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A Theory of Urban Squatting and Land-Tenure Formalization in Developing Countries[†]

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This paper offers a new theoretical approach to urban squatting, reflecting the view that squatters and formal residents compete for land within a city. The key implication is that squatters "squeeze" the formal market, raising the price paid by formal residents. The squatter organizer ensures that squeezing is not too severe, since otherwise, the formal price will rise to a level that invites eviction by landowners. Because eviction is absent in equilibrium, the model differs from previous analytical frameworks, where eviction occurs with some probability. It also facilitates a general equilibrium analysis of squatter formalization policies. (*JEL* O15, Q15, R14)

Informality of land tenure is usually a key characteristic of urban slums in the cities of developing countries. Informal tenure often involves squatting, where households occupy a parcel of land that belongs to someone else while paying no financial compensation. Given that 940 million people—over 30 percent of the world urban population—are estimated to live in slums (UN-Habitat 2003), it is reasonable to think that several hundred million people worldwide live under informal land tenure, and that many of them are squatters. Although there are no consolidated figures on the extent of squatting, case studies often point to significant numbers. In the city of Dhaka, Bangladesh, for instance, squatter settlements are estimated to provide as much as 15 percent of the housing stock (World Bank 2007).

While much anecdotal evidence about the daily lives of squatters and the organization of squatter settlements has accumulated (see Robert Neuwirth 2005 or Mike Davis 2006 for recent popular references), a few general observations can be made. First, squatting is always associated with crowding, yielding very high population densities. Second, squatted land is usually not developed or serviced, leading to highly

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restricted and congested access to basic services for squatters. Third, while squatting is often thought to occur on vacant public land, much squatting also occurs on private property (see Joe Flood 2006; Robert M. Buckley and Jerry Kalarickal 2006; World Bank 2007; Sebastian Galiani and Ernesto Schargrodsky 2004; and Rafael Di Tella, Galiani, and Schargrodsky 2007). The vacant private land that attracts squatters may be vacant for several reasons, including speculative land-holding when disorganized financial markets constrain other opportunities for investment, or because of regulatory requirements or rent controls that make investing on that land unprofitable (Emmanuel Jimenez 1984). Finally, although squatters do not pay a formal rent to an owner, they incur costs associated with squatting, including possible payments made to a community "leader" (Jean O. Lanjouw and Philip I. Levy 2002; Saumitra Jha, Vijayendra Rao, and Michael Woolcock 2007; World Bank 2007).

Aside from these general tendencies, not much is known concerning the economic mechanisms that lead to the emergence and sustainability of squatting. The scope and persistence of squatting remain puzzling issues. Suggested explanations usually point to some external constraints or market imperfections as causes of squatting. For some authors, the main culprit is the unresponsiveness of housing supply, reflecting a variety of obstacles that include underinvestment in infrastructure, monopolies that control the availability of land (World Bank 1993), topographical constraints, or mismanagement of public land development (World Bank 2007). More provocatively, other observers stress the possible unwillingness of the private sector to respond to the low end of the market, which leaves the poor with no other option aside from informal housing (including squatting). Others blame public policies for indirectly encouraging informal land development. A frequent claim is that policies such as zoning may artificially increase the cost of formal housing and act as an invitation for squatting (see Gilles Duranton 2008 for a diagrammatic analysis). Municipalities may also engage in exclusionary policies that preclude the development of formal neighborhoods, such as the withholding of public services from migrant areas (see Leo Feler and J. Vernon Henderson 2008 for evidence from Brazilian municipalities). Discrimination in land and housing markets may also bar a significant fraction of the population, who are often migrants of rural origin, from entry into the formal market. Lastly, local governments may be unable to enforce the property rights of owners, or they may simply tolerate squatting, either because evictions are too costly politically or because of a desire to ensure some degree of tenure security for squatters. This latter view matches a remark in a World Bank report, which states that "most governments, unwilling to engage in mass evictions, have gradually condoned existing squatter housing while attempting to resist further squatting" (World Bank 1993).

Even though these ideas are potentially useful, a formal theory of squatting can provide deeper insight into this important phenomenon. The purpose of this paper is to offer such a theory, building on a small existing theoretical literature.

The paper aims to provide a conceptual framework for analyzing some key issues related to squatting. How does squatting come into existence? How is the extent of squatting in a particular city determined? How do squatters interact with the formal housing market? What is the link between squatting and the prices of formal housing and land? How do policies targeted at squatters affect formal dwellers? The paper is based on the view that formal tenure and squatting represent two interlinked land uses within a single market and should be modeled as such. The model portrays squatters as "squeezing" the formal market by occupying land that could be developed for formal use. While this squeezing raises the formal price, too much price escalation invites eviction, and squatter communities are organized taking this threat into account.

In the small previous theoretical literature on the economics of squatting, some papers focus on the impact of eviction uncertainty on squatter behavior (their investment in housing capital), while others focus on landowner eviction decisions. An early contribution by Jimenez (1985) belongs to the first category. In the formal sector of his model, households must pay an exogenous rent, while squatters avoid a rental payment but incur other costs. These costs include an occupancy cost, which depends on the total squatter population, an outlay for "defensive" expenditures meant to protect the squatter's land, and a cost arising from possible loss of the housing investment in the event of eviction. The equilibrium requires households to be indifferent between formal tenure and squatting. The government evicts a fraction of squatter households, with this fraction matching the eviction probability that squatters use in computing their expected loss. Eviction costs per household rise with defensive expenditures and the number of squatters, and total costs must be covered by a fixed eviction budget. The equilibrium determines an eviction probability (fraction evicted) and an overall size for the squatter population. Jimenez carries out comparative-static analysis with his model, while also investigating the impact of squatter coalitions.

The present analysis adopts aspects of Jimenez's approach while introducing some key differences. Following Jimenez, defensive expenditures play a key role in the model, and eviction costs are also increasing in the size of the squatter population. However, in contrast to Jimenez's model, where the formal housing price is a parameter with no important role in the analysis, the formal price in the present model is endogenous and determined by the squeezing mechanism described above. Moreover, although the threat of eviction is present, actual evictions never occur, unlike in Jimenez's model. The reason is that the squatter "organizer," who governs the squatter group, sets the squatter population size, individual land consumption, and level of defensive expenditures to insure that the cost of eviction is high enough relative to the landowner's gain (which depends on the formal price) to make eviction unattractive. The organizer's goal is to maximize squatter utility subject to this "no-eviction" constraint. The model is thus a general equilibrium framework where squatters and formal households compete for the same land, with squatter decisions crafted so as not to invite eviction.

Since a model should be realistic to be useful, some evaluation of the realism of three key elements in the present framework is needed. First, although squatter evictions occur in reality, the fact that their volume is often small relative to the large stock of squatter households justifies a model where evictions are absent in equilibrium (see Flood 2006).[1] Second, although squatting often occurs on public land

[1] According to Flood (2006, 42), cities where the eviction of squatters is very frequent include Guangzhou (China), Harare (Zimbabwe), Mumbai (India), and Valledupar (Columbia). However, cities where evictions are

not eligible for private development, squatting on private land is common enough to validate a model where squatters squeeze the formal market. Data cited by Flood (2006, 30, table 6) indicate that the share of "land invasions" occurring on private land is 51 percent in sub-Saharan Africa, 39 percent in North Africa and West Asia, 10 percent in South Asia, 40 percent in East Asia, and 40 percent in Latin America and the Caribbean. Third, the presence in the model of a squatter organizer with substantial power to control the behavior of his group matches some real-world evidence. Examples of such organizers are common, including community bosses in Ecuador, shack lords in South Africa, or Mastaans in Bangladesh. A recent World Bank study on Dhaka (World Bank 2007) noted that Mastaans "are self appointed leaders who set up committees, maintain links and have patronage from local and national political leaders, government officials and local law enforcing agencies." In line with the model's assumptions, William Mangin (1967) noticed some 40 years ago that associations in the squatter settlements of Peru "do seem to be able to control, to a certain extent, who will be members of the invasion group."[2] Organizers of land invasions also often collect payments from squatters in return for "ownership" of their plot, matching the defensive expenditures that play a key role in the model. Alternatively, Erica Field (2007) argues that these costs may come in the form of forgone labor income, a result of a squatter's need to be physically present to protect a plot.

