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A SIMPLE MODEL OF SQUATTERS

By Eli M. Remolona*

The object of the model is to determine the number of squatters in a city. In the model, households with incomes below a certain threshold level of income choose to squat and households with incomes above that threshold choose not to squat. This threshold depends on the amount of land available to each squatter household, which itself depends on the number of households choosing to be squatters. The equilibrium established consists of values for the threshold and the amount of land per squatter household that are both consistent with utility-maximizing choices, given such factors as the rate of eviction and the distribution of income. An increase in the rate of eviction will reduce the equilibrium number of squatters in a city even if the total amount of squatter land remains fixed. Fewer households choose to squat because of this higher risk of eviction. A numerical example is presented to show how plausible the model is.

1. Introduction

The extent of squatting in many cities of less developed countries is striking. In Metropolitan Manila, for example, more than two million people are squatters.[1] By this count, 26 per cent of the population of the area would be squatters. By Charles Abrams' (1964) estimates, this proportion is 45 per cent in Ankara, 45 per cent in Karachi, 35 per cent in Caracas and 25 per cent in Santiago. Yet, to the best of my knowledge, squatting has not been subjected to formal economic analysis. The model to be developed here is intended to be a step in the direction of remedying this neglect.

The object of the model is to determine the number of squatters in a city. This the model proposes to do by establishing an equilibrium for: (i) a threshold level of income to tell whether a household will choose to squat or not and (ii) the amount of squatter land

*Assistant Professor of Economics, University of the Philippines. The author wishes to thank José Encarnación, Jr., Dante Canlas, Vito Inoferio, and Mahar Mangahas for helpful comments; Tina Bonifacio for research assistance; Pilna Espina for the data and the UPSE for financial support.

[1] Metropolitan Manila Commission. The exact 1979 figure is 2,033,480 squatters.

to be occupied by each squatter household. Such an equilibrium will depend on the rate and cost of eviction, the distribution of income, an index of the market price of urban land, the total amount of squatter land and the population of the city. In this paper, we shall focus mainly on the effects of changes in the rate of eviction. The rest of the factors will, for the most part, be taken as given.

2. Assumptions and Definitions

To keep the model simple, assume that the enforcement of property rights in the city is such that we may usefully consider only two types of land. For one type of land, property rights are so effectively enforced that the services from such land can be acquired only by purchase at a market rent here denoted by q. For the other type of land, property rights are so weakly enforced that such land is vulnerable to occupation by squatters. With such squatter land, we associate a rate of eviction p, a subjective estimate shared by all the households. The total amount of such vulnerable land we denote by x^s, an amount we shall take to be fixed.

We assume further that the amount of squatter land each household may occupy is the same for all squatters. This amount we denote by $\bar{x}$. This seems to be the reasonable assumption to make if all households are of the same size and if squatter land is acquired purely by physical occupation.

The unit of analysis is the household. This household consumes only two goods: residential land x and a composite private good z which we will treat as the numeraire. Our households all have the same tastes and differ only by income.

The distribution of income we take as exogenous and represent it by the cumulative distribution function $F(y)$ where y denotes household income. Finally, we take as given the total number of households in our city. This number we denote by N.

3. The Squatter Model

It is a stylized fact that most squatters are poor. To account for this, suppose that a threshold level of income exists such that households with incomes below the threshold choose to squat and households with incomes above the threshold choose not to squat. Call this threshold $\hat{y}$. In the model, this threshold depends on $\bar{x}$, the amount of land available to each squatter household, which in turn depends on the number of households choosing to be squatters. An equilibrium consists of values for $\hat{y}$ and $\overline{x}$ that are both consistent with utility-maximizing choices of households.

3.1. *Household choice*

Whether a household squats or not depends on which action yields the higher expected utility. The utility a representative household expects as a nonsquatter is utility maximized subject to the usual budget constraint:

$$(1) \qquad \max \; u(x, z) \qquad \text{s.t.} \qquad qx + z \leqslant y.$$

Let this maximized utility be represented by an indirect utility function $V^n(y)$[2].

