD analysis, replacing distance to the KIP boundary with dummies for different 100 meter-wide distance bins. The spatial decay patterns for land values, heights, and parcel density remain relatively stable, albeit with wide confidence intervals. We do not detect a significant enough pattern that can materially change our conclusions.

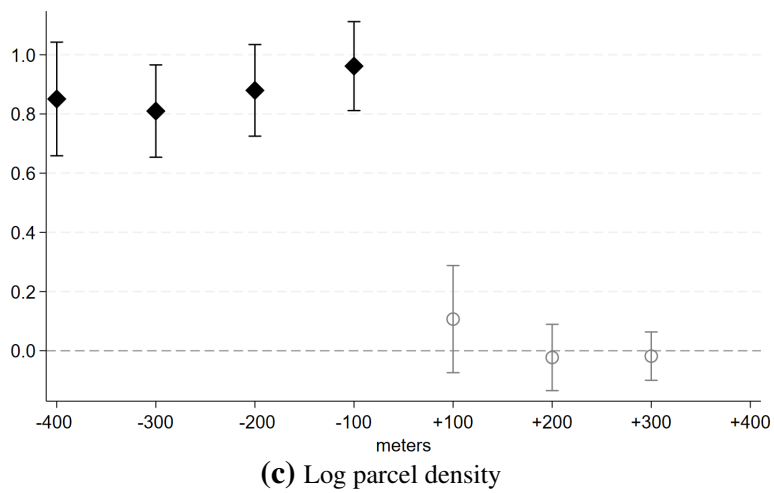
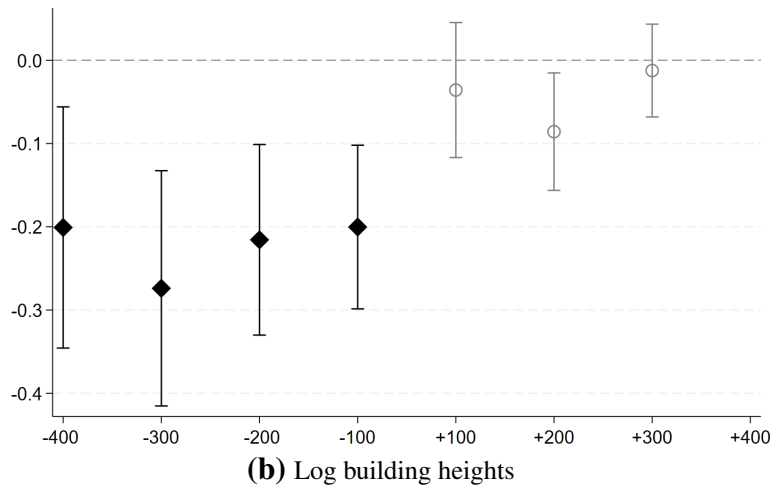
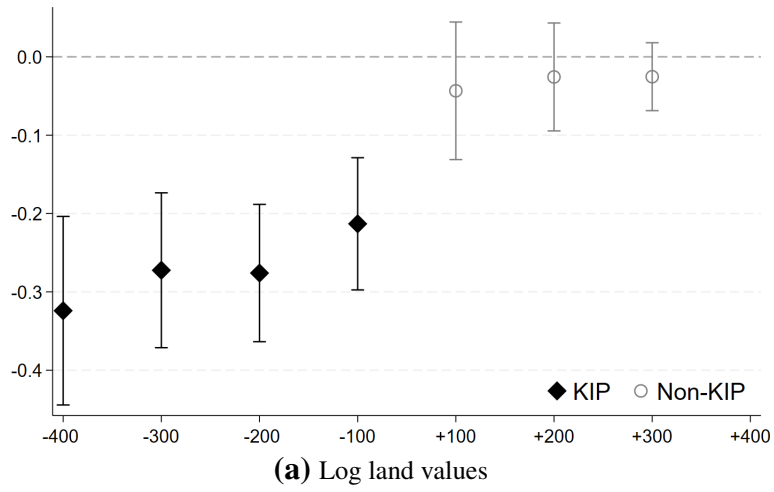
**Spatial decay from non-KIP slums.** We further probe the concern that our estimates may be biased by negative externalities from slums by considering spatial decay away from non-KIP slums (which cannot be confounded by the program) that have high population density (thus more likely to generate congestion externalities). Figure A8 shows limited evidence of spatial decay on land values and heights, conditional on our controls. There is a slight pattern of higher parcel density near the boundary, which is suggestive of negative spillovers, but the confidence intervals are large. Overall, we find limited scope for negative spillovers from slums. This is consistent with the prominence of gated communities in formal neighborhoods and the moderate crime levels in Jakarta. This finding also addresses the concern that lower land values in KIP may be driven by congestion and higher density alone, regardless of delayed formalization.