In addition to providing a new picture of the mechanisms underlying squatting, the paper's conceptual framework allows investigation of the general equilibrium effects of "formalization" policies, which require squatters to become formal residents, paying rent for the land they occupy. The resulting analysis offers a new perspective given that the literature previously focused on various effects of formalization (improvement in tenure security, labor market participation, access to credit, and health outcomes) but remained silent about impacts in the land market. Since opponents of sweeping formalization programs have noted that squatters may lose when faced with the full market price of housing, such impacts are important. The model illuminates this issue, exposing squatter losses from formalization and showing that the gains of existing formal residents are sufficient to compensate them. The analysis thus points to a Pareto-improving way of escaping a city's squatter equilibrium.[3]

Before proceeding to the analysis, the other contributions to the earlier squatting literature require some comment. Two other theoretical papers differ from Jimenez (1985) by endogenizing the eviction decision, as noted above. Rather than determining the volume of evictions via a fixed eviction-cost budget (as does Jimenez),

rare include Guadalajara (Mexico), Ho Chi Minh City (Vietnam), Istanbul (Turkey), Sao Paulo (Brazil), and Tehran (Iran), where no evictions at all were reported.

[2] The model assumes a single squatter organizer rather than a number of different organizers. This assumption can be justified by the large size of some squatter land invasions. While in South Asia, 200 plots per invasion was the norm, some very large invasions of up to 2,600 plots were reported in sub-Saharan Africa (Flood 2006, 31)

[3] De jure formalization is not the only type of possible intervention in squatter settlements. Other types of interventions, such as street addressing (Catherine Farvacque-Vitkovic et al. 2005) may simply seek the de facto recognition of occupancy (see Alain Durand-Lasserve and Harris Selod, forthcoming, for more details). Other direct interventions consist of improving the housing and living conditions of squatters (for a discussion of slum upgrading, see Somik V. Lall, Mattias K. A. Lundberg, and Zmarak Shalizi 2008).

landowners in Geoffrey K. Turnbull (2008) compare the formal price to the cost of eviction, as in the present model. Turnbull's formal price is exogenous (squeezing is absent), but since it is stochastic, evictions are generated with some probability. Michael Hoy and Jimenez (1991) analyze a model with a similar structure. Empirical work by Jimenez (1984) and Joseph Friedman, Jimenez, and Steven K. Mayo (1988) explores the effect of tenure insecurity on the price of informal housing. The results show that tenure security is valued, which provides one justification for formalization policies.[4]

The remainder of the paper is organized as follows. Section I presents the analysis of the basic model, including the analysis of formalization policies. Section II adds some realistic embellishments to the basic framework, while Section III considers two variants of the model. The first variant assumes that, although the squatter organizer can dictate the choices of his group, he cannot control the size of the squatter population, which is determined by free migration. The second variant explores an alternate portrayal of the squatter organizer, who is assumed to maximize his own profit rather than squatter utility. Section IV offers conclusions.

I. Basic Model

A. *The Setup*

The analysis relies on a stylized, static model of a city containing both squatters and residents of formal housing. Even though cities in underdeveloped countries are experiencing rapid growth, the squatting phenomenon does not appear to involve fundamental intertemporal linkages, which means that growth could be handled by a sequence of static models like the one developed below.

The city's land area is assumed to be fixed at $\overline{L}$, and land is homogeneous, with differential job access ignored. In addition, land heterogeneity between formal and squatter areas arising from differences in land "servicing" (public utilities, streets, etc.) is also suppressed at the outset, but this element is added to the model once the basic analysis is complete.

Letting L_s and L_f denote the land occupied by squatters and residents of formal housing, respectively, the requirement that the available urban land is fully occupied can be written as

$$L_s + L_f = \overline{L}. \tag{1}$$

Overall land consumption by the two resident groups depends on their individual land consumption levels, which are, in turn, tied to consumption of housing. For simplicity, housing and land consumption are equated, with the structure component of housing suppressed. Therefore, housing consumption for a squatter household

[4] While the tenure insecurity argument implies that informal rent should be lower than formal rent, Mudit Kapoor and David le Blanc (2008) argue that the rent-to-value ratio should be higher for informal than for formal dwellings given that their illegal status makes the income stream riskier. They provide empirical evidence in support of this prediction.

is equal to its consumption of land, denoted q_s, with q_f denoting land (housing) consumption by a formal household. Introducing a simple housing supply sector has no effect on the model, as shown below, following the derivation of the main results.

Letting N_s denote the number of squatter households, the squatter land area must satisfy

$$N_s q_s = L_s. \tag{2}$$

While N_s is an endogenous variable in the model, the size of the city's formal population is fixed, with its value denoted $\overline{N}_f$. Even though both population sizes would be endogenous in a richer model, this assumption allows the analysis to focus on the impact of squatter migration into a city with an established formal population. The formal land area must then satisfy

$$\overline{N}_f q_f = L_f. \tag{3}$$

The incomes of squatters and formal households are denoted y_s and y_f, respectively. The likelihood that squatters are unskilled workers while formal residents are skilled workers would imply $y_s < y_f$. However, almost none of the ensuing analysis depends on the relationship between the two income levels.[5] The main difference between squatters and formal households lies, of course, in their relations with the city's landowners, who are assumed to be absentee.[6] While a squatter household occupies the land for free, a formal household pays rent to the owner of the land it occupies, with p_f denoting the rent per unit of formal land. As a result, the individual consumption level q_f is connected to p_f via the household's housing demand function $d_f(\cdot)$, satisfying the relationship

$$q_f = d_f(p_f). \tag{4}$$

With their land being occupied for free, land consumption by individual squatters is not governed by a demand function in the usual way. The level of q_s is instead determined in a much different fashion, which constitutes a principal innovation of the paper. To begin the discussion, recall that squatters use a portion of their income for "defensive" expenditures, which are designed to raise the cost of eviction by landlords. These expenditures could consist of bribes paid to politicians designed to undercut government support for eviction. Alternatively, the expenditures could cover the cost of legitimate political organizing or, perhaps, payments to neighborhood "security" personnel. Like landlords, the recipients of any income generated by defensive expenditures are assumed to live outside the city.

The cost of eviction is then an increasing function of defensive expenditures per household, denoted A. Since the opposition to evictions is more forceful the larger

[5] With the fixed assignment of the two income groups to squatting and formal housing, endogenous sorting between the two tenure modes is not considered and could be left for future work.

[6] The city's rental income is then spent elsewhere, with local incomes having no rental-income component.

the size of the squatter group, eviction cost also rises with N_s, holding A fixed.[7] Letting k denote an institutional parameter measuring the difficulty of property-rights enforcement in the economy, eviction cost can then be written $e(A, N_s, k)$, with the effect of k positive.

This eviction cost is expressed on a per-unit-of-land basis, so that $e(A, N_s, k)$ gives the cost of squatter removal for each unit of occupied land. The landowner's gain from eviction is the rental income earned when the seized land is rented in the formal sector, equal to p_f. Therefore, in order for landowners to find eviction unattractive, the inequality

$$p_f \leq e(A, N_s, k) \tag{5}$$

must hold.[8] This condition is the "no-eviction" constraint.

