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Tenure Security Premium in Informal Housing Markets

A Spatial Hedonic Analysis

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Abstract

This paper estimates slum residents' willingness to pay for formalized land tenure in Pune, India. In so doing, it offers evidence that the legal assurance of slum residents' occupancy of their lands could benefit them. Previous studies have discussed legal and non-legal factors that substantially influence the tenure security of residents in informal settlements. However, it remains unclear to what extent, and how, the assignment of legal property rights through the formalization of land tenure improves the tenure security of residents in informal settlements and living conditions, even in the presence of other legal and non-legal factors that also contribute to their tenure security. To address the question, this study focuses on the city of Pune, India, where government agencies have formalized slums by legally ensuring the occupancy of the residents under "slum declaration." Applying a hedonic price model to an original household survey, this paper investigates how slum residents evaluate formalized land tenure. A spatial econometrics method is also applied to account for spatially autocorrelated unobserved errors. The spatial hedonic analysis finds that the premium of slum declaration is worth 19 percent of the average housing rent in slums. The associated marginal willingness to pay is equivalent to 6 percent of the average household expenditure, although it is heterogeneous depending on a household's caste and other legal conditions. This finding suggests that the assurance of occupancy rights is a vital component of land-tenure formalization policy even if it does not directly provide full property rights.

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Tenure Security Premium in Informal Housing Markets: A Spatial Hedonic Analysis

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1 Introduction

An unprecedented scale of urbanization has brought about challenges for urban planning in the Global South. Due to the persistent and insufficient supply and stock of affordable housing in the formal housing markets, a vast number of people currently live in informal settlements with substandard housing and inadequate access to infrastructure and basic services. According to the United Nations, 33% of the urban population in developing regions, or 863 million people, lived in informal settlements as of 2012 (United Nations, 2012). These people, who often occupy land owned by others and/or land reserved for other uses, tend to be vulnerable to the threat of eviction. On the other hand, a bulk of residents in informal settlements—despite the lack of legal status in their occupancy—somehow stay free from the threat of eviction. Those residents who enjoy such *de facto* tenure security have incrementally consolidated their houses and improved their living environments. It is not rare that those people trade such invested houses in informal housing markets, where property rights are not enforced by laws and the state.

Previous studies have discussed legal and non-legal factors that substantially influence the tenure security of residents in informal settlements and their housing investment behaviors. A strand of economics literature posits that the assignment of legal property rights through the formalization of land tenure enhances the tenure security of residents in informal settlements and stimulates their housing investment (Demsetz, 1967; World Bank, 1993; Field, 2005; Galiani and Schargrodsky, 2010). In particular, the assignment of legal property titles is expected to expand the financial capacity of residents in informal settlements by allowing them access to formal credit (de Soto, 2000). As reviewed by Payne et al. (2009), little empirical evidence has corroborated this hypothesis. Another line of literature emphasizes that a variety of non-legal factors significantly shape the tenure security of residents in informal settlements and the enforcement of their property rights (Doebele, 1987; Varley, 1987; Razzaz, 1993; Lanjouw and Levy, 2002; Payne, 2002; Nakamura, 2016). A key question that remains unclear is to what extent, and how, legal land tenure improves the tenure security of residents in informal settlements and living conditions, even in the presence of other legal and non-legal factors that also contribute to their tenure security.

In order to address the empirical question above, this paper investigates how residents in informal settlements evaluate the benefits of legal land tenure in light of their tenure security and property rights. For this purpose, this research focuses on Pune, India, where a third of its population of three million currently reside in informal settlements, or slums[1] (MASHAL, 2011; Pune Municipal Corporation, 2013; Government of India, 2013). Government authorities have formalized about half of the slum settlements in the city under the state-level

policy of "slum declaration." Similar policies are implemented under the name of "slum notification" in other parts of India, as well. This formalization of land tenure differs from common titling programs that provide full property title; slum declaration only guarantees the occupancy of slum residents and their entitlement to basic services. Even in formalized or "declared" slums, people have no legal basis in other bundles of property rights, such as the right to develop, inherit, sell, lease, or mortgage their houses. This characteristic of slum declaration offers a researcher an opportunity to examine whether the legal assurance of occupancy rights, rather than the provision of a full bundle of property rights, can benefit slum dwellers.

For the empirical investigation, this paper assesses the slum residents' willingness to pay for the benefits of slum declaration. Applying a generalized spatial two-stage least square (GSTSLS) model developed by Kelejian and Prucha (1999) and Kelejian and Prucha (2010), this paper develops a spatial hedonic model to identify and estimate the premium captured in housing rent in the informal housing market. Accounting for spatial autocorrelation and heterogeneity, as well as a host of housing, slum, and locational characteristics, the model makes it possible to reveal the tenure security premium associated with slum declaration status. Based on the identification strategy proposed by Bajari and Benkard (2005) and Bajari and Kahn (2005), this paper then explores the heterogeneity of the estimated marginal willingness to pay (MWTP) depending on household characteristics.

This paper draws on rare datasets that help to adequately take into account the legal, social, political, and geographical factors that are deeply embedded in the local contexts. The primary data source is a household survey conducted by the author in 2013. The surveys were collected from 562 slum households that represent the slum households in the entire city of Pune. This paper also retrieves slum-level information from the *Pune Slum Atlas*, prepared by the Maharashtra Social Housing and Action League, or MASHAL (MASHAL, 2011), and combines it with the household survey data. The dataset, constructed in this way, contains information about detailed housing, households, and slum and locational characteristics.

The series of analyses performed in this paper clarify that even in the presence of other legal and non-legal factors, slum residents highly evaluate the benefits from slum declaration as to what improves their tenure security. The hedonic analysis reveals that slum declaration status is associated with approximately 19% of the average housing rent in Pune's slums. The estimation result is robust against a bias stemming from spatial effects and selectivity in survey responses. The calculated MWTP is 600 Indian rupees, which is equivalent to approximately 6% of the average monthly expenditure of slum households in Pune. This is a strong premium, considering that a majority of slum residents enjoy *de facto* tenure security to some degree, as demonstrated by their fairly long average duration in their current

residences (32 years). The estimated MWTP is heterogeneous, depending on a household's caste and other legal conditions.

The empirical evidence this paper offers is particularly important for two reasons. First, the findings underline the benefits of the legal assurance of occupancy rights in informal settlements, even in the absence of the full legal property rights. As stated in recent reviews by Payne et al. (2009) and Marx et al. (2013), quantitative evidence about the link between land tenure, tenure security, and housing outcomes in informal settlements has been scarce. Field and Kremer (2005) rely on a quasi-experimental situation in Peru to identify the causal link, confirming that the provision of property titles has stimulated housing investment in informal settlements. Galiani and Schargrodsky (2010) also reached similar conclusion in Buenos Aires, Argentina. A study of informal settlements in Ecuador by Lanjouw and Levy (2002) illuminates that informal property rights that enable residents to transfer their housing also play a key role. In the Indian context, Nakamura (2014) suggests a positive linkage between slum notification and the amount of housing investments by slum residents. Closely related to this study is Nakamura (2016), which shows that slum declaration, among other legal and non-legal factors, influences slum residents' perceptions about property rights in Pune. The present paper advances Nakamura (2016) by revealing the extent to which slum residents value such slum declaration in Pune.

Second, this paper demonstrates the effectiveness of spatial hedonic analysis as a useful tool to explore the complex contexts of informal settlements. Despite the prevailing popularity and advancement of hedonic analysis methods in academic literature, only a few studies have applied the methods to informal settlements in the developing world due in part to data availability (for example, Daniere, 1994; Friedman et al., 1988; Jimenez, 1984; Crane et al., 1997; Kaufmann and Quigley, 1987; Jimenez, 1983). The application of spatial econometrics models (Anselin and Lozano-Gracia, 2008; Koschinsky et al., 2012) or spatial hedonic models (Anselin, 1988; LeSage and Pace, 2009; Anselin et al., 2010) to housing in informal settlements remains especially rare to date. By taking advantage of the recently developed GSTSLS model (Kelejian and Prucha, 1999, 2010), this paper successfully deals with spatial autocorrelation and heterogeneity. Spatial hedonic analysis can become an even more effective tool for the analysis of living conditions and policy prescriptions than ever, as the enumeration of the residents in informal settlements and the preparation of spatial data in slum settlements are becoming popular practices (UN-Habitat, 2010).

