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Empowerment and Efficiency : The Economics of Agrarian Reform*

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Abstract

We analyze the effect of agricultural tenancy laws that offer security of tenure to tenants and regulate the share of output they should pay the landlord as rent on farm productivity. Theoretically, the net impact of tenancy reform is shown to be a combination of two effects. A bargaining power effect tends to improve the crop-share of tenants and hence improves their incentives in general. A security of tenure effect tends to encourage investment by the tenant on one hand, but on the other hand eliminates the possibility of using eviction threats as an incentive device by the landlord. Analysis of evidence on how contracts and productivity changed after a tenancy reform program was implemented in the Indian state of West Bengal in the late seventies suggests that tenancy reform played an important role in increasing agricultural productivity.

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J.E.L. classification numbers:*D23, D82, O12, Q15*

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publicized campaign to register tenants within a stipulated period of time and was accorded the highest priority in the government's agenda for its first term. Moreover the two people chosen to be in charge of the program, the Minister of Land Revenue Mr. B. Chowdhury, and the newly appointed Land Reforms Commissioner, Mr. D. Bandyopadhyay, were widely respected across party lines for their integrity and efficiency. Under this program the formal institution used to register tenants - the settlement camps - was reformed in a way that would make it easier for the sharecropper to register. Land-revenue officials set up these periodic camps in villages to create, update and revise land records, including tenancy leases. Before Operation Barga these camps were organized in a manner which was not particularly conducive for registration of sharecroppers. For example, they were held at a time when sharecroppers were usually working in the field and at a place where they feel intimidated to go (usually, some landlord's house). Under the current strategy large groups of officials moved from village to village holding three-day camps. On the first day group-meetings were held at a time and location convenient to sharecroppers during which the new law would be explained and a list of those willing to register would be prepared; the next day the list was to be publicly verified by field enquiry and displayed in a prominent place; on the final day landlords' objections would be considered in public and registration certificates would be issued to qualified sharecroppers. According to the Land Revenue Commissioner this strategy of having a large group of officials stay in the village for three days at a time, holding evening meetings in a public place where all sharecroppers were brought together under the same roof, had two effects. It gave the sharecroppers the confidence to come forward and register, and also gave the registration process a transparency that ensured that landlords could not undermine it by force or bribery.[16]In addition to organizing these meetings, the revenue officers were also instructed to actively seek out individual sharecroppers who were hesitant to step forward on their own, to explain the law and offer them the opportunity to register.

Moreover the Left Front instructed its own political organizations at the village level to play a role in registration process, making sure that landlords did not intimidate the tenants and that the officials did not collude with the landlords. Equally importantly, after the camps left, they were to make sure that tenants who registered did not face any reprisal from the landlords, and to help those tenants who decided to register in the future. A sharecropper would be eligible to register even when these periodic camps were not in operation by applying to the concerned office and after due verification.

OB is widely regarded as a success. By 1993 more than 65% of the 2.3 million share-tenants had been registered, making West Bengal the state with by far the highest fraction of registered tenants in India. From the launching of Operation Barga in late 1978 to the end of the Left Front's first term in office, 1982, more than 8000 registration camps were conducted and around 0.7 million sharecroppers out of an estimated total of 2.3 million were registered. During the

[16]Private communication from D. Bandyopadhyay (1997b).

second term (1982-1987), the program went down in the list of priorities and the frequency of the settlement camps continued at a slower pace. In subsequent terms settlement camps were reduced to small routine settlement operations which continue to be held periodically. Registration continues to occur but more on an individual basis. Commensurate with the decline in program intensity the number of new registrations have fallen to a trickle since the late eighties (see Figure 1).

A substantial and sustained rise in agricultural productivity in West Bengal from the early mid-eighties onwards began to receive widespread attention by the end of the decade (see Figure 2).[17] This stood in sharp contrast with the dismal performance of the state in the past, as well as the performance of other states in India and neighboring countries, such as Bangladesh (see Figure 7). For example, between 1965 and 1980 the annual average rate of growth of productivity of rice in West Bengal was 1.39% whereas that of Bangladesh was 1.37%. However between 1980 and 1993, the respective growth rates were 4.2% and 2.8%. Now we turn to the analysis of the possible theoretical connection between effective implementation of tenancy laws and this growth in agricultural productivity in West Bengal.