As explained in the introduction, the squatter population is governed by a community organizer, who has the power to dictate defensive expenditures A as well as the plot size q_s. In addition, the organizer is initially assumed to control the size, N_s, of the squatter population, an assumption that is relaxed below. The organizer's goal is to choose these variables to maximize the common utility level of squatter households, who share the same well-behaved preferences. Let $u(x_s, q_s)$ denote squatter utility as a function of the consumption of housing (land) and a composite nonhousing good x. Then, using the budget constraint $x_s + A = y_s$, the community organizer's goal is to maximize

$$u(y_s - A, q_s) \tag{6}$$

by choice of A, q_s, and N_s subject to (1)–(5).[9] Given the desirability of setting A at the smallest possible value, the inequality in (5) will hold as an equality at the optimum and can be treated as such in the maximization problem. The maximal value of (6) is assumed to be larger than the rural utility level, denoted $\tilde{u}$, so that the organizer faces a willing supply of squatters.

The nature of the problem faced by the squatter organizer can be seen by considering the various constraints along with the objective function in (6). First, as mentioned above, setting A at a low value raises x_s, but the resulting decline in $e(A, N_s, k)$ invites eviction by landowners. In addition, for given N_s, allowing the plot size q_s to expand raises squatter utility but further squeezes the formal housing sector by raising L_s. The resulting drop in L_f then leads to an increase in the formal rent p_f, again inviting eviction by landowners. Similarly, while a higher N_s reduces the

[7] It could be argued that a very large population size reduces the cohesion of the squatter group, causing eviction cost to fall with N_s at large values. It is interesting to note that, if eviction cost were independent of N_s, then the optimal squatter population is unbounded in the maximization problem considered below.

[8] An alternate approach would be to assume that the e function gives the eviction cost for an entire squatter parcel, not per unit of land. Then, (5) would be replaced by $p_f q_s \leq e(A, N_s, k)$, with the left-hand side giving the formal rent that would be earned by the squatter parcel. This alternate formulation yields conclusions very similar to those reached using (5) while introducing some additional complexity.

[9] An alternative objective function would be total squatter utility, $N_s u(y_s - A, q_s)$, although this alternative would increase the complexity of the analysis. In any case, maximizing individual rather than total utility is seen as the appropriate objective in other types of analyses, including those dealing with the goals of trade unions (see Frans Spinnewyn and Jan Svejnar 1990).

threat of eviction, allowing a reduction in A, it leads to the same squeezing effect as an increase in q_s, and the resulting increase in p_f reverses the decline in the eviction threat. The squatter organizer must balance these various effects, choosing the best values of the decision variables while ensuring satisfaction of the no-eviction constraint in (5).

B. *Optimality Conditions*

To solve the organizer's optimization problem, the five constraints in (1)–(5) can be collapsed to a smaller number. First, using (4) and (5), q_f can be written as $q_f = d_f(e(A, N_s, k))$. Then, combining (1)–(3) yields $N_s q_s = \overline{L} - \overline{N}_f q_f$, and substituting the previous solution and solving for q_s yields

$$q_s = \frac{\overline{L} - \overline{N}_f d_f(e(A, N_s, k))}{N_s}. \tag{7}$$

The objective function can then be written as

$$u\left(y_s - A, \frac{\overline{L} - \overline{N}_f d_f(e(A, N_s, k))}{N_s}\right), \tag{8}$$

which is maximized by choice of A and N_s.

The first-order condition for choice of A reduces to

$$\frac{u^x}{u^q} = -\frac{\overline{N}_f d_f' e^A}{N_s} \equiv \frac{\partial q_s}{\partial A}, \tag{9}$$

where superscripts denote partial derivatives. This condition says that the loss from less x_s due to a marginal increase in A (given by u^x) should equal the gain from a higher q_s ($u^q \partial q_s/\partial A$). Note that the $\partial q_s/\partial A$ expression in the middle of (9) captures the following sequence of effects: the higher A raises eviction costs, allowing p_f to rise by e^A; the resulting reduction in q_f is $d_f' e^A$; multiplying by $\overline{N}_f$ gives the reduction in L_f, which equals the increase in L_s; dividing by N_s then yields the increase in q_s.

Since N_s only appears in the q_s argument of (8), differentiation of (7) yields the first-order condition for N_s, which can be written as

$$-\overline{N}_f d_f' e^{N_s} = \frac{\overline{L} - \overline{N}_f d_f}{N_s} \equiv q_s. \tag{10}$$

To interpret this condition, note that since $q_s = L_s/N_s$ from (2), maximizing q_s means maximizing "average" land consumption (total squatter land divided by population). But maximizing the average requires setting the marginal effect of N_s equal to the average itself, so that $\partial L_s/\partial N_s = L_s/N_s$ holds. The left-hand side of this equality is just the first expression in (10) (using the previous logic), while L_s/N_s is the second expression.

For (9) and (10) to yield a maximum, the relevant second-order conditions must be satisfied. For a simple understanding of these conditions, the maximization problem can be viewed as being solved sequentially, with N_s chosen conditional on A and with A then optimized in a second stage. From this perspective, the second-order conditions will be met if the following requirements are satisfied. First, q_s from (7) should be a strictly concave function of N_s, holding A fixed, at least in a neighborhood of the value where the derivative is zero. Then (10), the first-order condition for N_s, will yield a maximum conditional on A. It can be shown that this concavity condition reduces to $d_f' e^{N_s N_s} + d_f''(e^{N_s})^2 > 0$, where the double superscript denotes second partial derivative. Second, letting $N_s^*(A)$ be the N_s solution from (10) conditional on A, and letting $f(A, N_s)$ denote the q_s expression in (7), $f(A, N_s^*(A))$ should be a concave function of A.[10] Then, the optimization problem involves maximizing $u(y - A, q_s)$ subject to the concave constraint $q_s = f(A, N_s^*(A))$. With the utility function well behaved, the first-order conditions (9) and (10) then jointly yield a maximum.

The solutions for the endogenous variables A, q_s, N_s, L_s, L_f, and p_f depend on the parameters of the problem: $\overline{L}$, $\overline{N}_f$, y_s, y_f, k, and the parameters of $u(\cdot)$ and d_f. But given the complexity of the model, a general comparative-static analysis yields ambiguous conclusions. As a result, the remainder of the analysis focuses on a special case that imposes specific forms for the various functions appearing in the optimization problem. Satisfaction of the second-order conditions can also be verified under these functional forms.

Before turning to the special case, several additional points require discussion. First, in order for the above solution to make sense, squatting must be "sustainable;" squatters should not be able to raise their utility by entering the formal housing market. A condition on parameters that ensures sustainability is derived below for the special case. Second, formal households should not be able to gain by becoming squatters. This possibility is ruled out by assuming that squatting carries a strong enough stigma to make it unattractive, under any circumstances, for formal households. Such an assumption can be justified by imagining that formal employers engage in spatial "redlining" of workers, refusing to give jobs (or offering lower wages) to individuals living in undesirable areas of the city. See Yves Zenou and Nicolas Boccard (2000) and Zenou (2002) for detailed analyses of models with this kind of redlining behavior.