The utility the household expects as a squatter is the sum of utilities in two states: the state in which the household is not evicted and the state in which it is evicted. The utilities are weighted by the subjective probabilities associated with the states, and maximized subject to constraints that account for the consumption of no more than $\overline{x}$ of residential land if not evicted and for a cost of eviction if evicted:

$$(2) \qquad \max \; (1-p)\, u(\overline{x}, z) + p\, u(x, z')$$

$$\text{s.t.} \quad z \leqslant y \text{ and } qx + z' \leqslant y - c$$

where c is the cost of eviction. Again, let this maximized utility be represented by an indirect utility function $V^s(y, p, \overline{x})$. For convenience we suppress the arguments q and c in V^s and V^n.

It is natural to specify both V^n and V^s to be increasing in y and V^s to be increasing in $\overline{x}$ and decreasing in p.

Now given V^n and V^s the utility of any household is max (V^n, V^s). If for given values of y and $\overline{x}$, V^s exceeds V^n, the household chooses to squat, and if V^n exceeds V^s, the household chooses not to squat.

[2] A good discussion of indirect utility functions can be found in Lau (1969). The Jacobian here should be nonsingular.

3.2. *The equilibrium threshold income*

That a threshold level of income $\hat{y}$ exists implies $V^s(y, p, \overline{x}) > V^n(y)$ for $y < \hat{y}$ and $V^s(y, p, \overline{x}) < V^n(y)$ for $y > \hat{y}$. Sufficient conditions for $\hat{y}$ to exist are:

$$V^s(o, p, \overline{x}) > V^n(o) \text{ and} \tag{3}$$

$$\frac{\partial V^s}{\partial y} < \frac{\partial V^n}{\partial y} \text{ for all } y > 0. \tag{4}$$

These conditions are shown in Figure 1. Assuming such conditions are satisfied and given $\overline{x}$, the threshold is determined by the equilibrium condition:

$$V^s(\hat{y}, p, \overline{x}) = V^n(\hat{y}). \tag{5}$$

What remains to be determined now is the equilibrium value for $\overline{x}$.

3.3. *The amount of land per squatter household*

Given the distribution of income $F(y)$ and the threshold $\hat{y}$, the proportion of squatters in the city is simply $F(\hat{y})$ and the number of squatter households $F(\hat{y})N$. Hence, the equilibrium value for $\overline{x}$ must satisfy the condition

$$X^s = \overline{x}F(\hat{y})N. \tag{6}$$

where X^s is the total amount of squatter land. Here all squatter land is occupied. The eviction of a squatter household does not leave vacant the land the household had occupied. The squatters not evicted take up the space vacated by those evicted.

Suppose from (5) we can write $\hat{y} = g(\overline{x})$ where $g'(\overline{x}) \geqslant 0$: a higher $\overline{x}$ implies a higher $\hat{y}$. Then an equilibrium for $\hat{y}$ and $\overline{x}$ exists. Put $g(\overline{x})$ in (6) and rearrange to get

$$\begin{aligned} \overline{x} &= X^s\,[F(g(\overline{x}))N]^{-1} \\ &= X^s\,H(\overline{x})^{-1} \end{aligned} \tag{7}$$

where $H(\overline{x})$ is monotonically increasing in $\overline{x}$, so that $\overline{x}$ is determined uniquely. This is shown in Figure 2. Hence, conditions (5) and (6) together establish an equilibrium for $\hat{y}$ and $\overline{x}$.

