Technological Stagnation, Tenurial Laws, and Adverse Selection

By KAUSHIK BASU*

This note explores the relation between the structure of property rights and output-augmenting activity, like investment and the adoption of new technology.[1] The principal weakness of most existing arguments is that they are one-sided. Consider Gale Johnson's (1950) suggestion that technological innovations do not occur in the agrarian sector of many less developed economies because of the landlord's inability to evict tenants. Because of this he cannot expect to reap the benefits of new investment since the old tenant will continue to pay the same rent. The trouble with this line of reasoning is that in making a case for why a landlord would not innovate, it inadvertently provides an explanation of why a rational tenant would innovate. After all, if a tenant is confident of not being evicted, he should be willing to spend on the innovation because he can appropriate the benefits.

Tenant-based explanations of technological stagnation (for example, Kalecki, 1976, p. 19) suffer from the converse problem of inadvertently explaining why rational landlords would innovate.

A more complete theory of stagnation has to explain *simultaneously* why it will not be worthwhile for *any* agent (that is, the landlord *or* the tenant) to innovate. This turns out to be a more difficult task and is the subject matter of this paper.

*Delhi School of Economics, Delhi 110 007, India.
I have benefited from conversations with Albert Hirschman, Eric Jones, Siddiqur Osmani, and from seminars at the Indian Statistical Institute, Calcutta, and the Institute for Advanced Study, Princeton, NJ. I am grateful to WIDER, Helsinki, where a part of this work was done and to the Indian Council of Social Science Research for financial support.

[1]Several writers have addressed this issue: D. Gale Johnson (1950); Amit Bhaduri (1973); David Newbery (1975); Michal Kalecki (1976); Pranab Bardhan (1984); and Avishay Braverman and Joseph Stiglitz (1986).

A common element of property-rights laws or customs in several countries is that the rights of *both* the landlords and tenants are circumscribed in important ways. In particular, it is frequently the case that landlords do not have the right to evict tenants. A tenant can occupy the land or house for as long as he wishes. However, he does not have the right to sublet the property or sell the tenancy rights to someone else.

It is being assumed that these legal tenets hold no matter what individuals may agree to among themselves This is certainly true in India. If a tenant promises to quit his landlord's house or land after a certain period and then at the end of the period refuses to go, the landlord has little hope of appealing to the law because the tenant's prior right to continue to occupy a house or land for as long as he wishes virtually nullifies their subsequent contract.

The innovation that I shall be considering is a "sunk" investment in land. That is, once it has been adopted, it cannot be separated from the land and sold off without loss of value. Soil improvement, a new irrigation facility, and a deep tube-well are examples of such innovation. This model could be applied to urban housing. House maintenance is an example of a *sunk* investment. Though it is not stated in these terms, the model provides an explanation of the poor upkeep of apartments.[2]

I. Adverse-Selection and Suboptimal Investment

An innovation is an ordered pair (X, C), with the restriction $X - C > 0$, where C is the cost of adopting this innovation which

[2]The various sections of the Delhi Rent Control Act (see DRCA, 1958) read very much like the axioms of a theory of nonmaintenance of houses.

has to be incurred "now" and X is the benefit that will accrue subsequently, that is, after a time-lapse.

In between the adoption of a new technology and its bearing fruits the tenant may quit. If he does so, the landlord gets X. If he stays, the tenant gets X. This is our "basic axiom" and it is assumed to be true in the ensuing analysis.

This axiom follows from the legal framework assumed above.[3] If a tenant stays, given the fixed-rental system, he gets the additional output, X, that emerges from the land. If he quits, given that he cannot sell his tenancy rights, the landlord gets back full possession of his land. He can now rent it out again and charge his new tenant an additional rent of X.

Let q be the exogenously given probability of the tenant's quitting. It is now easy to see that neither the landlord nor the tenant may wish to accept an innovation. If the landlord undertakes the innovation his expected profit is $qX-C$. If the tenant undertakes the innovation his expected profit is $(1-q)X-C$. Clearly each of these could be negative even though $X-C$ is positive.

As an explanation of suboptimal adoption of new technology the above argument is more powerful than the popular arguments described in Section I, but it is still far from adequate. This is because a simple cost-sharing arrangement can get the landlord and his tenant out of the problem. If the landlord offers to pay qC of the cost of innovation and asks the tenant to pay $(1-q)C$, then both will profit from this innovation.

Fortunately a more compelling explanation becomes possible if we allow for the possibility that the landlord owns many plots of land and on each plot he has a tenant. Tenants may have different probabilities of quitting. An innovation, (X,C), is suddenly available which can be adopted on each plot. It is assumed that the landlord announces the fraction of the cost he is willing to incur. It is then up to each tenant to accept the innovation or reject it. Of course each acceptor has to bear the remaining cost. Suppose a very high cost-share is unprofitable for the landlord. If, then, he offers to pay a smaller fraction, the tenants who are likely to quit soon will reject the innovation. Hence the acceptors will be the less desirable tenants from the landlord's point of view, and the landlord may continue to find the innovation unprofitable. This adverse selection of tenants as the landlord's cost-share is lowered may result in a low level of innovative activity. This section formalizes this intuitive idea and explores its implications.