The remainder of this paper is structured as follows: Section 2 introduces the regional background with a focus on slums in Pune. Section 3 discusses a theoretical framework concerning the link between property rights and other tenure security factors. This paper hypothesizes that housing rent in declared slums is higher than in non-declared slums, with

a control for other characteristics. Section 4 is about the empirical strategy of this paper and explains data and statistical models. This section develops a spatial hedonic model by presenting the basic framework of hedonic analysis and a spatial econometrics model. Section 5 reports the estimation results of the models. Section 6 concludes.

2 Background

Located 90 miles southeast of Mumbai, Pune is the second largest city in the state of Maharashtra and the ninth largest Indian city, with a population of more than three million (Government of India, 2013). Unlike landlocked Mumbai, Pune has been growing outward in a relatively monocentric form, from the old city area to the inner and outer suburbs (Pune Municipal Corporation, 2013). The city is divided into 14 administrative wards; the municipal government (the Pune Municipal Corporation, or PMC) opens its branches in each.[2,3] In addition, the city of Pune consists of 76 electoral wards, from which a pair of male and female municipal councilors (municipal corporators, or *nagarsevak* in Marathi) is elected through direct election every four years. In tandem with the rapid population growth of the city, slum population increased from 36,725 (7% of the city's total population) in 1951 to 274,000 (23%) in 1976, and to 1,050,000 (39%) in 2001 (Bapat, 2004). Currently, 5.25 square kilometers of slum area, which accounts for only 2.3% of the total area in the city, accommodate more than 200,000 households (Figure 1) (MASHAL, 2011).

(Insert Figure 1 here)

Based on the Maharashtra Slum Areas (Improvement, Clearance, and Redevelopment) Act (henceforth, the Slum Act), government agencies have identified 477 slum pockets in Pune. The Slum Act defines a slum based on its poor living environment and as any area that "is or may be a source of danger to the health, safety or convenience of the public of that area or of its neighborhood, by reason of the area having inadequate or no basic amenities, or being insanitary, squalid, overcrowded or otherwise" (Government of Maharashtra, 1971). In its planning document, the Pune Municipal Corporation describes slums in the following three categories (Pune Municipal Corporation, 2013): The first type of slums are those located in the core city area. Poor people settled in these areas back in the 18th century, and these settlements later turned to slums. The second type of slums exist in today's inner suburb areas. As the city grew in size, migrants settled in the areas outside the core city area in order to take advantage of good employment opportunities and available vacant land. Extraordinarily huge slum agglomerations have developed in the Parvati Hill and Yerwada

areas. The third type of slums are located in the outer suburbs, where people squatted on government-owned vacant land parcels and/or near industrial and information technology (IT) growth centers.

Land ownership, land tenability, and land tenure (i.e., slum declaration status) are the main factors that constitute the legality of slum settlements. According to MASHAL (2011), 356 slums, or three-fourths of the total number of slums in the city, are located on privately owned land, while the rest stand on land belonging to local or state government authorities (84 slums, or 18%) and central government agencies (37 slums, or 8%). Although 78% of slums are located in zones designated by Pune's master plan as areas where residential activities are permissible,[4] the other slums exist in areas particularly prone to eviction and relocation, such as those along railway tracks, rivers, and on slopes of hills.

Based on the Slum Act, government authorities have formalized some slum settlements by declaring them as slums primarily in order to deliver basic services. In those declared slums, residents are legally protected from forced eviction without due legal process and compensation. It is well known that a vast number of buildings in non-slum settlements violate planning and building regulations. Government agencies have formalized unauthorized colonies in an inconsistent way in Delhi, Mumbai, and other major Indian cities (Bhan, 2009; Roy, 2009; Zimmer, 2012; Anand and Rademacher, 2011). Similarly, the ambiguity in the definition of a slum appears to have resulted in the ad hoc declaration of slums in Pune. Among today's 238 declared slums, the majority of them were formalized around the mid-1980s (MASHAL, 2011). The State Government of Maharashtra has suspended the declaration of new slums since 1995, except for some unique cases.

Another legal condition that forges the legality of slum dwellers in Pune is the so-called cut-off date criteria. The State Government of Maharashtra has set up the cut-off date in order to distinguish who is eligible for basic services and who is not. The cut-off date has been extended several times, and the current cut-off date is set to January 1, 1995.[5] Slum dwellers that arrived in their current residences prior to the cut-off date AND possess valid residential proofs concerning the cut-off date are eligible to receive basic services. Moreover, they are allowed to participate in the slum redevelopment program, the Slum Rehabilitation Scheme (SRS), initiated by the state government in the 1990s. Each participant can obtain a room in a redeveloped building, *in situ* or another place, free of cost. The government cross-subsidizes private developers that engage in slum redevelopment by easing the floor area ratio on the site and allowing the transfer of the development rights to the other sites. The implementation of the program has been slow, however. According to a recent report by Bapat (2012), only 1,745 households have been rehoused under the SRS in Pune.

Tenure security conditions in Pune slums are mixed. On one hand, the risk of forced

eviction remains a threat to some slum dwellers. As mentioned in Nakamura (2016), 9% of the surveyed 562 households had moved to their current residences as a result of eviction from previous residences; 8% of respondents had been asked to move out of their current residence; 8% of respondents recognized litigation filed by landowners against their occupation; and 4% of respondents had witnessed their neighbors being forcibly evicted during the last 10 years. However, although residents of non-declared slums have no legal basis for their occupancy in the slums, many of them enjoy *de facto* tenure security to some degree. Despite a lack of legal eligibility, a number of residents in non-declared slums have access to basic services provided by the municipal government.

As with other cities in developing countries, functional informal housing markets have been established in Pune slums. Housing quality in Pune slums has been improving over the last decades. Given the limited outreach of government assistance for housing provisions, these improvements should be primarily attributed to slum residents' own efforts. A key role of government has been instead slum declaration and the delivery of basic services. In the meantime, the trading of housing frequently takes place in informal housing markets. According to the survey of 562 slum households for this study, approximately 23% of households purchased their current housing from previous residents in Pune slums. Tenants who pay rent for housing constitute approximately 10% of slum households in the city. The next section discusses property rights and tenure security in informal settlements, which contribute to the establishment of such informal housing markets.

3 Theory and Hypotheses

Property Rights and Tenure Security

Previous studies have considered property rights an essential determinant of tenure security in informal settlements. Although it remains an ambiguous concept in academic literature (see a review by van Gelder, 2010), tenure security, in its minimum definition, is the risk of—or the protection from—forced eviction without due legal process and compensation. The assurance of tenure security is a vital need for residents of informal settlements. Theoretically, insufficient tenure security discourages investment in assets, notably housing, by the residents of informal settlements who would otherwise have the motivation and capacity to do so (Turner and Fichter, 1972). Among various factors that contribute to the level of tenure security, a strand of economics theory has focused on property rights. The increased attention to the role of property rights corresponds to the shift in development policies, from

program-based approaches (e.g., sites-and-services) to an emphasis on institutional reforms (i.e., enabling approach) (Buckley and Kalarickal, 2006). Although a number of empirical studies have investigated the role of property rights as the driver for investment in rural areas as reviewed by Arnot et al. (2011), rigorous research in the context of informal settlements in urban areas remains scarce.

Property rights determine the scope of potential housing activities. A property right is commonly defined as "a claim to a benefit (or income) stream that the state will agree to protect through the assignment of duty to others who may covet, or somehow interfere with, the benefit stream" (Bromley, 1991, p.2). This definition highlights that property rights are enforceable, meaning that the holder can command state or other authority structures to exclude others. Property rights involve a bundle of rights, including rights to use, occupy, develop, inherit, lease, sell, and mortgage. Aside from the formal property rights backed up by the law, people often enjoy informal property rights that are enforced by means other than those that are legal. For instance, Jha et al. (2007) notes that housing transactions in Delhi slums take place in front of a group of neighbors who serve as witnesses.