C. *The Special Case*

In the special case, which is imposed for the remainder of the analysis, squatters and formal residents have the common Cobb-Douglas utility function $x^{1-\alpha}q^{\alpha}$, where $0 < \alpha < 1$. The formal housing demand function is then given by $d_f(p_f) \equiv \alpha y_f / p_f$. In addition, the eviction-cost function is given by $e(A, N_s, k) \equiv kAN_s$, indicating that eviction cost is proportional to the total defensive expenditures of squatters, AN_s, with the proportionality factor equal to the property-rights parameter k. Then, (7)

[10] It can be shown that concavity of the f function requires

$$(d_f' e^A / N_s - d_f'' e^{AN_s})\,(d_f' e^A / N_s - d_f' e^{AN_s} - d_f'' e^{N_s} e^A) - (d_f' e^{N_s N_s} + d_f''(e^{N_s})^2)\, d_f'' e^{AA} \leq 0.$$

becomes $q_s = (1/N_s)(\overline{L} - \alpha y_f \overline{N}_f / kAN_s)$, and, as shown in the Appendix, the solutions for the endogenous variables are given by

$$A = \alpha y_s \tag{11}$$

$$q_s = \frac{k y_s \overline{L}^2}{4\overline{N}_f y_f} \tag{12}$$

$$N_s = \frac{2\overline{N}_f y_f}{k y_s \overline{L}} \tag{13}$$

$$L_s = L_f = \frac{\overline{L}}{2} \tag{14}$$

$$p_f = \frac{2\alpha \overline{N}_f y_f}{\overline{L}}. \tag{15}$$

These solutions show that squatters devote a fraction α of their income to defensive expenditures. While this outcome is natural given Cobb-Douglas utility, other features of the solution are somewhat surprising. In particular, the amount of land occupied by squatters, L_s, equals exactly half of the city's land area, regardless of squatter and formal income levels, the strength of property rights, the size of the formal group, or the magnitude of the preference parameter α. This result is a consequence of the maintained functional form assumptions and has no easy intuitive explanation. Since L_f, the supply of land to the formal market, is also independent of the above parameters, it follows that the formal price p_f depends only on the parameters that affect formal demand ($\overline{N}_f$, y_f, and α), being independent of y_s and k. Thus, the extent of squeezing of the formal market is curiously independent of these two key features of the squatter environment. By contrast, all of the model's parameters (aside from $\overline{L}$) affect how the fixed squatter land area is allocated, determining whether the area has a large number of squatters and small plots or, alternatively, few squatters and large plots. Note that the positive effect on N_s of an increase in $\overline{N}_f$ or y_f, and the negative effect of an increase in $\overline{L}$, appear to be generated by the interaction of squeezing and the need to deter eviction. A higher $\overline{N}_f y_f$ raises the demand for formal housing and thus p_f, which requires the squatter organizer to raise the squatter population in order to deter eviction (recall that eviction cost rises with N_s). Conversely, an increase in $\overline{L}$ reduces p_f, allowing N_s to fall (and q_s to rise) without inviting eviction.

D. *Formalization and the Impact of Squatting on Formal Households*

Because the extent of squeezing of the formal market by squatters is independent of the model's parameters, the solution in (11)–(15) tends to obscure the welfare impact of squatting on formal residents. To highlight that impact, it is useful to ask a broader question that goes beyond the comparative-static exercise. In particular, how does the very existence of squatting affect formal residents? In other words, if the squatter households were "formalized," being forced to pay for the land they occupy, would the original formal households be better off? Answering this question will also lead to an analysis of squatter formalization as a policy option.

To answer the given question, another issue must be addressed first: sustainability of the squatter equilibrium. In order for the equilibrium characterized by (11)–(15) to be sustainable, squatter households should not be able to gain by individually opting out, switching to formal residence at the prevailing formal rental price. Using the Cobb-Douglas demand functions, the x and q consumption levels following such a switch equal $(1 - \alpha)y_s$ and $\alpha y_s/p_f$, respectively. The condition for the absence of a gain is then

$$[(1 - \alpha)y_s]^{1-\alpha} (\alpha y_s/p_f)^{\alpha} < (y_s - A)^{1-\alpha} q_s^{\alpha}. \tag{16}$$

Note that since $A = \alpha y_s$, x consumption is the same on both sides of (16), which implies that the inequality holds if q is lower after the switch. Substituting for p_f and q_s from (12) and (15) and rearranging, (16) reduces to the condition

$$k\overline{L} > 2. \tag{17}$$

Therefore, for the squatter equilibrium to be sustainable, the city land area weighted by the property-rights parameter should be sufficiently large.[11]

Using this result, the welfare impact of squatting on formal residents can be derived, answering the above question. This impact is found by computing the formal price that would prevail if the equilibrium group of squatter households were formalized, becoming formal residents. If that price is lower than the p_f solution in (15), then formal residents are harmed by squatting.

If squatters were formalized, the aggregate demand function for land in the city would be given by $\alpha(N_s y_s + \overline{N}_f y_f)/p_f$. This demand is larger than the demand from formal households alone, but formalization also means a doubling of the supply of land to the formal sector, from $\overline{L}/2$ to $\overline{L}$. Setting demand equal to $\overline{L}$ and substituting for N_s from (13), the new equilibrium price would equal

$$\hat{p}_f = \frac{\alpha(N_s y_s + \overline{N}_f y_f)}{\overline{L}} = \frac{\alpha[2\overline{N}_f y_f/k\overline{L} + \overline{N}_f y_f]}{\overline{L}}. \tag{18}$$

However, using the sustainability condition (17), it follows that

$$\hat{p}_f < \frac{2\alpha \overline{N}_f y_f}{\overline{L}} = p_f. \tag{19}$$

[11] The sustainability condition is also relevant to the comparison of $\overline{N}_f$ and the equilibrium squatter population. Using (13), $N_s > (<) \overline{N}_f$ holds as $y_f > (<) (k\overline{L}/2)y_s$. Given $y_f > y_s$ and (17), the direction of this inequality is ambiguous. Since the housing consumption levels for the two groups are given by $\overline{L}/2$ divided by their respective populations, the comparison between q_s and q_f is then also ambiguous. In order for q_s to be realistically smaller than q_f, $N_s > \overline{N}_f$ must hold, which requires that $k\overline{L}$, while larger than 2, should not be too much larger.

Thus, when the squatter equilibrium is sustainable, the formal price would be lower if all squatters were formalized. As a result, formalization benefits existing formal households.[12]

Note that, with a lower rental price, individual and thus total land consumption by the original formal households is higher after the squatters have been formalized. Instead of splitting the city's land area equally, the original formal residents then occupy an area larger than $\overline{L}/2$, while the original squatters occupy a smaller area. Thus, squeezing of the formal housing market is relaxed by formalization.

With the total land area occupied by squatters lower after formalization, and their number held fixed by assumption, individual land consumption is lower as well. Given that x consumption remains the same at $(1 - \alpha)y_s$, it follows that squatters are worse off following formalization. Summarizing yields

PROPOSITION 1: *Under the maintained functional-form assumptions, formal residents benefit from formalization of squatter households, indicating that they are harmed by squatting. Conversely, squatter households are made worse off by formalization.*

Recall that, when (17) holds, a single squatter household is worse off when it alone is switched to formal tenure (which leaves the formal price unaffected). Proposition 1, however, indicates that the welfare of each squatter household falls when the entire group is formalized, even though this event leads to a decline in the formal price. Interestingly, the sustainability condition (17) is necessary and sufficient for a decline in squatter welfare in both cases, even though they involve different formal prices.[13]

E. *Inefficiency of the Squatter Equilibrium*

While squatters lose when they are formalized, could formal households offer compensation for this loss while still enjoying a net gain? To address this question, the first step is to note that, since such compensation is just an income transfer, it leaves total income unchanged and has no effect (under Cobb-Douglas preferences) on the price $\hat{p}_f$ that prevails in the new equilibrium where everyone is a formal resident. Therefore, the analysis can proceed by computing compensating variations while holding $\hat{p}_f$ fixed.

The compensating variation for squatters, denoted C_s, equals the addition to income that allows each squatter household to achieve its original utility in the new equilibrium, and it satisfies

[12] It can be shown that this result also holds for a general utility function. However, the proof (which is available on request) maintains the assumed multiplicative form of the $e(A, N_s, k)$ function.