3 Theory: Tenancy Reform, Contractual Change and Productivity

In this section we develop a simple theoretical model of a landlord-tenant relationship based on moral hazard and limited wealth of tenants. We will use this model to analyze the potential effects of the reform. There are two ways in which the reform could have altered the set of potential contracts between the landlord and the tenant.

First, it is likely to have changed an incumbent tenant's outside option. The fact that the landlord could no longer evict the tenant meant that the tenant could always hold out for the share of the output that was legally his. The landlord could no longer threaten to replace him by another tenant if he refused to accept a lower share. Of course, this does not mean that the contract between them necessarily has to be the legally stipulated contract. There may be - indeed under some conditions there will be - a different contract that suits them both better, but the tenant should not be worse off than he would be if he stuck to the letter of the law. We show that in general, an increase in the incumbent tenant's outside option will result in a higher crop share for him. This will give him better incentives to supply non-contractible inputs, resulting in an increase in productivity. However, it will make the landlord worse off.

A second potential effect of the reform is directly related to the restrictions on eviction. Under the new law, the tenant could plan to crop the same piece of land for as long as he would like to without fearing eviction. On the other hand, the landlord could no longer expect to use the threat of eviction as a credible incentive device. One would expect the optimal

[17] See Saha and Swaminathan (1994) and Sawant and Achuthan (1995).

contract to change for both these reasons.[18] We show that the former effect will tend to increase the tenant's incentive to supply non-contractible investment inputs on the land that affect its long-term productivity. The latter effect, however, will tend to reduce his incentives to supply non-contractible inputs that affect current productivity.

3.1 The Model

Suppose there is an infinitely-lived landlord who owns a plot of land which he cannot crop himself. In each period he employs exactly one tenant to crop the land. There is however a large population of identical infinitely lived tenants who are all willing to work for the landlord as long as the landlord pays them their outside option (or, reservation payoff), m in that period which is given exogenously. The landlord and the tenants are all risk-neutral and share the same discount factor $\delta < 1$. In each period output can take on two values, $Y_H = 1$ ('high' or 'success') and $Y_L = 0$ ('low' or 'failure') with probability e and $1 - e$ respectively. The tenant chooses e, ('effort'), which costs him $c(e)$. For simplicity, we assume that the cost function is quadratic : $c(e) = \frac{1}{2}ce^2$. The realizations of output are independent over time.

The key assumptions of this model are:

- The tenant's effort choice e is non-observable and hence non-contractible.
- Past and present realizations of output are however contractible. Specifically, we assume that at the beginning of each period the landlord can commit himself to a one-period contract which maps current and past realizations of output into (a) current payments to each potential tenant and (b) a decision about which tenant will work for him in the next period.
- The landlord faces a limited liability constraint.[19] In particular, in a given period each tenant has a limited amount of wealth $w > 0$, so that the least he can get paid is $-w$.[20]

[18]This is less obvious than it seems because, after all, the tenant and the landlord are not bound to honor the letter of the law in their mutual contracting. Thus, in principle, the two parties could continue using eviction threats as an incentive device even after evictions are made illegal - the tenant can voluntarily agree to let the landlord evict him if he fails to produce enough. However it would seem that this possibility is limited by commitment problems on both sides. A tenant who is actually facing eviction may want to renege on his promise to leave quietly and may seek the protection of the law. Similarly, a landlord who has been given the right to evict by his tenant may be tempted to abuse his power to his bargaining advantage.

[19]There are models of sharecropping based on moral hazard that do not use the hypothesis of limited liability (see Stiglitz (1974) and Eswaran and Kotwal (1985)).We use it because it provides an analytically simple way of generating rents for the tenant (which is necessary for eviction threats to be meaningful) as well as the static inefficiency associated with tenancy. See Shetty (1988), Dutta, Ray and Sengupta (1989), and Mookherjee (1994) for alternative models of sharecropping based on limited-liability.

[20]We are assuming that tenants do not save and non-monetary punishments are not allowed. Mookherjee and Ray (1997) and Ghatak, Morelli and Sjostrom (1998) study under what conditions tenants do not save in similar environments.