What remains unclear is which components among the aforementioned set of property rights, formal or informal, are profoundly tied to the level of tenure security and the incentive for housing investment. Based on the associated bundle of property rights, land tenure is classified into those with only limited bundles available (e.g., the group of pavement dwellers, squatters, and tenants in squatter settlements) at the one end and those with full property rights (e.g., freeholders) at the other end (Payne, 2001; Durand-Lasserve and Selod, 2009). Conceptually, the level of tenure security may vary when corresponding to such available sets of property rights.

Given the prevalent risk of forced eviction, occupancy or use rights are particularly important in the context of informal settlements. In this regard, slum declaration in Pune, or slum notification in other parts of India, may be a crucial land tenure status for slum residents. Under the Slum Act in Maharashtra, occupancy of the land is legally guaranteed in declared slums, while ownership of the land remains in the hands of the original owners. Residents of declared slums are permitted to build housing made of non-permanent materials within a height of 14 feet. However, they have no legal right to transfer such housing to others. When relocation is inevitable for infrastructure development or other public purposes, governments are required to pay compensation and/or provide alternative accommodations to the affected households in declared slums.

Other Legal and Non-Legal Tenure Security Factors

In the real world, various factors other than land tenure substantially affect slum residents' legal tenure security in informal settlements. In the case of Pune, slum residents who possess valid documents that prove their current residence as of the cut-off date can receive basic services and participate in slum redevelopment programs. Government agencies have issued specific documents for this purpose, known as "photo-pass," though only a limited number of photo-passes have been distributed. Government employees, in practice, accept other documents as well, including ration cards, tax and utility bills, and birth certificates. Possession of such residential proofs greatly improves tenure security by helping slum residents resist forced eviction or at least helps them negotiate for alternative accommodations. However, obtaining these documents without having to resort to support from middlemen and politicians is still a challenging task for new migrants (Kumar and Landy, 2009; Rao, 2013).

A body of literature has pointed to the fact that residents of informal settlements enjoy moderate tenure security irrespective of their legal status (Doebele, 1987; Varley, 1987; Razzaz, 1993; Lanjouw and Levy, 2002; Payne, 2002). Those studies call attention to factors contributing to the formation of such *de facto* tenure security. Examples of non-legal factors pointed out by the literature are the duration of residence, the size of informal settlements, and the location of the settlements. As households continue to stay in the same residences for a longer period of time, their occupancy tends to gain some legitimacy and is more likely to be tolerated by governments and landowners. In addition, those households become more confident about their tenure security. The level of tenure security tends to be higher in larger sized informal settlements because it makes it physically, economically, and politically difficult for landowners and governments to evict them. Finally, those who occupy land in locations attractive for real estate development are likely to face the intense pressure of eviction.

The provision of infrastructure and basic services also improves the tenure security of residents in informal settlements. Although the installment of basic amenities itself does not necessarily legally guarantee their occupancy of the land, it could significantly improve their *de facto* tenure security of informal settlement residences. In the case of Pune, a vast number of residents in non-declared slums have access to basic services provided by the municipal government. Receiving water supplied by the municipal government also opens up a chance for them to gain legal tenure security. Many slum residents properly pay a water tax (1 Indian rupee per day, or 365 rupees per annum), and they strategically keep the bills as residential proof in order to demand compensation in case the government enforces relocations.

Another important resource for the survival of the urban poor in Indian cities is political

patronage. In major Indian cities, the population of slums accounts for a significant portion; for example, one-third of the population of the city currently live in slums in Pune. In view of such *en masse* voting power held by slum residents, local politicians have favored them through informal arrangements for secure tenure and access to basic services (Benjamin, 2008). For this reason, the declaration of new slums tends to take place in time with elections (Anand and Rademacher, 2011). Even in non-declared slums, local politicians extend informal protection to the residents by pressuring local bureaucrats to tolerate their occupancy and provide basic services.

Hypotheses

Acknowledging the variety of legal and non-legal tenure security factors above leads to the question of whether and to what extent slum residents evaluate formalized land tenure and what improves their tenure security and property rights. On one hand, slum dwellers may greatly value living in declared slums. Those who would otherwise face the risk of forced eviction benefit from the declaration of their settlements. Even if other legal and non-legal factors already shape tenure security to some degree, slum declaration could render the residents even more confident that they can claim their occupancy. On the other hand, slum residents may not value slum declaration in some cases. Socially and economically disadvantaged households may not enjoy the benefits of slum declaration due to the lack of capability to do so. Also, slum dwellers might be indifferent to the declaration status of their settlements if they have already enjoyed a high level of *de facto* tenure security. In view of slum declaration in Pune as a land tenure formalization with the legal assurance of occupancy rights, I hypothesize that, all else being equal, slum dwellers in Pune positively value the benefits of slum declaration even if other legal and non-legal factors also contribute to their tenure security. The degree of the evaluation, however, must vary depending on the level of tenure security enjoyed by the households based on factors other than slum declaration.

I examine the above hypotheses by taking advantage of the informal housing market in Pune slums in which housing transactions frequently take place. If people value the benefits of slum declaration and are thus willing to pay an additional cost for it, housing rent in declared slums should reflect the tenure security and property rights premium. Thus, housing rent in declared slums must be higher than in non-declared slums, controlling for housing, slum, and locational characteristics. The next section explains how to estimate such premium based on a hedonic approach. In testing the hypothesis above, the challenge is to extract the tenure security premium tied to slum declaration. I emphasize here that

this cross-sectional study does not aim to estimate the causal effect of slum declaration on tenure security or housing outcomes. Estimating the causal effect of slum declaration as the value reflected in housing rent would result in an underestimation if I statistically control the current housing conditions and the accessibility to basic services. This is because these variables have already been affected by slum declaration. Nevertheless, this study offers enlightening insight as to how slum dwellers evaluate the current benefit of slum declaration for their tenure security.

4 Methodology

Data

This paper relies on household surveys collected in the city of Pune in 2013 by the author. Based on a two-stage random sampling scheme, 56 slum settlements are randomly chosen out of the 477 slums listed in MASHAL (2011). Black dots in Figure 1 indicate the surveyed slums. From each of the selected slums, 10 households are randomly selected as respondents for the survey, amounting to 562 total respondents.[6] The survey includes questions about a variety of household and housing characteristics. Surveyors visit respondents, read aloud the questionnaire in either Hindi or Marathi, a local language spoken in Maharashtra, and write down answers on behalf of them. The locations of surveyed households are recoded in longitude and latitude by referencing the geographic information system (GIS) maps in MASHAL (2011) and Google Earth satellite images. In addition, I retrieve slum-level information from MASHAL (2011) and combine this with the survey data.

Table 1 reports summary statistics for housing, household, and slum and locational characteristics.[7] While 72 respondents currently pay monthly rent for their housing, the other households pay no rent. The survey asks the latter group of households to figure out the amount of money other people would pay for the monthly rent. Recovering imputed rent in such a manner is a common practice in hedonic literature (Malpezzi, 2003). Among the total of 562 respondents, 84 households do not report the amount of rent. The influence of omitting those households who do not report rent is assessed as a robustness check against a sample selection bias at the end of Section 5. The average of the reported monthly rent is 3,128 rupees, which is worth one-third of the average monthly household expenditure (9,868 rupees).[8]

(Insert Table 1 here)

The data contains information about a variety of housing characteristics. The types of walls are categorized by their materials, such as cement (72%), metal sheets (15%), bricks (9%), and mud or other non-permanent materials (3%). Similarly, the types of roofs include those made of metal sheets (75%), bricks or cement (23%), and bamboo or other (2%). The carpet area, which excludes yard and veranda areas, ranges from 49 square feet to 1,680 square feet (mean= 270). About 38% of houses have a second floor; housing with more than three stories is very rare in Pune slums. Around 2% of households live in housing constructed through an *in situ* slum improvement program, the Basic Services for the Urban Poor (BSUP) scheme. Appointed by the PMC, three non-governmental organizations (NGOs) have rebuilt housing made of temporary materials into new housing with reinforced cement concrete (RCC) structures in designated slum areas since 2008. Although the property titles are provided to women, they can neither sell nor lease these houses. In addition, 3% of households live in housing prepared by the government for resettlement due to the devastating flood in the 1960s in Maharashtra.