[13] This conclusion can also be seen by evaluating (16) with $\hat{p}_f$ in place of p_f. Note that while (16) previously reduced to $k\overline{L} > 2$, (16), with $\hat{p}_f$ in place of p_f, reduces to $k\overline{L} > 4/(2/k\overline{L} + 1)$. Since the right-hand side of the last inequality exceeds 2 when $k\overline{L} > 2$, the inequality is satisfied by a narrower margin, indicating the loss from switching to formal residence is smaller when the rental price is lower, at $\hat{p}_f$. But after rearrangement, the inequality reduces to $k\overline{L} > 2$, the original sustainability condition.

$$(y_s - A)^{1-\alpha} q_s^{\alpha} = [(1 - \alpha)(y_s + C_s)]^{1-\alpha}[\alpha(y_s + C_s)/\hat{p}_f]^{\alpha}. \tag{20}$$

Substituting the previous solutions for A, q_s, and $\hat{p}_f$ and solving yields

$$C_s = y_s\left[\left(\frac{1}{2} + \frac{k\overline{L}}{4}\right)^{\alpha} - 1\right]. \tag{21}$$

Note that C_s is appropriately positive when the sustainability condition $k\overline{L} > 2$ holds, indicating an uncompensated loss from formalization.

Similarly, the compensating variation for formal households, denoted C_f, equals the income loss that reduces their utility following formalization to the original level, and it satisfies

$$[(1 - \alpha)y_f]^{1-\alpha}(\alpha y_f / p_f)^{\alpha} = [(1 - \alpha)(y_f - C_f)]^{1-\alpha}[\alpha(y_f - C_f)/\hat{p}_f]^{\alpha}. \tag{22}$$

Substituting the previous solutions and solving yields

$$C_f = y_f\left[1 - \left(\frac{1}{2} + \frac{1}{k\overline{L}}\right)^{\alpha}\right], \tag{23}$$

a positive expression when $k\overline{L} > 2$.

In order for compensation of the former squatter households to be feasible, the inequality

$$\overline{N}_f C_f > N_s C_s \tag{24}$$

must hold, indicating that the outlay that keeps formal households at their original utility level is more than sufficient to keep former squatters at their original utility level. Substituting for N_s and using (21) and (23), the inequality in (24) reduces to

$$\frac{k\overline{L}}{2}\left(1 - \left(\frac{1}{2} + \frac{1}{k\overline{L}}\right)^{\alpha}\right) + 1 - \left(\frac{1}{2} + \frac{k\overline{L}}{4}\right)^{\alpha} > 0. \tag{25}$$

Since the Appendix shows that this inequality is satisfied, it follows that formal households can compensate squatters for the losses they incur in being formalized. Note that if the compensation were designed to keep squatters at their original utility level, each formal household would contribute an amount equal to $T \equiv N_s C_s/\overline{N}_f < C_f$ from (24).

While this result points toward an inefficiency verdict in evaluating the squatter equilibrium, the economy has two additional stakeholder groups whose welfare must be considered. Absentee landowners clearly are affected by squatting, and their income in the original equilibrium is equal to $p_f\overline{L}/2 = \alpha\overline{N}_f y_f$. Although the rental price falls, the area generating land rent doubles when the squatters are formalized, yielding total income of $\hat{p}_f\overline{L} = \alpha\overline{N}_f y_f(2/k\overline{L} + 1)$. Subtracting, landowners then enjoy a gain of

$$\hat{p}_f\overline{L} - p_f\overline{L}/2 = 2\alpha\overline{N}_f y_f/k\overline{L}. \tag{26}$$

Another potential stakeholder group, the recipients of income from squatter defensive expenditures (political operatives, for example), must also be considered. These expenditures, which equal AN_s in total, disappear when the squatters are formalized, resulting in an income loss of this magnitude for the recipients. Remarkably, however, the lost income of AN_s exactly equals the gain to absentee landowners in (26), as can be seen by substituting the A and N_s solutions. Therefore, landowners can exactly compensate these income recipients for their loss.

Summarizing the foregoing results yields[14]

PROPOSITION 2: *The squatter equilibrium is inefficient. In particular, if squatter households were formalized, the gainers (original formal residents, absentee landowners) could compensate the losers (former squatters, recipients of defensive expenditures) for their losses.*

Note that another population group, potential squatters who remain in rural areas, is unaffected by the switch and need not be considered.[15]

The inefficiency of the squatter equilibrium is, from one perspective, not very surprising. However, since this finding requires comparisons of the outcomes under two different behavioral regimes (squatting versus formal residence), it differs from a typical inefficiency verdict, which focuses on the gain from removing a distortion within a single institutional framework. The source of the inefficiency in the present model is evidently the absence of mutually accepted transactions between squatters and landowners, which constitutes a market failure that allows room for general improvement when squatters are formalized.[16]

Although the model is highly stylized, making the results mainly suggestive, Proposition 2 points to an important policy lesson. Since the gainers from formalization in the model can compensate the losers, the Proposition suggests that the government could engineer a mutually agreeable transition out of a squatter equilibrium. Using the tax system or some other method, it must transfer income from formal households to squatters in return for their agreement to formalize, while assuring the formal households that they will end up better off despite the transfer.

[14] This result and the subsequent proposition are conditional on the maintained functional-form assumptions.

[15] Another indicator of the inefficiency of the equilibrium is a difference in the marginal rate of substitution (MRS) between housing and x across squatters and formal households. While $u^q/u^x = p_f$ holds for formal households, the MRS for squatters is given by the reciprocal of (9). Evaluating the expression using the solutions from (11)–(15) and simplifying, the squatter MRS equals $2p_f/k\overline{L}$, which is less than p_f when (17) holds. We thank Spencer Banzhaf for this observation.

[16] To put this result into context, observe that the literature on land-tenure formalization, both for rural areas (Gershon Feder et al. 1988, Feder and Ahihiko Nishio 1998, and Klaus Deininger 2003) and for urban areas (Field 2005, 2007, Galiani and Schargrodsky 2004, Di Tella et al. 2007), exclusively focuses on some specific potential consequences of land titling such as capital investment, labor market participation, or health improvement. None of these works focuses on the redistribution effects of formalization in a unified land-market framework.

Escape from the squatter equilibrium can raise welfare for everyone, but the transition will not occur unless the government assumes the missing coordination role.[17]

II. Realistic Embellishments of the Model

A. *Formalization and Land Servicing*

The harmful impact of formalization on squatter households needs to be qualified given that formalization programs are almost always accompanied by some degree of improvement in infrastructure and land servicing, as provided by the local government. In other words, while formalized squatters tend to incur a loss from their exposure to the market price of land, they may benefit from improved access to infrastructure and land services. Whether the net outcome is beneficial depends on the relative intensities of the two effects, as well as on the financing of the policies. In particular, whether the cost of infrastructure improvements should be recovered from the beneficiaries or subsidized has been at the center of a debate for years. In practice, the full-cost recovery of slum-upgrading projects may prove difficult (Buckley and Kalarickal 2006), so that infrastructure improvements may require subsidies to cover all or part of the cost.

The model allows a straightforward discussion of infrastructure improvements and land servicing, financed by taxes on the original formal residents. These taxes take the place of the cash transfers discussed above. Suppose that formal occupancy requires servicing of the land, at a cost of g per household.[18] Before formalization of the squatters, formal households pay only for the servicing of their own land through taxes, so that their budget constraint is $g + x_f + p_f q_f = y_f$. Assuming that land services are a perfect substitute for x consumption (recall that x is a composite, nonhousing good), formal utility is then $u(g + x_f, q_f) = u(y_f - p_f q_f, q_f)$, leaving the objective function of formal households the same as without land servicing. If formal households were to pay an additional tax of t to finance provision of services on former squatter land, utility would become $u(y_f - t - p_f q_f, q_f)$.