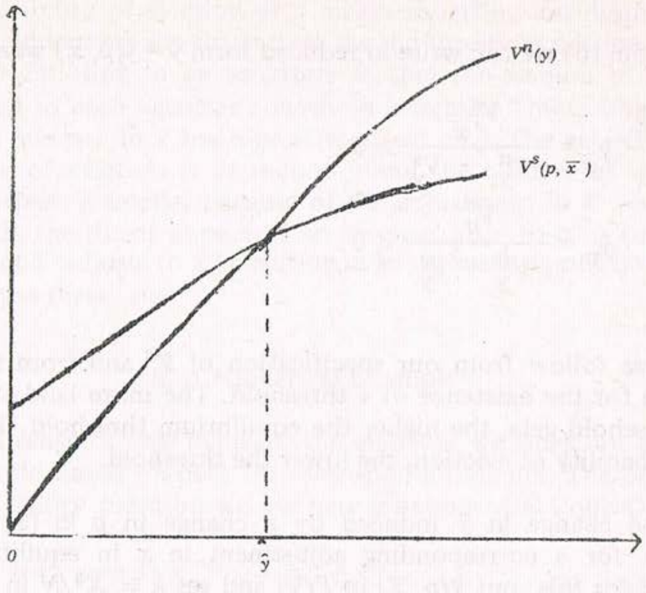

Figure 1. The Threshold Level of Income

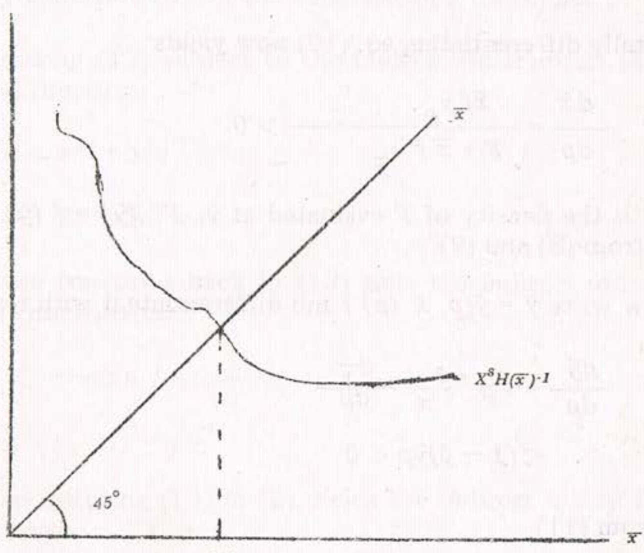

Figure 2. The Amount of Land per Squatter Household

4. Comparative Statics

From (5) we can write in reduced form $\hat{y} = \hat{y}(p, \overline{x})$ where

$$\text{(8)} \qquad \hat{y}_{\overline{x}} = \frac{V^s_{\overline{x}}}{V^n_y - V^s_y} > 0$$

$$\text{(9)} \qquad \hat{y}_p = \frac{V^s_p}{V^n_y - V^s_y} < 0 .$$

The signs follow from our specification of V^s and from the condition (4) for the existence of a threshold. The more land each squatter household gets, the higher the equilibrium threshold. The higher the probability of eviction, the lower the threshold.

The change in $\hat{y}$ induced by a change in p in (9) does not account for a corresponding adjustment in $\overline{x}$ in equilibrium. To account for this, put $\hat{y}(p, \overline{x})$ in $F(\hat{y})$ and set $k \equiv X^s/N$ in (6) where k is fixed:

$$\text{(10)} \qquad k = \bar{x}\, F[\hat{y}(p, x)] .$$

Totally differentiating eq. (10) now yields

$$\text{(11)} \qquad \frac{d\bar{x}}{dp} = \frac{\overline{x} f\, \hat{y}_p}{F + \overline{x}\, f\, \hat{y}_{\overline{x}}} > 0$$

where f is the density of F evaluated at $\hat{y}$: $F'(\hat{y}) = f(\hat{y})$. The sign follows from (8) and (9).