The data indicates that a large portion of households enjoys access to basic services. For instance, virtually all the households in the data use water taps, though the types of taps vary. Types of household water access include taps shared by the community (16%), common in building (3%), or exclusively used by the household (82%). The data also contains information about the length of time for water availability: approximately 18% of households have water access for less than two hours per day. In terms of the types of latrines, 64% of households use public toilets, 32% use their own toilets, and 4% have no toilet access. The types of drainage are recoded as either covered (95%) or not (5%). The fact that a majority of slum residents, despite the lack of legal eligibility, have access to these basic amenities reflects their *de facto* tenure security.[9]

Key land-related variables included in the data are slum declaration, zoning, and land ownership. Approximately 61% of households live in declared slums, and 71% of households live in areas designated by Pune's master plan as zones where residential activities are permissible. A total of 44% of households live in declared slums in residential areas. In terms of topological conditions, 26% of houses exist along the Mula-Mutha River or other canals, and 23% of households live on the hillside. The data also includes the indicator of land ownership. Approximately 56% of households live in slums on privately owned land. Nearly 28% of households live in slums on land that belongs to local or state government agencies, and 16% of slum households reside in land owned by central government agencies.[10]

I also prepared some variables to control the locational characteristics of slums. While slum areas in Pune are recorded as small pockets in MASHAL (2011), some of those slum

pockets lay side-by-side, forming large clusters. The size of such slum clusters ranges from 54 to 13,385 households (mean = 3, 360). I also calculated the number of slum households in each electoral ward, ranging from 188 to 5,342 households.[11] This variable helps to capture the degree of regional concentration of slum housing. In addition, I calculated the ellipsoidal distance between each surveyed house and the city hall, which is located in central Pune. The distance ranges from 0.9 to 10.3 kilometers (Figure 2).

(Insert Figure 2 here)

Alongside the group of variables concerning housing, slum, and locational characteristics above, the data encompasses information about household attributes. This includes householder's caste (scheduled caste [SC]/scheduled tribe [ST]/other backward caste [OBC]/other), religion (Hindu/Muslim/other), and education (none/primary/secondary/higher). The average household's duration of residence in their current address is 32 years. Approximately 19% of households are female-headed. The survey also asks respondents to report the amount of the average household monthly expenditure (mean= 9, 868 Indian rupees). Because of its importance as a residential proof, more than 90% of households possess tax receipts. However, only 20% of households possess photo-passes. In order to measure the level of political patronage, the survey asks respondents to evaluate the support they had received from municipal councilors. Their answers were divided: 47% of households negatively evaluated the performance of local politicians, 37% evaluated positively, and 15% of households said "yes and no," which reflects their ambiguous evaluation of politicians' performance.

Spatial Hedonic Models

In the standard hedonic framework developed by Rosen (1974) (see Taylor, 2008, for details), the market prices of housing units represent the sum of expenditures in a bundle of characteristics that can be priced separately. Let Z represent a housing bundle with characteristics $Z = z_1, z_2, \ldots z_r$. With the consumption on non-housing items C, the utility of household i is written as

$$U^i(C, z_1, z_2, \ldots z_r; d^i) \tag{1}$$

where d^i are the demographic characteristics of household i. The budget constraint for household i is given as $Y^i = C + P(Z)$, where Y^i is the income of household i, P is the price schedule for Z determined in a equilibrium. The household seeks to maximize the utility by

choosing C and each element of Z such that the following marginal condition is satisfied for each z_j:

$$\frac{\partial P}{\partial z_j} = \frac{\partial U/\partial z_j}{\partial U/\partial C} \tag{2}$$

The set of housing characteristics commonly includes structural characteristics, neighborhood characteristics, environmental characteristics, public sector factors, and accessibility.

With N and K respectively representing the number of households in the sample and the number of independent variables, the baseline non-spatial specification of the hedonic model is:

$$y = X\beta + \epsilon \tag{3}$$

where y denotes an $N \times 1$ vector consisting of one observation on housing rent assessed by every household; X denotes an $N \times K$ matrix of explanatory variables, including housing, slum, and locational characteristics in Table 1; β is a $K \times 1$ vector of parameters to be estimated; and ϵ is an $N \times 1$ vector of an independently and identically distributed error term.

To deal with spatial effects, this paper instead estimates a generalized spatial two-stage least squares model accounting for heteroscedasticity in the error term, or GSTSLS-HET, developed by a series of works by Kelejian and Prucha (1999, 2010). Recent applications of the model include Kelejian et al. (2013), Koschinsky et al. (2012), de Dominics et al. (2013), and Helbich et al. (2014). The model is written as follows:

$$\begin{aligned} y &= X\beta + \lambda W y + u \\ u &= \rho W u + \epsilon \end{aligned} \tag{4}$$

where $\lambda W y$ describes the spatially dependent variable and $\rho W u$ describes the spatially autocorrelated errors. λ and ρ are commonly referred to as the spatial autoregressive coefficient and the spatial autocorrelation coefficient, respectively. W is an $N \times N$ matrix describing the spatial arrangement of the spatial unit in the sample. This model is referred to as a spatial autoregressive model with autoregressive disturbances of order (1,1) or SARAR (1,1) (Kelejian and Prucha, 1998), SAC model (LeSage2009), or Kelejian-Prucha model (Elhorst, 2010). The correlation of Wy with the disturbances ϵ in Equation (4) motivates an instrumental variable approach. Following Kelejian and Prucha (2010), I use the following matrix of instruments $H = (X, WX, W^2X)$. If the innovations $\epsilon_1, \ldots, \epsilon_n$ are assumed to be independent with zero mean and the non-constant variance σ_i^2, a robust estimator for the variance

covariance matrix is necessary. The GSTSLS-HET estimator combines instrumental variables (IV) and generalized method of moments (GMM) estimation. For the computation, I use the library *sphet* (Piras, 2010) of R statistical software (R Core Team, 2014).

For the spatial hedonic model above to be estimated, a spatial weight matrix W needs to be constructed. Based on the assumption that spatial interaction is stronger between houses in closer distances, I create a matrix of binary inverse distance spatial weights that assign weight to every pair of households inversely proportional to the distance between them (Bivand et al., 2008). The maximum distance between a pair of households is 16.4 kilometers (mean= 4.5, median= 3.9) (Figure 3). I choose households living within a one-kilometer radius of its neighboring household based on the additional assumption that the value of a house does not affect other houses beyond the cut-off distance. I also test alternative spatial weights matrices in order to examine whether this construction of spatial weights matrix affects the estimation of tenure security premium. While a spatial weights matrix is commonly row standardized so that the elements of each row sum to unity, such standardization of an inverse distance weights matrix results in a misspecification problem. Following Elhorst (2001) and Kelejian and Prucha (2010), I instead normalize the weights matrix by dividing all of the elements by the largest characteristic root in the matrix.

(Insert Figure 3 here)

Heterogeneity in the Marginal Willingness to Pay

Household characteristics in the data allow me to examine the heterogeneity in the estimated premium of slum declaration. Of particular interest is how the marginal willingness to pay changes depending on household characteristics that contribute to their *de facto* tenure security. Rosen (1974) proposes a two-step approach to recover demand functions, though the problem of its identification is well known (Taylor, 2008). I rely on Bajari and Benkard (2005) and Bajari and Kahn (2005), who developed a strategy to identify structural parameters in a single market setting.

Let us consider the following linear utility function for each household i in housing j:

$$u_{i,j} = \sum_{k} \gamma_{j,k} z_{j,k} + C \tag{5}$$

where γ_k is the utility function parameter for the kth housing attribute. In case of a dichotomous attribute such as slum declaration, utility-maximizing households choose to consume the kth amenity if

$$\gamma_{i,k} > \frac{\partial P}{\partial z_{j,k}} \tag{6}$$

where the right-hand side is the estimated implicit price in the spatial hedonic model. Considering housing preferences as a function of household characteristics,

$$\gamma_{i,k} = \theta_{0,k} + \sum_{s} \theta_{k,s} d_{i,s} \tag{7}$$

where $d_{i,s}$ is the sth characteristic of household i and θ is a parameter to be estimated, the probability of the households to consume the amenity is

$$1 - N(\theta_{0,k} + \sum_{s} \theta_{k,s} d_{i,s} - \frac{\partial P}{\partial z_{j,k}}) \tag{8}$$

where N is the normal cumulative distribution function. Bajari and Benkard (2005) and Bajari and Kahn (2005) propose to estimate this through a maximum-likelihood profit model with the dichotomous indicator of slum declaration as the dependent variable. The independent variables include household characteristics and the coefficient on price that is normalized to -1.