**BDD robustness.** In line with the spatial patterns above, Table A5 shows that our BDD estimates are similar if we consider alternative buffer distances (the optimal bandwidth as per Calonico et al.

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<sup>22</sup>Our automated procedure which assigns observations to the closest boundary results in a majority of treated observations being within 500 meters of KIP boundaries. We also consider spatial decay all the way to 1000 meters and our conclusions remain the same. Empirical estimates from the urban literature suggest spillovers decay relatively sharply within 500 meters and tend to dampen out beyond 1000 meters (Diamond and McQuade, 2019, Rossi-Hansberg et al., 2010, Autor et al., 2014, Campbell et al., 2011).

**Figure 3: Spatial decay: distance from KIP boundaries**



Notes: We employ a similar specification as our BDD analysis in Table 1, but replace distance to the KIP boundary with dummies for 100m-wide distance bins, pooling the two outermost bins for 400m and 500m.

(2014) and 500 meters). Table A6 shows that our BDD estimates are also robust to excluding boundaries that overlap with historical and contemporaneous waterways and roadways.

## 8.2 Persistence

Next, we consider the role of persistence in pre-KIP differences. Formally, assume that unobserved quality in pixel  $i$  in neighborhood  $j$  evolves according to the following process:  $\xi_{ijt} = \rho \xi_{ij,t-1} + u_{jt} + \varepsilon_{ijt}$  where  $\rho < 1$ ,  $u_{jt}$  is a contemporaneous neighborhood component, and  $\varepsilon_{ijt}$  is a mean 0 idiosyncratic shock. To trace back to pre-KIP differences, let the beginning of KIP be  $t = 0$  and modern Jakarta be 40 years later. The potential selection bias comparing KIP ( $K$ ) and non-KIP ( $NK$ ),  $E(\xi_{ijt}|K_{ij}, \mathbf{X}_{ij}, \delta_j) - E(\xi_{ijt}|NK_{ij}, \mathbf{X}_{ij}, \delta_j)$ , can be expressed in two components stemming from pre-KIP factors and contemporaneous factors. Our identifying assumption is that both components are small conditional on granular fixed effects ( $\delta_j$ ) and controls ( $\mathbf{X}_{ij}$ ):

$$\underbrace{\rho^{40} [E(\xi_{ij0}|K_{ij}, \mathbf{X}_{ij}, \delta_j) - E(\xi_{ij0}|NK_{ij}, \mathbf{X}_{ij}, \delta_j)]}_{\text{Muted impact from pre-KIP differences}} - \underbrace{[E(u_{jt}|K_{ij}, \mathbf{X}_{ij}, \delta_j) - E(u_{jt}|NK_{ij}, \mathbf{X}_{ij}, \delta_j)]}_{\text{Common shocks are differenced out}}$$

Below we examine several dimensions of historical neighborhood quality: whether a neighborhood was a kampung initially, which could confound our full sample and BDD estimates, and initial population density, which was part of the program selection rule. In line with the literature on persistence in cities (e.g. [Ambrus et al. \(2020\)](#), [Bleakley and Lin \(2012\)](#)), we find evidence that historical conditions matter, but are unlikely to explain our results.

**Persistence of slums.** Table 10 presents a falsification test to address potential confounding of our BDD estimates due to the generic persistence of slums. We implement a specification similar to our BDD one, but we consider historical slum boundaries in non-KIP areas as placebo borders. Specifically, we include non-KIP observations that are within 200 and 500 meters of a historical kampung boundary. This yields 45 and 41 boundary segments respectively.

If historical slums have persistently lower land values, we should find a negative and significant effect when we compare areas that were historical kampungs against areas that were not. Instead, we find an insignificant effect, both within a 200 meter and a 500 meter distance band. The limited evidence of a historical slum effect at the boundary is in line with our finding of limited decay in land values away from dense slums presented in Section 8.1 (Figure A8). We caveat that in the exercises above we are considering non-KIP slums, that were higher-quality initially than KIP slums. We did not collect photos for heights around the placebo boundaries.