Now write $\hat{y} = \hat{y}(p, \bar{x}(p))$ and differentiate it with respect to p:

$$\text{(12)} \qquad \frac{d\hat{y}}{dp} = \hat{y}_p + \hat{y}_{\overline{x}} \frac{d\overline{x}}{dp}$$

$$= (1 - \beta)\hat{y}p < 0$$

where from (11)

$$\beta = \frac{\overline{x}\, f\, \hat{y}_{\overline{x}}}{F + \overline{x}\, f\, \hat{y}_{\overline{x}}}$$

and clearly, $0 < \beta < 1$. The story behind all this is that an increase in the probability of eviction of p makes squatting less desirable, so the threshold income should decline. As the threshold declines, fewer people are choosing to be squatters so that the amount of land to be allocated to each squatter household increases. This is why $d\bar{x}/dp > 0$ This increase in $\bar{x}$ has a positive effect on $\hat{y}$. The net effect of a higher rate of eviction is to reduce $\hat{y}$ and the number of squatters but this effect is smaller because of the adjustment in $\bar{x}$. As shown in Figure 3, the direct impact of an increase in p to p' is to reduce $\hat{y}$ to $\hat{y}'$. But $\bar{x}$ adjusts to $\bar{x}'$ resulting in an ultimate equilibrium value of $\hat{y}''$ for the threshold.

5. A Numerical Example

For a sense of how plausible the model is, we work out a numerical example based on data for Metropolitan Manila. The primitive household utility function we use here is exponential Cobb-Douglas:

$$u = -exp\ [-x^{-\alpha}(a + z)^{,-\alpha}]. \tag{13}$$

The Cobb-Douglas is used because it is convenient. It is used as an exponent to incorporate risk aversion. The parameter a is there to help satisfy condition (3) for the existence of a threshold.

Maximizing (13) subject to the budget constraint in (1) yields the demand functions

$$x = \alpha(a + y)q^{-1}$$

$$z = (1 - \alpha)y - \alpha a$$

Putting these functions back in (13) gives the indirect utility function for the nonsquatter:

$$V^n = -exp\ [-\gamma(a + y)]$$

where $\gamma = \alpha^{\alpha}(1 - \alpha)^{1-\alpha} q^{-\alpha}$.[3]

Similarly substituting (13) in (2) yields the indirect utility function for the squatter

$$V^s = -(1 - p)\ exp\ [-\bar{x}^{\alpha}\ (a + y)^{1-\alpha}]$$
$$-p\ exp\ [-\gamma(a + dy)]$$

[3] The parameter γ is Pratt's (1964) measure of absolute risk aversion.