5 Results

Tenure Security Premium in Housing Rent

Table 2 reports the estimation results of hedonic models. Column 1 is the baseline non-spatial model as expressed in Equation (3) in the previous section.[12] Column 2 additionally includes administrative ward fixed effects. The coefficient estimates of slum declaration are 0.050 in column 1 and 0.116 in column 2, none of which are statistically significant at the 10% level. While the spatial fixed effects improved the fit, the result of Moran's I test (Anselin and Kelejian, 1997) points to the remaining presence of spatial autocorrelation in the residuals (standard deviate = 3.319, $p < 0.01$) and thus the need of spatial econometrics models. The Breusch-Pagan test (Breusch and Pagan, 1979) also indicates heteroscedasticity in the residuals ($p < 0.01$).

(Insert Table 2 here)

Column 3 reports the estimation result of the GSTSLS-HET model in Equation (4). The estimated autoregressive coefficient $\lambda = 0.078$ ($p < 0.01$) indicates the spatial dependence

among the dependent variable. The autocorrelation coefficient ρ is also estimated to be significant (0.663, $p < 0.01$). The estimated premium of slum declaration is 0.189 ($p < 0.05$). This is the direct effect of slum declaration, which does not yet include the indirect effect due to the spillover effect. Following LeSage and Pace (2009), I calculate the total effect of slum declaration that incorporates the spatial spillover effects. The total effect of slum declaration and its 95% confidence intervals is calculated through Markov Chain Monte Carlo (MCMC) simulations.[13] The estimated total effect of slum declaration is 0.193 ($p < 0.05$, 95% CI = [−0.007, 0.345]) (Table 3). Associated marginal willingness to pay (MWTP) that can be obtained by multiplying the average rent values in the sample into the total effect is 604 Indian rupees per month.

Aside from slum declaration, the coefficient estimates of cement walls (0.159), roofs made of either brick or cement (0.162), the natural logarithm of the carpet area (0.407), no rent payment (0.370), slum improvement project (−0.402), and riverside (−0.286) are statistically significant at the 5% level. These estimates in column 3 are reasonable overall, yet some results need explanation. The association of a slum improvement project with its rent is found to be negative. On one hand, rent of the project housing may be higher than other housing even if their physical characteristics and access to services are controlled. This is because people may evaluate tenure security that is enhanced by government interventions. On the other hand, their assessed rent can be low if people take into account the restricted property rights. For example, these households are not allowed to sell their houses for a certain period of time. The negative influence of the latter stands out in this case.

Based on Equation (8), I then explore the heterogeneity of the estimated premium of slum declaration. Table 4 reports the estimation results of the probit models with the declaration status as the dependent variable. The probit models include independent variables of household characteristics and the premium of slum declaration in thousand rupees estimated through the GSTSLS model. It is noted that the premium is normalized to −1.

(Insert Table 4 here)

Column 1 of Table 4 reports the estimation result of the probit model with basic demographic characteristics, such as householder's caste, religion, and educational attainment. Estimated coefficients for caste, with non-SC/ST/OBC as the reference group, are all negative. For example, compared with the reference group, OBC households would pay 304 rupees less for living in declared slums. The result suggests that those who are socially disadvantaged tend to lack capability to enjoy greater benefits from slum declaration.

Column 2 additionally includes variables that are closely tied to household tenure security conditions. Compared with households who arrived in their current residences during

the last 15 years, households who have stayed for longer than 15 years pay an additional 370 rupees for living in declared slums, even when their expenditure levels are controlled. In addition, slum residents who possess photo-passes pay additional rent (463 rupees more) for the declaration of their settlements. Together, these results demonstrate that slum residents who meet the cut-off date criteria highly evaluate the benefits from slum declaration.

Robustness Check

I assess the robustness of the estimated premium of slum declaration against the construction of a spatial weights matrix, the choice of spatial models, and a selection bias. Overall, those analyses demonstrate the robustness of the estimation result of the GSTSLS model in column 3 of Table 2.

First, I estimate the GSTSLS models with different spatial weights matrices. I create alternative weights matrices based on the combinations of different cut-off distances (0.5km, 1km, 1.5km, and 2km), the zones of indifferences (100m, 200m), and different weight functions (exponential distance weights). While inverse distance is a commonly used weight function, it may assign too much weight on the households who live in very close proximity. For example, a neighbor who lives 10 meters from a household is provided a weight 10 times larger as another neighbor who lives 100 meters from the household. To mitigate such potential assignment of overweight, I introduce a zone of indifference in which all neighbors receive equal weights. I test 100 meter and 200 meter zones of indifferences. In addition, I employ exponential distance weight functions as alternatives to the inverse distance function. The exponential distance weight is generally calculated as follows: $w_{ij} = \exp(-\alpha d_{ij})$ where α is any positive exponent. I choose $\alpha = 1$ and $\alpha = 2$ for this study.

Table 3 summarizes the estimated total effect of slum declaration based on the GSTSLS-HET model in Equation (4) with different sets of spatial weights matrices. In the models with inverse distance weights, introducing a zone of indifference resulted in a weaker total effect. For instance, in the case of cut-off = 1km, the premium decreases from 0.193 ($p < 0.05$) to 0.169 ($p < 0.1$) when a 200m zone of indifference is introduced. The total effects based on exponential distance weights were weaker overall than those based on inverse distance weights in the cases of no zone of indifference. When zones of indifferences were introduced, however, the models with exponential distance weights return stronger total effects than those with inverse distance weights. Overall, this exercise suggests that the estimated premium in column 3 of Table 2 is near the upper bound.

(Insert Table 3 here)

Secondly, as a robustness check against both the specification of the spatial weights matrix and the choice of a spatial hedonic model, I estimate a geoadditive model. A generalized additive model (GAM) is a semi-parametric model in which the linear predictor is specified as the sum of smooth functions of regressors (Wood, 2006). In essence, a geoadditive model is a GAM model with a smooth of longitude and latitude (Geniaux and Napoleone, 2008; Kammann and Wand, 2003). The model is written in the following way:

$$\ln(p_i) = \alpha + \beta X_{1i} + \sum_{l=1}^{L} s_l(X_{2i}) + s(u_i, v_i) + \epsilon_i \tag{9}$$

where X_1 and X_2 contain a set of covariates for the linear function and smooth functions, respectively. I let X_2 include the carpet area (in square feet) for this study.[14] $s(u_i, v_i)$ is a smooth term for u_i and v_i, which, respectively, represents the longitude and latitude associated with the location of household i. This geoadditive model is useful because the smooth of longitude and latitude can capture spatial effects without constructing any spatial weight matrix. Another advantage is that its smooth terms can capture nonlinear relationships of covariates. In addition, incorporating the interaction terms of covariates and $s(u_i, v_i)$ can be used as a test for spatial stationarity (Geniaux and Napoleone, 2008).

The estimation result of the geoadditive model in Equation (9), which is reported in column 4 of Table 2, does not differ substantially from the GSTSLS-HET model. Akaike Information Criterion (AIC) values indicate that the GAM model fits better than the ordinary least squares (OLS) model with spatial fixed effects in column 2. The smooth term of longitude and latitude is statistically significant ($p < 0.01$), which appropriately captures spatial effects. Figure 4 illustrates the fit of smooth lines for the carpet area and the surface of longitude and latitude. The estimated premium of slum declaration is 0.195 ($p < 0.05$), which is comparable to the total impact estimated in column 3. In order to examine the spatial stationarity of the estimated premium of slum declaration, I added the interaction term of slum declaration and the smooth of longitude and latitude to the GAM model, which yields the insignificant coefficient for the interaction term ($p = 0.519$) (not reported). This result indicates no evidence of the violation of stationarity in the specification of column 4.