The magnitude of the tax t depends on the level of these services, denoted h. While h could equal g, indicating equal service provision throughout the city, $h < g$ would hold if inferior services are provided to formalized land. Given h, the tax on the original formal households must then equal $t = N_s h/\overline{N}_f$.

The servicing expenditure of h effectively increases x consumption for the former squatters and helps to offset the utility loss from facing the market price of land.[19] If $h > C_s$ from (21), then the benefits from land servicing are more than enough to offset this loss. However, if $h < C_s$ holds, then the original formal households must offer an additional cash transfer of $r = N_s C_s/\overline{N}_f - t$ to induce squatters to accept formalization. Instead of paying t, their payment is then $t + r = N_s C_s/\overline{N}_f \equiv T$.

[17] Although the discussion has viewed the transfers to squatters' households as coming from formal residents, tranfers more generally can originate with any agent who gains from formalization. Thus, landowners could also provide funds for squatter compensation.

[18] This cost is the annualized capital cost of infrastructure plus the recurring cost of services.

[19] It can easily be checked that the equilibrium land price is the same as in the case without land services, a consequence of the fact that the provision of services is equivalent to a cash transfer.

This discussion shows that the land servicing requirement has no effect on the preceding analysis, with the required servicing outlay encompassed in the transfer from formal to squatter households.[20] Note, however, that this conclusion is overturned if the tax required to support servicing costs exceeds the amount formal households are willing to pay for formalization (if $t > C_f$). Then, voluntary formalization cannot occur unless additional outside resources can be found for squatter compensation.[21]

B. *Adding a Simple Housing Supply Sector*

In place of direct land consumption by households, housing could be produced using a simple technology. Suppose that one unit of land continues to yield one unit of housing in both the formal and squatter areas, but that a cost is incurred to convert the land to housing. Let a_f and $a_s < a_f$ denote the conversion costs per unit of land, with the lower squatter cost reflecting an ability to use cheaper construction methods. A quality difference between the two types of housing is still absent, and introducing one could be a possible extension of the model.

Suppose that housing is produced by competitive developers in both the formal and squatter areas. In the formal area, the developer's profit per acre is $p_f - r_f - a_f$, where p_f is again the rent per unit of housing and r_f is the rent per unit of land, rents that are now distinct. Housing rent p_f is determined as before, while the zero-profit condition for developers yields $r_f = p_f - a_f$. Thus, land rent in the formal area now equals housing rent minus the formal conversion cost per acre.

Squatter choices continue to be dictated by the organizer, but squatters now illegally rent housing from the competitive developers. These developers pay no land rent, having seized the land without compensating its owners, but they do incur the conversion cost of a_s per unit. Competition forces the housing rent charged to squatters down to the level a_s, leaving developers with zero profit per acre. Thus, in addition to their outlay A for defensive expenditures, squatters now make a rent payment of a_s. Aside from this change and the subtraction of a_f in the formula for formal land rent, the model is otherwise unchanged.[22]

[20] Observe that an alternative way of modeling the benefits of improved infrastructure to formalized households could relax the assumption of perfect substitution between services and x consumption. For instance, preferences could be represented by a separable utility function of the form $u(x,q) + v(g)$. Assuming that $v'(0)$ is large, formalized squatters would receive a large benefit from even a small level of services as opposed to none at all. Under this new assumption, only a small transfer from formal households would be required to compensate formalized households for their exposure to market prices. It might even be the case that no transfer at all is needed, so that formalized households would gain even when bearing the full cost of services themselves. Even though no resource transfers to squatters would then be required for formalization, the government must play an active role by offering land services. A dysfunctional government might fail to do so, blocking what would otherwise be a frictionless transition out of a squatter equilibrium.

[21] This difficulty could be addressed by a reduction in h, but the t associated with minimum possible servicing expenditure could be larger than formal households are willing to pay. It should also be noted that a more elaborate analysis of service provision would acknowledge the links between the spatial extent of a city's infrastructure network, the development of land, and squatting. In a situation where public resources for infrastructure provision are constrained, landowners who can successfully lobby the local government to get their land serviced would make it available for formal development, whereas those who are unsuccessful would keep the land undeveloped, encouraging squatting. Since landlord efforts in lobbying for infrastructure provision depend on the price of formal land, and since that price is affected by the squeezing effect from squatting, this more complex model would yield results comparable to those obtained using the current approach.

[22] Two other realistic alterations of the model can be introduced easily. First, suppose that formalization involves a transactions cost of z for each squatter household. The right-hand side of the compensation condition

C. *Squatting on Government or Marginal Land*

Squatters often occupy land that is government-owned or marginal in quality, where eviction is less of a threat than on private prime land. The model applies to these cases as well, under a particular assumption. To see the argument, let L_g denote the amount of vacant government land in the city (alternatively, this could be land of marginal quality). Assuming the threat of eviction is low on such land, it will be fully occupied by squatters. But suppose the gains from squatting are sufficient to induce occupation of some prime land as well, with the amount of such land denoted $\tilde{L}_s$, which satisfies $\tilde{L}_s + L_g = L_s$. Then, the no-eviction constraint (5) becomes relevant, and the previous equilibrium conditions apply. This argument assumes, however, that the squatters occupying government land are required by the organizer to make the same defensive outlay A as squatters on prime land, even though their eviction threat is lower, while also consuming a plot of the same size. These requirements are plausible given that the totality of defensive expenditures by squatters, both on prime and government land, may be relevant in deterring the eviction threat on prime land.

III. Variants of the Model

A. *Uncontrolled Squatter Migration*

So far, the squatter population size has been controlled by the organizer, who has the power to limit migration into the city. Since this assumption may be unrealistic, it is useful to explore the alternate case where migration cannot be controlled. In this case, N_s is no longer a decision variable of the squatter organizer, who now chooses A to maximize utility in (8) viewing N_s as parametric. The optimality condition in (9) remains relevant,[23] but the previous first-order condition (10) for N_s is replaced by a new equilibrium condition, which says that squatter utility equals $\tilde{u}$, the prevailing level in rural areas:

$$(y_s - A)^{1-\alpha} q_s^{\alpha} = \tilde{u}, \tag{27}$$

where q_s is given by (7). Thus, squatter migration proceeds up to the point where the gain relative to rural living is exhausted. Note that the squatter organizer attempts to maximize utility through choice of A even though migration ultimately forces utility

(24) then becomes $N_s(C_s + z)$, and if z is sufficiently large, the condition will no longer be satisfied. Thus, if the transactions cost of formalization is high, a mutually agreeable transition out of a squatter equilibrium may not be possible. Secondly, formalization may yield noninfrastructure benefits that are not captured by the model. While the existing empirical evidence does not show that formalized households have better access to credit, as sometimes claimed, it does suggest significant labor-market effects and health improvements (see Durand-Lasserve and Selod forthcoming, for a survey). If these effects generate dollar benefits of m per household, then the net cost of formalization is $z - m$, which could take either sign. The presence of such benefits clearly relaxes the compensation condition, improving the prospects for voluntary formalization.

[23] It can be shown that the second-order condition for choice of A conditional on N_s is satisfied. The second total derivative of utility with respect to A, holding N_s fixed, is globally negative.

down to the rural level. Equations (27) and (9) jointly determine the values of A and N_s in the uncontrolled-migration equilibrium.