**Persistence of historical density.** Table A7 explores the role of pre-KIP population density, one

**Table 10: Effect of placebo boundaries**

Dependent variable:	Log land values	
	BDD 200m	BDD 500m
Sample:	(1)	(2)
Kampung	-0.03 (0.10)	0.09 (0.07)
N	1793	2631
R-Squared	0.50	0.50
Control Group Mean	15.28	15.32
Infrastructure	Y	Y
Topography	Y	Y
Landmarks	Y	Y
Distance to boundary	Y	Y
Geography FE	Boundary	Boundary

\* 0.10 \*\* 0.05 \*\*\* 0.01

Notes: This table reports the effect of placebo kampung boundaries on land values, where the key regressor is the historical kampung indicator. The sample includes sub-blocks that are not in KIP and are within 200 (500) meters of a historical kampung boundary for column 1 (2), conditional on 45 (41) historical kampung boundary fixed effects. Both control for quadratics in distance to the nearest historical kampung boundary. Standard errors are clustered by boundary.

of the criteria in the scoring rule. We observe 1960 population at the locality level from the Census and define a dummy for localities in the top two densest quintiles. Consistent with crowding and persistence, land values are lower ( $-0.13$ ) in historically denser places (column 2). The KIP effects on land values and heights, however, remain stable with or without controlling for historical density, suggesting the potential bias from historical density is muted.

**Crowding over time.** Table A8 investigates whether KIP caused crowding by considering the KIP effect on decadal population density. We find a pattern suggestive of population density in KIP increasing over time, but the coefficients are not statistically significant.

**Historical land institutions.** A potential concern with our comparisons is that, historically, KIP and non-KIP areas may have been differentially titled. In our historical kampung specification, we only restrict the comparisons to (informal) kampungs, so both KIP and non-KIP were likely comparable. The historical maps we use classify kampungs differently from “beboude kom” or “built-up” settlements that were titled under the Dutch cadastral system. As an additional check, in Table A9, we exclude all hamlets that have any “beboude kom” areas (a proxy for historical titling rates) and, reassuringly, our results are similar.

### 8.3 Endogenous sorting

We consider endogenous population sorting into KIP as a potential confounder. Using data on 10 million individuals in the 2010 population census, our tests suggest that compositional differences that could arise due to endogenous sorting are unlikely to explain our findings. If anything, educational attainment is slightly higher in KIP (Table A10), which tends to go against the lower land values in KIP. These results corroborate the conclusions in [World Bank \(1995\)](#) that “KIP did not disturb the existing residential stability of the kampungs” and that “residents are ... better educated and healthier” (p. 6).

### 8.4 Other robustness checks

**Selection for development activity and land values.** We consider selection into development activity stemming from the fact that the potential for building high-rises depends on zoning regulations and market access. Table A11 shows that the results for building heights survive after dropping pixels with parks and large roads (columns 1 through 3) or restricting to pixels within 1000 meters of pre-determined historical main roads, as a proxy of market access (columns 4 through 6).

Table A12 considers selection into our land values dataset by KIP status, showing that KIP areas are not underrepresented. If anything, KIP pixels in the full sample are 3% more likely to have an assessed land value observation. In the historical sample the percentage is 4%.

**Standard errors robustness.** We replicate the specifications in Table 1 using [Conley \(1999\)](#) standard errors with a radius of 200 meters, 500 meters, up through 1200 meters. The p-values for the KIP treatment effect are all below 2% and our conclusions under alternative standard errors specifications are unchanged.

## 9 Conclusion

We study one of the world’s largest slum upgrading programs, the 1969-1984 Kampung Improvement Program, which upgraded slums for 5 million residents and covered 25% of land in Jakarta. On average, KIP areas have lower land values in 2015, shorter buildings and are more informal. The negative effects are largest within 5km of the CBD. We develop a spatial equilibrium model to quantitatively assess the role of slum upgrading in influencing spatial misallocation of land, finding that 79% of the welfare gains from removing KIP are associated with land close to the CBD. Elsewhere, removing KIP has minimal welfare implications.

Our findings deliver policy-relevant lessons for developing countries facing massive urbanization with severe shortages in housing. As cities are reshaped to accommodate urban growth (Harari, 2020, Lall et al., 2021), policy makers debate how to allocate land and where to upgrade and preserve slums, as well as how to alleviate losses to displaced residents.

There are several avenues for future research. Future work can be directed to comparing slum upgrading versus other shelter policies, such a public housing or sites and services. There are also open questions on how to design slum upgrading, including whether to bundle upgrades with titles and person-based as opposed to place-based approaches. More research is needed to understand how policy makers should trade-off the short-run benefits of upgrades and long-run opportunity costs from delayed formalization. Finally, it will be important to investigate the human capital implications and inter-generational spillovers for the beneficiaries of slum upgrading programs.

**Data availability statement:** The data and code underlying this research is available on Zenodo at <https://doi.org/10.5281/zenodo.15678041>.

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