(Insert Figure 4 here)

Finally, I assess the influence of selectivity in household response for the survey. Among the surveyed 562 households, 84 respondents (15%) did not report the amount of monthly rent. If households with specific characteristics tend to not answer the question, a hedonic estimation could be biased. I assess this potential problem by employing a Heckman model (Heckman, 1979, 1976). Column 5 in Table 2 reports the estimation result of the outcome

model (see Table A1 for the estimation result of the selection model).[15] The estimated ρ is -0.552 ($p < 0.01$), which points to the presence of negative selection, i.e., households who live in housing with a lower amount of rent (or imputed rent) tend not to report rent in the survey. Correcting this selection suggests the significant interaction between slum declaration and whether the household lives in a residential zone (-0.492, $p < 0.01$). This means that slum declaration poses a very high premium (0.395) in non-residential zones, while the premium is weaker in residential zones (0.179). Assuming that slum residents in non-residential zones highly value the benefits of slum declaration is reasonable, considering that they otherwise enjoy low levels of tenure security there.

6 Conclusion

This paper offers empirical evidence that residents of informal settlements evaluate benefits from formalized land tenure even in the presence of other legal and non-legal factors that contribute to their tenure security. I analyze slum declaration in Pune as a land tenure formalization that legally guarantees the occupancy of slum residents and entitles them to basic services. This slum declaration system differs from common titling programs that provide full property titles to slum dwellers. I estimate slum residents' willingness to pay for living in declared slums by taking advantage of the fact that housing rent in the informal housing market reflects such benefits from formalized land tenure. To do so, I apply a spatial hedonic model to a rare dataset that contains a variety of household, housing, and slum and locational characteristics in the city of Pune.

The spatial hedonic analysis shows that slum residents highly and positively evaluate the benefits of slum declaration in Pune. I employ a GSTSLS-HET model that takes into account spatial dependence and heterogeneity. The non-spatial hedonic models based on the OLS models with or without spatial fixed effects inadequately deal with spatial effects, yielding non-significant estimates of slum declaration premium. By contrast, the GSTSLS-HET model shows that the premium of slum declaration is worth 19% of the average housing rent. The calculated marginal willingness to pay for living in declared slums is about 600 Indian rupees per month, which is approximately 6% of the average monthly expenditure of slum households in Pune. I show that the estimation result above is robust against the construction of the spatial weights matrix, the choice of hedonic models, and the selectivity in survey response.

The estimated premium of slum declaration in Pune is heterogeneous depending on a household's social and legal status. Slum residents who belong to SC/ST/OBC tend to

evaluate the benefits of living in slum declaration less. In addition, slum residents who arrived at their current residences more than 15 years ago and/or who possess photo-passes evaluate the declaration of their settlements more particularly. Because those people fulfill the cut-off date criteria, they can enjoy a high level of tenure security.

The empirical evidence in this paper suggests that even if slum dwellers already enjoy tenure security to some degree based on various legal and non-legal factors, they would still value formalized land tenure that legally guarantees their occupancy rights. Governments could aid slum residents by legally ensuring their occupancy rights; such tenure formalization does not necessarily have to accompany the instant provision of a full bundle of property rights. Nevertheless, they should pay attention to who actually benefits, or moreover who fails to benefit, from the formalization of land tenure.

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Endnotes

1. Despite its potential pejorative connotation, I use "slums" in this paper because this is an official policy terminology in India. In Section 2, I discuss its definitions in the Indian context.

2. A new administrative ward has recently been added, yet this paper adheres to the 14 wards as shown in the *Pune Slum Atlas.*

3. This study does not include the areas governed by the Pune Cantonment Board and the Khadki Cantonment Board.

4. These areas include residential zones, commercial zones, and land reserved for the Economically Weaker Section (EWS).

5. The cut-off date has recently been extended again to January 1, 2000 (Kulkarni, 2014).

6. Two extra households were unexpectedly surveyed in a slum.

7. The inverse of the probability of each household being selected are multiplied as sampling weights. I refer to MASHAL (2011) to obtain the total number of households in each slum.

8. 3,128 Indian rupees is equivalent to approximately 50 USD as of 2013.

9. Virtually all the surveyed households had access to electricity. Because of the lack in variation, I did not include this variable in this study.

10. The local and state government agencies include the Pune Municipal Corporation, the State Government of Maharashtra, and the Maharashtra Housing and Area Development Authority (MHADA), which is a parastatal agency in charge of affordable and public housing development. The central government agencies include the railway and defense authorities.

11. Instead of the current 76 electoral wards, I use 144 electoral wards in reference to the *Pune Slum Atlas.*

12. Variance inflation factors (VIF) for variables in column 1 are all less then 2, demonstrating that multicollinearity is not a serious issue in the model.

13. I use *spdep* library (Bivand, 2014) of R software (R Core Team, 2014).

14. The number of households in an electoral ward is also a continuous variable, but it turns out that the logarithm of the variable fits very well.

15. Moran's I test did not detect spatial autocorrelation in the residuals ($p = 0.114$).

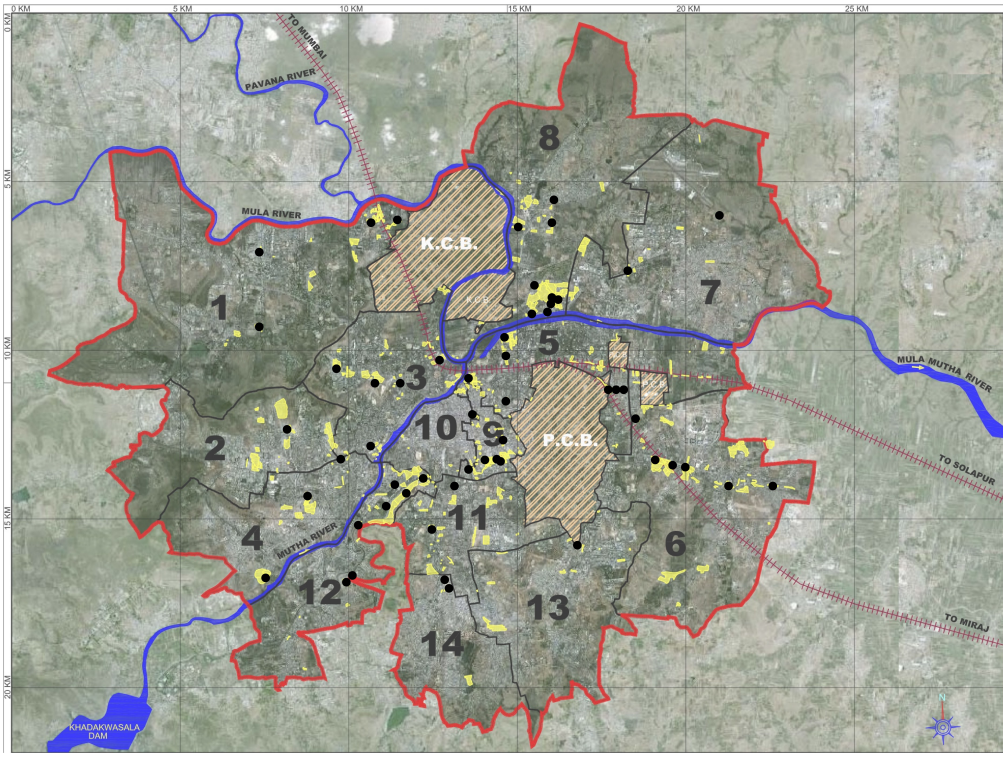

Figure 1: Location of slums in Pune. Note: Areas highlighted in yellow indicate slum areas. Black dots indicate 56 slums surveyed by the author. Pune and Khadki Cantonment Board (P.C.B. and K.C.B.) are not included in the study area. Numbers indicate administrative wards. Source: Author's work based on MASHAL (2011).