Unlike in the earlier analysis, closed-form equilibrium solutions are not available for the uncontrolled-migration case, and comparative-static analysis of the equilibrium does not produce determinate results. Nevertheless, some useful comparisons between the equilibria with controlled and uncontrolled migration can be derived. To begin, consider Figure 1, which shows squatter utility as a function of N_s, where A has been chosen optimally, conditional on N_s via (9).[24] When the organizer can control migration, N_s is chosen to maximize squatter utility, leading to the value N_s^* in the figure, equal to (13), and a utility level of u^*. In the uncontrolled equilibrium, however, the squatter population expands up to $\tilde{N}_s > N_s^*$, exhausting the gain from migration. Note that, while another value of N_s lying below N_s^* also leads to a squatter utility of $\tilde{u}$ (see Figure 1), this outcome represents an unstable equilibrium.[25]

Relative to the controlled equilibrium, the impact of uncontrolled migration can be analyzed by deriving the effect of a parametric increase in N_s on the remaining variables of the model. Relying on the special case, the first step is to derive the impact on defensive expenditures A. Solving (9), which is a quadratic equation in A (see (A3) in the Appendix), yields

$$A = \frac{1}{N_s}\left(\Phi + \sqrt{\Phi^2 + \Omega N_s}\right), \tag{28}$$

where Φ and Ω are positive expressions.[26] It is easily seen that $\partial A/\partial N_s < 0$ holds, indicating that defensive expenditures fall in moving to the uncontrolled-migration equilibrium. To derive the impact on the formal price, multiplication of (28) by N_s and use of $p_f = kAN_s$ from (5) yields $p_f = k(\Phi + \sqrt{\Phi^2 + \Omega N_s})$, an increasing function of N_s. Therefore, the formal price rises moving from the controlled to the uncontrolled-migration equilibrium, indicating a decline in the formal land area L_f and an increase in L_s. Thus, uncontrolled migration leads to greater squeezing of the formal market, as intuition would suggest. Finally, since $u(y_s - A, q_s) = \tilde{u} < u^*$ holds while A falls, it follows that q_s must be lower with uncontrolled migration. Note that the increase in N_s offsets this decline in q_s, leading to the increase in the squatter land area. Summarizing yields

PROPOSITION 3: *In moving from the controlled squatter equilibrium to the uncontrolled-migration equilibrium, the squatter population N_s rises. In response, defensive expenditures A, the squatter plot size q_s, and the formal land area L_f fall, while the squatter land area L_s and the formal price p_f rise. The welfare of formal residents declines.*

[24] Note that this sequence is the reverse of the two-stage sequence discussed earlier in deriving the second-order conditions (choice of N_s conditional on A followed by choice of A).

[25] Figure 1's curve relating squatter utility to N_s must have a local maximum at N_s^* given satisfaction of the second-order conditions for the controlled-migration case.

[26] These expressions are given by $\Phi = (1-2\alpha)\alpha y_f \overline{N}_f/[2(1-\alpha)k\overline{L}]$ and $\Omega = \alpha^2 y_s y_f \overline{N}_f/[(1-\alpha)k\overline{L}]$.

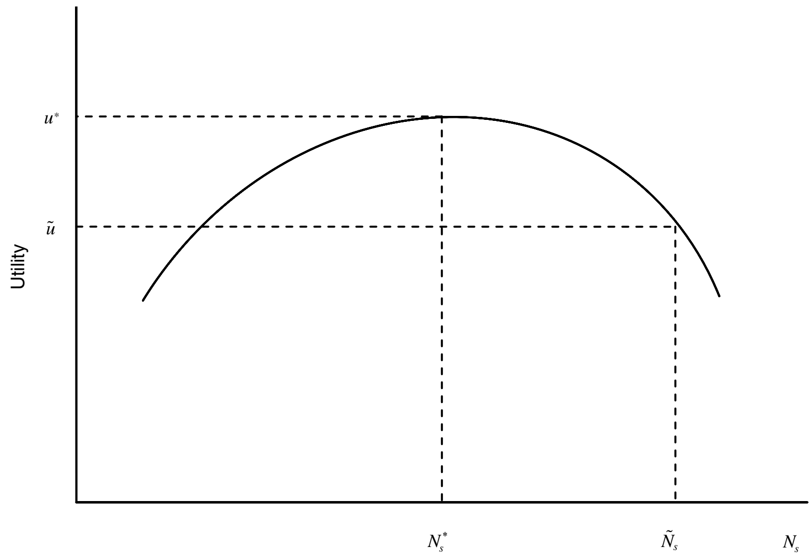

Figure 1. The Uncontrolled-Migration Equilibrium

A sustainability condition is again required to ensure the viability of the uncontrolled-migration equilibrium. This condition once again requires satisfaction of (16), but given (27), sustainability reduces to the requirement

$$\tilde{u} > [(1-\alpha)y_s]^{1-\alpha}(\alpha y_s/p_f)^{\alpha}, \tag{29}$$

which must hold at the new equilibrium value of p_f. In the absence of closed-form solutions, however, this condition cannot be reduced to a parametric statement like (17).

With uncontrolled migration, the analysis of squatter formalization differs from the previous case. While squatters previously required compensation to accept formalization, rural migrants now receive a utility of $\tilde{u}$ regardless of the city's institutional arrangement, given the unlimited supply of new households at this reservation utility level. As a result, if all migrants to the city were formalized, their equilibrium utility would be unaffected. However, assuming that the initial squatter equilibrium was sustainable, the original formal households would be better off. This conclusion follows because the new migration equilibrium condition is $\tilde{u} = [(1-\alpha)y_s]^{1-\alpha}(\alpha y_s/p_f)^{\alpha}$, which insures that rural migrants, now living in formal housing, achieve the rural utility level. This condition, which determines p_f, yields a value lower than in any sustainable squatter equilibrium (compare (29)), implying a gain for the original formal residents. So even though formal residents would be willing to pay squatters to formalize, the squatters themselves require no compensation, at least in equilibrium.[27]

[27] The two other stakeholder groups would be affected by formalization. While the recipients of income from defensive expenditures would lose, the effect on absentee landowners is ambiguous in the absence of closed-form

Numerical solutions for the uncontrolled-migration case reveal some comparative-static properties of the squatter equilibrium, while allowing the sustainability condition to be checked. Results that are available on request give particular insight into the effect of the property-rights parameter k.[28] Although this parameter had no effect on the squeezing of the formal market in the controlled-migration model, a strengthening in property rights (a reduction in k) limits squeezing when migration is uncontrolled, reducing p_f. This result suggests an interesting possibility. If property rights could be strengthened through costly institutional investment by formal residents, the gain from reduced squeezing of the formal market might justify the cost. The "optimal" stringency of property rights would be achieved when the marginal cost of reducing k equals the dollar value of the utility gain from reduced squeezing. For a fully developed model of this kind of "investment" in property rights, see Vimal Kumar (2007).

B. *A Profit-Maximizing Squatter Organizer*

The squatter organizer has so far been portrayed as a benevolent agent, whose goal is to maximize squatter utility. Under an alternate view, however, the organizer could be viewed as self-interested. The organizer would then divert a portion of the outlays meant for defensive expenditures to himself, so that an amount less than A goes toward the intended use. A simple scenario assumes that the organizer can appropriate a fixed share δ of the total defensive expenditures, with the magnitude of δ perhaps limited by potential squatter opposition. The organizer's goal is to maximize his total earnings (or "profit"), equal to $\delta A N_s$. Assuming that the organizer is able to control migration, he maximizes this expression while ensuring that squatter utility is at least as large as the rural level. The relevant constraint, which is $(y_s - A)^{1-\alpha} q_s^{\alpha} \geq \tilde{u}$, will bind at the solution. Note that the q_s expression in this constraint is $(1/N_s) \times (\overline{L} - \alpha y_f \overline{N}_f / k(1-\delta) A N_s)$, with total defensive expenditures equal to $(1-\delta) A N_s$ rather than $A N_s$.