There is one landlord and he has T types of tenants. Let $H=\{1,\dots,T\}$ be the set of the types of tenants. For each i belonging to H, let n_i be the number of tenants of type i and q_i be the probability that a tenant of type i will quit.[4] We follow the convention of labeling tenant-types such that

$$q_1 > q_2 > \cdots > q_T. \tag{1}$$

Note that if $q_i = q_{i+1}$, then i and $i+1$ need not be distinguished. Hence not using *weak* inequalities in (1) imposes no restrictions.

Information is asymmetric. Each tenant knows his q. The landlord does not know this, though he knows how many types of tenants he has and how many of each type. The assumption of asymmetric information has been contested in the literature (Bardhan, 1984; Mukesh Eswaran and Ashok Kotwal, 1985) on the grounds that relations in such economies are personalized. I would however give asymmetric information a chance to explain certain features of rural economies.[5] It is true that relations here are personalized. But as long as we assume less

[3] What has been attributed to the law thus far could also be a consequence of social customs. As argued in Kaushik Basu, Eric Jones, and Ekkehart Schlicht (1987), customs, which emerge through long historical processes, could be sustained by and, at the same time, constrain individual behavior in the same way as formally enacted laws.

[4] Though quit probabilities are being treated as exogenous here, they can be modeled endogenously in terms of opportunities available to tenants elsewhere. This leaves the results unchanged as I have shown in Basu (1987a).

[5] In Basu (1987) I try to show that it plays an important role in understanding credit markets and interlinkage in rural economies.

than perfect information (which seems an eminently reasonable assumption) it seems reasonable to suppose that i's information about j is worse than j's information about j.

Let d be the fraction of the cost of innovation (i.e., C) which the landlord agrees to pay if a tenant adopts the innovation (X,C). Since to the landlord all tenants are identical, he does not discriminate between them and it is being assumed that he offers them all the same cost-sharing arrangements, that is, d. A tenant will adopt the new technology only if he expects to make a profit as a consequence. Hence, the expected profit of a tenant of type i, R_i, is given by

$$(2)\quad R_i(d) = \max\{(1-q_i)X-(1-d)C,0\}.$$

Let $A(d)$ be the set of tenant-types who adopt the new technology

$$(3)\quad A(d) = \{i\in H|(1-q_i)X-(1-d)C\geq 0\}.$$

Implicit in (3) is the assumption that a tenant who is indifferent between accepting the innovation and not, accepts it. This is a harmless tie-breaking assumption.

The landlord's profit, R_L, is given by

$$(4)\quad R_L(d)=\sum_{i\in A(d)} n_i[q_iX-dC].$$

The landlord's aim is to maximize $R_L(d)$ with respect to d. Hence the cost-sharing arrangement that will emerge in the equilibrium is given by d^*, defined as follows:

$$R_L(d^*)\geq R_L(d),\qquad \text{for all } d \text{ in } [0,1].$$

What is interesting is that in this model, at equilibrium, there may be severe underinvestment or widespread non-adoption of this new technology. The argument is essentially one of adverse selection. Consider first $d=1$. As the landlord lowers d, the share of his cost falls, which seems to be good from his point of view (see (4)). But as d is lowered, $A(d)$ becomes smaller, that is, fewer tenants accept the innovation. And note that the tenants who remain in $A(d)$ are the ones with low quit probability, that is, the ones with whom the landlord would least like to go into a cost-sharing venture. However, given that he cannot recognize tenant-types in advance and that the legal system is such that he is not allowed to write contracts contingent on a tenant's quitting decision, he has no method of averting the adverse-selection problem. Hence as d becomes smaller, his profit may fall.

As a result of this, several interesting possibilities arise as the following theorems illustrate.

THEOREM 1: *There are situations such that for all i belonging to H, there exists $d(i)>0$ such that both the landlord and the tenant of type i can earn positive profit if they have a cost-sharing arrangement where the landlord pays fraction $d(i)$ of the total cost; but nevertheless the landlord refuses to invest anything, that is, $d^*=0$.*

Remark 1: In this case the only tenants who will invest will be those whose tenure is so certain, that is, q so small, that they find it profitable to "go it alone." It is easy to show that the adoption rate of the innovation may be suboptimal and, in fact, "very low."

PROOF:

Let d_i be the smallest value of d which will induce group i to invest. Thus d_i is defined implicitly by

$$(5)\qquad (1-q_i)X-(1-d_i)C=0.$$

It is easy to check that d^* must be either 0 or one of $d_1,\dots,d_T$. I prove this by contradiction. If d belongs to the open interval (d_i,d_{i+1}) then it is possible to lower d a little without altering the set $A(d)$. Hence it follows from (4) that $R_L(d)$ will rise. Hence d could not have maximized $R_L(\cdot)$.