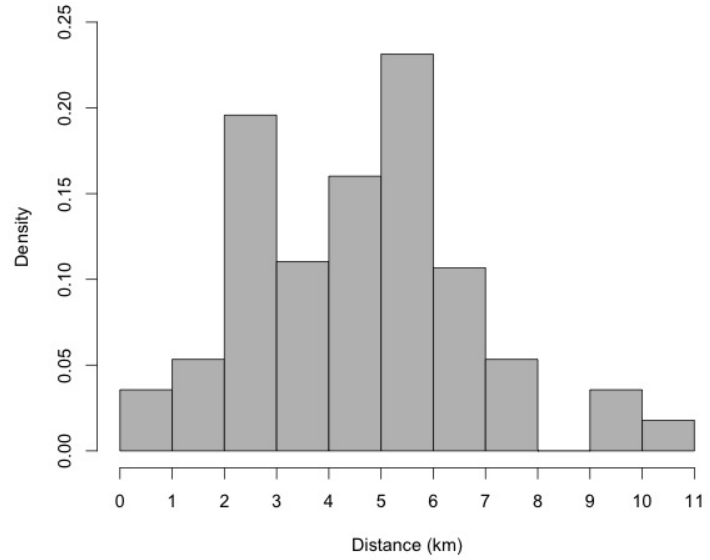

Figure 2: Distribution of distance from the city hall

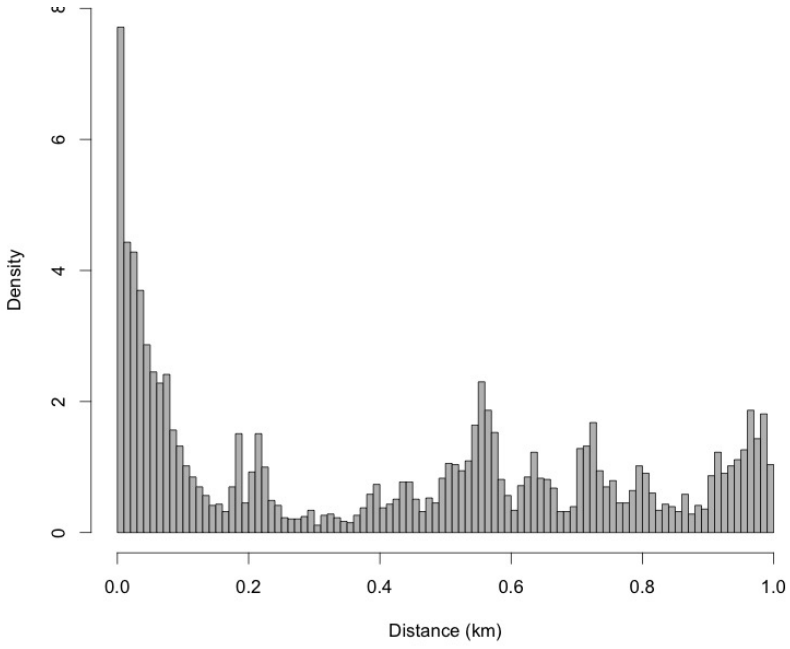

Figure 3: Distribution of distance between neighbors

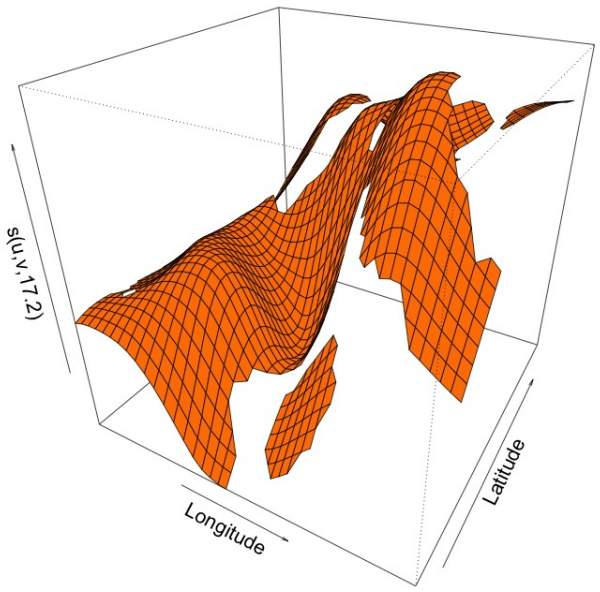

Figure 4: Smooth term in generalized additive model

Table 1: Summary statistics

	N	Mean	St. Dev.	Min	Max
Housing characteristics					
Monthly rent (in Indian Rupees)	478	3128	3029	0	48000
Wall: mud or other	562	0.029	0.167	0	1
Wall: brick	562	0.094	0.292	0	1
Wall: metal sheet	562	0.154	0.361	0	1
Wall: cement	562	0.723	0.448	0	1
Roof: bamboo or other	562	0.016	0.127	0	1
Roof: metal sheet	562	0.752	0.432	0	1
Roof: brick/cement	562	0.231	0.422	0	1
Carpert area (in square feet)	562	269.9	190.9	49	1680
Second floor (1=yes; 0=no)	562	0.378	0.485	0	1
Water: community	562	0.157	0.364	0	1
Water: common	562	0.028	0.164	0	1
Water: excluxive	562	0.815	0.388	0	1
Water availability (1=less than 2 hours; 0=otherwise)	562	0.180	0.385	0	1
Latrine: none	562	0.041	0.198	0	1
Latrine: public	562	0.643	0.480	0	1
Latrine: own	562	0.316	0.465	0	1
Drinage (1=covered; 0=open)	562	0.949	0.219	0	1
Path (1=paved; 0=not paved)	562	0.922	0.268	0	1
Rent payment (1=no payment; 0=rent paid)	561	0.884	0.321	0	1
Slum improvement	562	0.018	0.135	0	1
Resettlement	562	0.034	0.182	0	1
Household characteristics					
Caste: scheducled caste [SC]	562	0.228	0.420	0	1
Caste: scheduled tribe [ST]	562	0.027	0.163	0	1
Caste: other backward class [OBC]	562	0.229	0.421	0	1
Caste: other	562	0.393	0.489	0	1
Caste: unknown	562	0.059	0.236	0	1
Religion: Hindu	562	0.801	0.399	0	1
Religion: Muslim	562	0.112	0.315	0	1
Religion: others	562	0.086	0.281	0	1
Education: none	562	0.213	0.410	0	1
Education: primary	562	0.145	0.353	0	1
Education: secondary	562	0.537	0.499	0	1
Education: higher	562	0.104	0.305	0	1
Duration of residence (in years)	561	31.671	20.298	0	150
Female headed (1=yes; 0=no)	561	0.186	0.390	0	1
Monthly household expenditure (in Indian Rupees)	546	9868	5178	2000	32500
Possession of tax bill	549	0.913	0.283	0	1
Possession fo photo-pass	562	0.203	0.402	0	1
Evaluation of politicians: negative	562	0.466	0.499	0	1
Evaluation of politician: neutral	562	0.151	0.358	0	1
Evaluation of politicians: positive	562	0.361	0.481	0	1
Slum/Location characteristics					
Slum declaration (1=declared; 0=non-declared)	562	0.610	0.488	0	1
Land ownership: private	562	0.564	0.496	0	1
Land ownership: state/local	562	0.277	0.448	0	1
Land ownership: central	562	0.159	0.366	0	1
Residential zone (1=yes; 0=no)	562	0.706	0.456	0	1
Riverside (1=yes; 0=no)	562	0.256	0.437	0	1
Hillside (1=yes; 0=no)	562	0.233	0.423	0	1
Declared and Residential	562	0.435	0.496	0	1
Number of households in the slum cluster	562	3360	4177	54	13385
Number of households in the electoral ward	562	2382	1245	188	5342
Distance from the city hall (in kilometers)	562	4.557	2.101	0.858	10.327

Note: Sampling weights are applied.