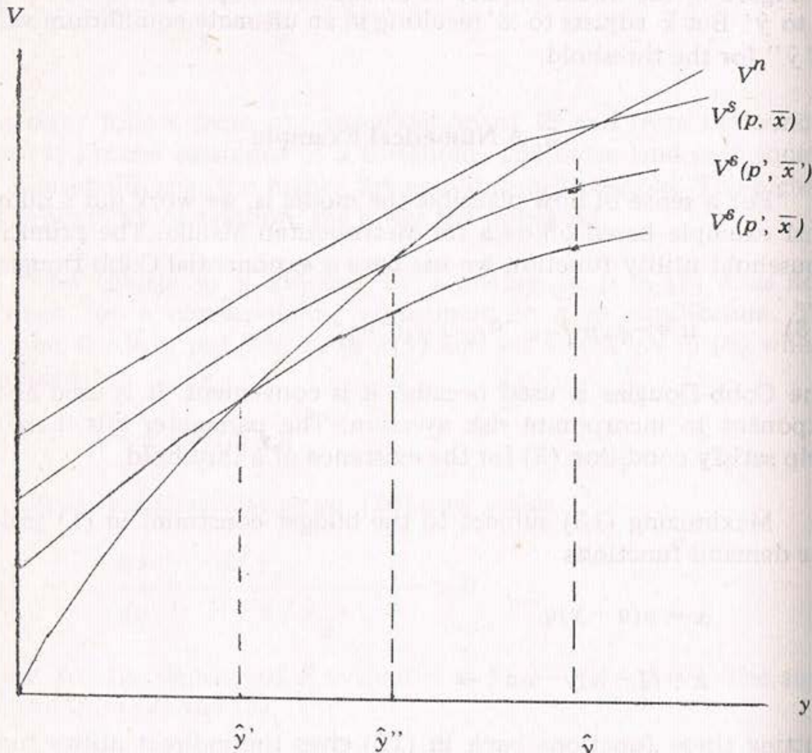

Figure 3. The Effect of a Higher Rate of Eviction

where the cost of eviction is proportional to income: $c = (1 - d)y$ and d is between 0 and 1.

The model is calibrated using the following values:

$\alpha = 0.1$
$q = 0.02$
$a = 4$
$d = 0.9$
$p = 0.1$

The value for α is roughly the ratio of rent expenditures on land to income of an average household.

The value for q is based on a land price of ₱200.00 per square meter converted to rent at a 10 per cent discount rate and expressed in thousands of pesos per year for convenience in computation. The value for a is arbitrarily set close to the subsistence income estimated by Tan and Tecson (1974) and expressed in thousands of pesos per year. With such values, conditions (3) and (4) are easily satisfied.

A lognormal distribution of income for Metropolitan Manila is assumed here. The parameters of the distribution are estimated from 1971 data projected to 1979 by assuming an annual rate of increase of approximately 20 per cent to account for both the rate of inflation and the growth in productivity.

On the basis of 1979 data on squatters from the National Housing Authority, a threshold level of ₱16,000.00 per year seemed to us to be reasonable. If the threshold is set at that level, the equilibrium value for the amount of land per squatter household is 38 square meters and the total amount of squatter land for Metropolitan Manila is 1,248 hectares which is well within the range of estimates by the Metropolitan Manila Commission. This equilibrium is consistent with the actual proportion of squatters in Metropolitan Manila of 26 per cent.

In Table 1, we present our estimates of the effect on the proportion of squatters $F(\hat{y})$ in Metropolitan Manila of varying the rate of eviction from 0 to 0.3, of a ten per cent increase in the geometric mean income, and of one-point and two-point improvements in the Gini ratio.[4] The table shows that the number of squatters is most sensitive to improvements in mean incomes.

[4] Mangahas suggests in conversation that these improvements in income distribution are optimistic five-year targets. Here, we use a formula relating the Gini ratio to the standard deviation of log incomes found in Mangahas and Barros (1979), p. 31.

6. Conclusion

The virtue of the static model just presented is that it yields clear results. An increase in the rate of eviction will reduce the number or proportion of squatters in a city even if the total amount of squatter land remains fixed. Fewer households will choose to squat because of the higher risk of being evicted and the cost associated with eviction. If the eviction of squatters also results in a reduction of squatted land, then the reduction in the number of squatters will obviously be greater.

The model can be extended in a number of ways. We can analyze the effects of changes in the cost of eviction, the market price of urban residential land, the total urban population and the distribution of income. We can specify different types of squatter land with different rates of eviction, perhaps indexed by distance to the center of the city.

A more difficult but more important extension would be to consider the life cycle of squatter households more carefully. Most squatters are apparently fresh migrants to the city. They come not in the hope of evading eviction as squatters, but with the expectation of better conditions, of eventually crossing the threshold. Many of them make it, and this is why other squatters come.

Table 1 — $F(\hat{y})$ for Different Values of the Rate of Eviction and for Improvements in Mean Income and in Income Distribution

Eviction rate p	Mean y=₱26,000.00 $\alpha(\ln y)$=0.78	10% Better mean y	One Gini point improvement	Two Gini point improvement
0.00	0.294	0.254	0.290	0.285
0.05	0.279	0.240	0.275	0.269
0.10	0.263	0.225	0.259	0.253
0.15	0.248	0.211	0.243	0.237
0.20	0.232	0.197	0.227	0.220
0.30	0.200	0.168	0.195	0.188

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