For any given N_s, the constraint determines a corresponding A value, denoted $A(N_s)$, that equates utility to $\tilde{u}$. The squatter organizer's goal is then to maximize $\delta A(N_s) N_s$ by choice of N_s. The first-order condition is $A(N_s) + A'(N_s) N_s = 0$, where the derivative $A'(N_s)$ is computed from the constraint. Assuming satisfaction of the second-order condition, this condition yields the profit-maximizing value of N_s and the corresponding A. As in Section II, a closed-form solution is not available, which, in this case, means that nothing further can be said analytically. However, to demonstrate that the profit-maximization problem can be well behaved, the function $\delta A(N_s) N_s$ can be graphed for given parameter values. For the parameter values used above, the function is concave and single-peaked curve, yielding a proper maximum.[29]

solutions. Assuming that losses within these two stakeholder groups can be compensated (possibly with help from formal residents), the previous inefficiency verdict would again apply.

[28] The parameter values used in the example are $\alpha = 0.4$, $y_s = 0.5$, $y_f = 3$, $k = 1$, $\overline{L} = 10$, $\overline{N}_f = 5$, $\tilde{u} = 0.4$.

[29] Given that the squatter organizer benefits from increases in A and N_s, which raise eviction costs, it might appear that the no-eviction constraint need not bind. To see that this conjecture is incorrect, suppose that A and q_s are set at values that satisfy the utility constraint. Then, the organizer prefers to set N_s at the largest possible

A somewhat more-complex approach to profit maximization would assume that the organizer expropriates an endogenous amount τ from each squatter's defensive outlay, so that the total funds spent for defensive purposes equal $(A - \tau)N_s$ (this change is equivalent to assuming that δ from above is endogenous). This expression replaces $(1 - \delta)AN_s$ in the above q_s formula. With this modification, the utility constraint then determines τ as a function of both N_s and A, so that the organizer's profit is equal to $\tau(N_s, A)N_s$. N_s and A would be jointly chosen to maximize this expression.

IV. Conclusion

This paper has offered a new theoretical approach to urban squatting, reflecting the view that squatters and formal residents compete for land within a city. The key implication of this view is that squatters "squeeze" the formal housing market, raising the price paid by formal residents. The squatter organizer, however, ensures that this squeezing is not too severe, since otherwise, the formal price will rise to a level that invites eviction by landowners. Because eviction is absent in equilibrium, the model differs crucially from previous analytical frameworks, where eviction occurs with some probability.

The main policy lesson of the model is that formalization of squatter households can make squatters and formal residents better off. Formal residents are willing to pay for the reduction in squeezing that accompanies formalization, and the analysis shows that they can pay enough to compensate squatters for their loss in the transition to formal tenure. In practice, this payment could come in the form of infrastructure investments in squatter areas, financed by taxes on formal households. An important implication of this finding is that squatter formalization may not necessarily require external funding from development agencies, requiring only the coordination function provided by the local government to succeed. However, technical assistance from such agencies may still be helpful.

The model is stylized, and future work could be devoted to relaxing some of its assumptions. For example, instead of assuming a fixed urban land area, the supply of land could be made elastic. In addition, housing investment beyond the simple type considered in Section IIB could be allowed, with formal and squatter households adding endogenous amounts of capital to the land. Resident landownership would be another useful modification, replacing absentee ownership. Labor complementarity between formal residents and low-skill squatters could also be introduced, making the formal income y_s an increasing function of the squatter population. Finally, the model's extreme view of formalization could be modified by analyzing an intermediate case, where only a portion of the squatter population is formalized. Given the importance of squatting as a worldwide phenomenon, this kind of additional theoretical work, as well as well-targeted empirical research, deserves high priority.

value. But doing so means reducing the formal land area to zero, which in turns leads to an infinite p_f, causing violation of the no-eviction constraint.

Appendix

A. *Solving for the Squatting Equilibrium under the Special Case*

Under the maintained assumptions, (7) reduces to

$$q_s = \frac{\overline{L} - \overline{N}_f\beta/AN_s}{N_s}, \tag{A1}$$

where $\beta \equiv \alpha y_f/k$. With Cobb-Douglas preferences, the objective function is then

$$(y_s - A)^{1-\alpha}\left(\frac{\overline{L} - \overline{N}_f\beta/AN_s}{N_s}\right)^{\alpha}, \tag{A2}$$

and the first-order conditions for A and N_s ((9) and (10)) reduce to

$$-(1-\alpha)(\overline{L}N_sA^2 - \beta\overline{N}_fA) + \alpha(y_s - A)\beta\overline{N}_f = 0 \tag{A3}$$

$$\beta\overline{N}_f/AN_s^2 - (\overline{L} - \beta\overline{N}_f/AN_s)/N_s = 0. \tag{A4}$$

Rearrangement of (A4) yields

$$AN_s = 2\beta\overline{N}_f/\overline{L}, \tag{A5}$$

and substitution in (A3) yields $A = \alpha y_s$ after rearrangement. Substitution of this A solution into (A5) then yields N_s, and further substitution into the constraints of the problem gives solutions for the remaining variables.

To verify satisfaction of the second-order conditions, note that the second derivative of (A1) with respect to N_s is negative when evaluated at the N_s solution (conditional on A) given by (A5). Therefore, conditional on A, q_s is a strictly concave function of N_s near the value where the derivative is equal to zero, as required for the first-order condition in (A4) to yield a maximum. Next, note that solving (A5) for N_s conditional on A, and then substituting the result into (A1), yields $q_s = \overline{L}^2A/4\overline{N}_f\beta$, a linear function. Thus, under the two-stage view of the optimization problem, the (well-behaved) utility function is being maximized with respect to A in the second stage subject to a linear constraint, ensuring that the resulting first-order condition yields an optimum.

B. *The Sign of (25)*

Letting $b \equiv k\overline{L}$, (25) can be written

$$\text{(A6)}\qquad \frac{b}{2}\left(1-\left(\frac{1}{2}+\frac{1}{b}\right)^{\alpha}\right)+1-\left(\frac{1}{2}+\frac{b}{4}\right)^{\alpha}$$

$$=\frac{b+2}{2}-\frac{b}{2}\left(\frac{b+2}{2b}\right)^{\alpha}-\left(\frac{b+2}{4}\right)^{\alpha}$$

$$=\frac{b+2}{2}-\left(\frac{b}{2}\right)^{1-\alpha}\left(\frac{b+2}{4}\right)^{\alpha}-\left(\frac{b+2}{4}\right)^{\alpha}$$

$$=\frac{b+2}{2}\left[1-\left(1+\left(\frac{b}{2}\right)^{1-\alpha}\right)\left(\frac{b+2}{2}\right)^{\alpha-1}\left(\frac{1}{2}\right)^{\alpha}\right].$$

The series of terms following the 1 inside the large brackets in (A6) is less than unity, establishing positivity of the expression. This fact can be demonstrated by rewriting these terms as

$$\text{(A7)}\qquad \frac{1}{2}\left(1+\left(\frac{b}{2}\right)^{1-\alpha}\right)\left(\frac{1}{2}\right)^{\alpha-1}\left(1\ +\ \frac{b}{2}\right)^{\alpha-1},$$

which will be less than unity when

$$\text{(A8)}\qquad \left(\frac{1}{2}\cdot 1^{1-\alpha}+\frac{1}{2}\cdot\left(\frac{b}{2}\right)^{1-\alpha}\right)<\left(\frac{1}{2}\cdot 1+\frac{1}{2}\cdot\frac{b}{2}\right)^{1-\alpha}.$$

This inequality holds by the definition of strict concavity, as applied to the strictly concave function $w^{1-\alpha}$.

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