Table 2: Estimation results of hedonic models

	OLS		GSTSLS	GAM	Heckman
	(1)	(2)	(3)	(4)	(5)
Wall: brick	0.187	0.200	0.150	0.202	0.173
	(0.130)	(0.127)	(0.112)	(0.124)	(0.119)
Wall: cement	0.256***	0.239***	0.159**	0.228**	0.179**
	(0.093)	(0.091)	(0.073)	(0.089)	(0.086)
Wall: mud and others	−0.051	−0.007	−0.282	−0.014	−0.055
	(0.189)	(0.183)	(0.223)	(0.178)	(0.167)
Roof: bamboo and others	−0.123	−0.139	−0.094	−0.098	−0.118
	(0.239)	(0.223)	(0.170)	(0.219)	(0.202)
Roof: brick/cement	0.130*	0.150**	0.162**	0.138*	0.167**
	(0.075)	(0.075)	(0.077)	(0.074)	(0.068)
Log of carpet area	0.373***	0.357***	0.407***		0.402***
	(0.057)	(0.053)	(0.067)		(0.049)
Second floor	0.023	0.084	0.068	0.079	0.084
	(0.070)	(0.066)	(0.069)	(0.067)	(0.060)
Water: common	0.134	0.040	0.187	0.108	−0.078
	(0.191)	(0.180)	(0.180)	(0.177)	(0.182)
Water: exclusive	−0.025	−0.005	0.068	0.024	−0.010
	(0.080)	(0.076)	(0.081)	(0.076)	(0.071)
Water less than 2 hours	−0.170*	−0.172*	−0.036	−0.161	−0.220**
	(0.093)	(0.097)	(0.092)	(0.103)	(0.089)
Latrine: none	−0.221	−0.399**	−0.148	−0.396**	−0.628***
	(0.176)	(0.170)	(0.179)	(0.168)	(0.172)
Latrine: own	0.088	0.099	0.072	0.116*	0.078
	(0.069)	(0.065)	(0.087)	(0.066)	(0.060)
Drainage covered	0.207	0.022	0.058	0.054	0.014
	(0.163)	(0.153)	(0.150)	(0.151)	(0.141)
Pavement	0.011	0.105	0.159	0.002	0.026
	(0.126)	(0.122)	(0.127)	(0.120)	(0.112)
No rent payment	0.205**	0.217**	0.370***	0.226***	0.248***
	(0.093)	(0.087)	(0.107)	(0.086)	(0.089)
Slum improvement	−0.134	−0.277	−0.402**	−0.313	−0.172
	(0.210)	(0.202)	(0.161)	(0.201)	(0.183)
Resettlement	−0.089	−0.095	−0.159	−0.038	−0.066
	(0.164)	(0.153)	(0.155)	(0.159)	(0.137)
Slum declaration	0.050	0.116	0.189**	0.195**	0.395***
	(0.074)	(0.077)	(0.085)	(0.098)	(0.122)
Land: state/local	−0.173**	0.040	−0.093	0.113	0.014
	(0.075)	(0.112)	(0.083)	(0.099)	(0.109)
Land: central	0.166*	−0.234	0.116	0.022	−0.085
	(0.093)	(0.159)	(0.103)	(0.130)	(0.153)
Residential zone	−0.040	0.058	−0.141	0.096	0.276***
	(0.086)	(0.095)	(0.094)	(0.108)	(0.101)
Riverside	−0.314***	−0.296**	−0.286***	−0.325***	−0.338***
	(0.090)	(0.119)	(0.104)	(0.123)	(0.114)
Hillside	−0.159*	−0.063	−0.120	0.057	−0.203
	(0.084)	(0.131)	(0.103)	(0.146)	(0.129)
Log of households in electoral zone	−0.006	−0.060	−0.058	−0.171**	−0.090
	(0.045)	(0.063)	(0.053)	(0.069)	(0.059)

Table 2: (continued)

	OLS		GSTSLS	GAM	Heckman
	(1)	(2)	(3)	(4)	(5)
Distance from city hall	0.094	0.260***	−0.002		0.252***
	(0.068)	(0.086)	(0.065)		(0.081)
Distance (squared)	−0.008	−0.025***	0.003		−0.023***
	(0.007)	(0.009)	(0.006)		(0.009)
Declared & Residential					−0.492***
					(0.146)
Constant	5.317***	5.205***	5.198***	8.445***	5.190***
	(0.505)	(0.699)	(0.643)	(0.527)	(0.653)
λ			0.078***		
			(0.023)		
ρ			0.663***		
			(0.202)		
Administrative ward fixed effects		Yes			Yes
Observations	460	460	460	460	528
Adjusted R^2	0.286	0.398			
AIC	982.5	917.5		904.6	

Note: Standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Reference categories are Wall:metal sheets, Roof:metal sheets, Water:community, Latrine:none, Land:private. GCV score=10.78, Scale est.=9.697, edf for s(longitude, latitude)=17.652*** in column (4). Smooth term for carpet area is also added in column (4). $\rho = -0.552^{***}$ in column (5).

Table 3: Estimated total effects of slum declaration

	0.5km	1km	1.5km	2km
	(1)	(2)	(3)	(4)
Inverse distance				
No ZOI	0.191**	0.193**	0.192**	0.193**
	[0.035, 0.377]	[−0.007, 0.345]	[0.026, 0.353]	[0.004, 0.352]
100m ZOI	0.131	0.148	0.122	0.134
	[−0.088, 0.319]	[−0.077, 0.347]	[−0.087, 0.336]	[−0.061, 0.358]
200m ZOI	0.149	0.169*	0.136	0.150
	[−0.066, 0.332]	[−0.011, 0.372]	[−0.073, 0.303]	[−0.037, 0.330]
Exponential distance ($\alpha = 1$)				
No ZOI	0.159	0.187*	0.140	0.160
	[−0.030, 0.360]	[0.010, 0.388]	[−0.047, 0.320]	[−0.034, 0.343]
100m ZOI	0.161*	0.189*	0.140	0.160
	[−0.020, 0.338]	[−0.009, 0.367]	[−0.059, 0.330]	[−0.036, 0.345]
200m ZOI	0.162*	0.191**	0.141	0.162
	[−0.028, 0.339]	[0.009, 0.367]	[−0.028, 0.353]	[−0.050, 0.364]
Exponential distance ($\alpha = 2$)				
No ZOI	0.148	0.173	0.154	0.159
	[−0.056, 0.353]	[−0.034, 0.380]	[−0.034, 0.363]	[−0.046, 0.349]
100m ZOI	0.154	0.179*	0.158	0.163*
	[−0.040, 0.370]	[−0.025, 0.365]	[−0.021, 0.352]	[−0.028, 0.357]
200m ZOI	0.156	0.183*	0.161*	0.166*
	[−0.025, 0.342]	[−0.001, 0.356]	[−0.017, 0.350]	[−0.028, 0.349]

Note: 95% confidence intervals in square brackets. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. ZOI: Zone of indifference.

Table 4: Estimation result of second-stage analysis

	Probit	Probit
	(1)	(2)
Caste: SC	−0.243	−0.304
	(0.175)	(0.192)
Caste: ST	−1.065**	−1.164***
	(0.424)	(0.437)
Caste: OBC	−0.304*	−0.527***
	(0.163)	(0.176)
Caste: unknown	−0.294	−0.634**
	(0.284)	(0.300)
Religion: Muslim	0.323	0.260
	(0.243)	(0.271)
Religion: other	−0.329	−0.451*
	(0.237)	(0.253)
Education: primary	0.162	0.289
	(0.211)	(0.226)
Education: secondary	0.217	0.225
	(0.164)	(0.178)
Education: higher	0.165	0.335
	(0.254)	(0.277)
Duration of residence $>$ 15 years		0.370**
		(0.188)
Monthly expenditure		0.031*
		(0.016)
Photo-pass		0.463***
		(0.147)
Evaluation of politicians: negative		0.065
		(0.155)
Evaluation of politicians: neutral		−0.205
		(0.235)
Constant	0.860***	0.159
	(0.164)	(0.271)
Price of slum declaration (in thousand rupees)	1	1
Observations	429	388
Log Likelihood	-351.156	-281.231

Note: Standard errors in parentheses. Dependent variable is a dummy indicator of slum declaration status. The coefficient on the implicit price is normalized to −1. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table A1: Estimation results of selection equation

	Heckman (1)
Duration of residence	−0.011
	(0.010)
Duration of residence (squared)	0.0001
	(0.0001)
Tax bill	−0.709
	(0.368)
Evaluation of politicians: neutral	−0.335
	(0.189)
Evaluation of politicians: positive	0.157
	(0.163)
Land ownership: state/local	0.556**
	(0.198)
Land ownership: central	−0.386
	(0.198)
Log of distance from the city hall	−0.344*
	(0.139)
Constant	2.460***
	(0.474)
Observations	528
Log Likelihood	-515.122
ρ	-0.552** (0.212)

Note: Standard errors in parentheses. $^{***}p < 0.001, ^{**}p < 0.01, ^{*}p < 0.05$. Dependent variable is a binary indicator about whether the household reported rent in the survey or not. See column (6) in Table 2 for outcome model. Reference categories are Evaluation of politicians: negative and Land ownership: private.