Given the observation in the above paragraph it is easy to see how to construct an example which validates Theorem 1:

Let q_T be any number in the open interval $[0,1-(C/X)]$. Note that (5) implies that as

q_i becomes larger, d_i becomes larger as well. Suppose now that q_{T-1} is sufficiently large so that d_{T-1} is such that

$$(6) \qquad q_T X - d_{T-1} C < 0.$$

Observe now that if the landlord sets $d = d_j$, then all tenants of type i, where $i < j$ will reject the new technology. Hence,

$$(7) \quad R_L(d_j) = n_j(q_j X - d_j C) + n_{j+1}(q_{j+1} X - d_j C) + \cdots + n_T(q_T X - d_j C).$$

Given (1), (5), and (6), it follows that for all d_j belonging to $\{d_1, \dots, d_{T-1}\}, (q_T X - d_j C)$ is negative. Hence there exists a sufficiently large n_T, say $n_T(d_j)$, such that $R_L(d_j) < 0$ if $n_T = n_T(d_j)$. Suppose now that

$$n_T > \max\{n_T(d_1), \dots, n_T(d_{T-1})\}.$$

Then $R_L(d_j) < 0$, for all d_j in $\{d_1, \dots, d_{T-1}\}$. Since $d_T < 0$ and $R_L(0) = 0$, it follows that $d^* = 0$. Hence the landlord will not invest anything toward the adoption of the new technology (X, C). Clearly only those groups, j, for whom $q_j < 1 - (C/X)$, will implement this new technology, thereby ensuring under-adoption.

THEOREM 2: *There are situations such that for all $i \leq T-1$, there exists $d(i) > 0$ such that both the landlord and the tenant of type i earn a positive profit if they have a cost-sharing arrangement where the landlord pays $d(i)$ of the cost, but nevertheless for all $d > 0$, the landlord earns a negative profit.*

Remark 2: Theorem 1 established a case in which the landlord's preferred share of investment was zero. In Theorem 2, not only is each $d > 0$ rejected by the landlord, but for each such d the landlord actually earns a negative profit.

PROOF:

Consider this example. There are only two types of tenants and these are characterized as:

$$q_1 = 1; \quad n_1 = 10$$

$$q_2 = 0; \quad n_2 = 1$$

In other words there are 10 sure quitters and one sure "stayer." The innovation available is given by

$$(X, C) = (12, 11).$$

From the first paragraph of the proof of Theorem 1 we know that d^* in this case can be either 0 or 1. Now $R_L(1) = -1$ and $R_L(0) = 0$. Hence $d^* = 0$. It may be checked that for all $d > 0$, $R_L(d) < 0$. Since $X - C > 0$ (as is the assumption throughout this paper), every plot will benefit from the implementation of this new investment. But in this case, at equilibrium only one tenant out of the eleven makes the investment, thereby illustrating the under-adoption problem.

Before stating the next proposition, I need to introduce some terminology. Consider two situations: one where $q = [q_1, \dots, q_T]$ denotes the quit probabilities (of the T types of tenants) and another where $q' = [q_1', \dots, q_T'\}$ denotes the quit probabilities. If for all i, $q_i' \geq q_i$ and there exists j such that $q_j' > q_j$, then we shall say that in the q-situation there is less mobility of tenants than in the q'-situation.

THEOREM 3: *The relation between mobility of tenants and output is not monotonic. That is, with a decrease in the mobility of tenants, output may rise or fall.*

Remark 3: Hence in the absence of an arbitrary prior assumption that either landlords or tenants cannot innovate (an assumption which underlies a lot of conventional writing), one cannot monotonically relate adoption of technology to the likelihood of tenants' quitting. The proof is easily constructed using the example in the proof of Theorem 1 and is available in Basu (1987a).

Finally, and this is related to Theorem 3, it is worth observing that the *level* of quit probabilities is not important for the under-adoption of technology. What matters are the *differentials*. The proof is easy and omitted.

THEOREM 4: *Suppose in society* 1 *the quit probabilities are given by* $(q_1,\dots,q_T)$. *Society* 2 *is identical to society* 1 *in every way excepting that its quit probabilities*, $(q_1',\dots,q_T')$, *are such that for all* i, $q_i' = q_i - e$, *where* e *is any number* (*satisfying the condition that* $q_i' \in [0,1]$ *for all* i). *In this case the level of under-adoption of technology* (*or the number of people who adopt the technology*) *is identical in societies* 1 *and* 2.

II. Conclusion

In a more elaborate model it will be essential to bring in time more explicitly and model behavior as a *sequence* of moves. Contracts may then have the problem of subgame perfection because there may be advantages in not fulfilling one's part in the contract after the other agent has done his share. The law curtails this perfection problem by ensuring that there is no reneging on contracts which the law recognizes as valid. If the law recognizes only a limited range of contracts as valid, the problem of suboptimality crops up.

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