Because both the landlord and the tenants are infinitely-lived, this defines an infinite extensive-form game between the landlord and the tenant which, in principle, can have many equilibria. Here we restrict ourselves to studying equilibria of this game where the strategies in each period are *history independent* except in as much as the identity of the landlord's current tenant is determined by past history.[21] Furthermore, consistent with the assumption that there are many potential tenants and one landlord, we will focus on the equilibrium which maximizes the landlord's per-period profits. At the end of this section we comment on what would happen if we were to choose a different equilibrium concept.

It should be clear that in this game there is no reason to pay those tenants who are not working for the landlord in the current period - so the contract only needs to specify payments to the tenant who is currently working for the landlord. Likewise, the landlord has no reason to discriminate among those who are not working for him in the current period. Therefore if and when he decides to get a new tenant, he can simply choose randomly from among those who are not working for him currently (here we make use of assumption that there are many potential tenants; otherwise the landlord would only randomize among those who have never worked for him.). Furthermore, by the assumption of history independence, the contract vis-à-vis each tenant will just depend on the current realization of output. Therefore, the contract in any given period will just need to specify four numbers - the payment to the tenant and the probability of his being continued in the job when the output is high (denoted respectively by h and φ) and the same two numbers when output is low (l and ψ). We will find it convenient to refer to h and l as success and failure wages. Note that we could have, instead, conducted our analysis in terms of a *linear* contract, $sY - r$, with s denoting the *crop-share* of the tenant and r, a *fixed-rent component* with $s = h - l$ and $r = -l$. This is because, since output takes only two values in this model, all contracts can be expressed as linear contracts.

3.2 Optimal Tenancy Contracts and the Bargaining Power Effect

We first solve the landlord's problem under the assumption that incumbent tenants cannot be evicted and will therefore continue to be the tenant in all future periods. In this case the problem reduces to solving the one-period contracting problem. What we learn from solving this problem can be summarized in three simple results. For a formal proof of these and all other results in this section see the appendix.

> **Result 1:** The tenant earns less than the marginal product of his effort and therefore puts in less than the optimal level of effort.

[21] Formally we are looking at Markov equilibria where the state variable is the identity of the current tenant (Fudenberg and Tirole, 1991). Dutta, Ray, and Sengupta (1989) study *history-dependent* Markov equilibria in a similar environment. See section 3.5.4 for a discussion of these alternative equilibrium concepts.

Result 2: As long as the tenant's outside option is not too attractive, he earns rents by being in the tenancy relation (i.e., his participation constraint does not bind). Hence he is strictly better off than he would be if he were to be evicted from the land.

Result 3: An improvement in the tenant's outside option always (weakly) increases the success wage and effort. Over the range of its values such that the tenant does not earn rents but the effort is below the first-best level, the increases in effort and wages are strict.

Each of these results have simple intuitions. Normally, when both parties are risk neutral the best contract is a fixed rental contract that asks the tenant to pay a fixed amount to the landlord irrespective of the level of output and keep the residual for himself. This allows the tenant to capture the full marginal product of his effort and there would be no departure from the full-information outcome. But because of the limited wealth of the tenant, these efficient fixed transfers from the tenant to the landlord have an upper bound, namely, w. If the tenant has little wealth this will seriously restrict the landlord's ability to extract the full surplus out of the relationship, especially when the tenant's outside option, m, is low. The only way the landlord can extract more of the surplus is by making the tenant pay more when his output is high than when his output is low. The problem is that this is like a tax on the tenant's effort and such a tax, for obvious reasons, discourages effort - but since it benefits the landlord such a tax will be imposed even at the cost of some inefficiency.[22]

The tenant may earn rents because the landlord realizes that he can only reduce the tenant's surplus by reducing the tenant's share of the output when output is high (i.e., his success wage). Since this obviously has adverse incentive effects, the landlord will typically not try to extract the entire surplus when m is very low.[23]

An increase in m forces the landlord to pay the tenant more, in situations where initially the tenant was not earning rents. So long as the tenant receives less than the full marginal product of effort, i.e., $1 > h - l$, the landlord strictly prefers the success state to the failure state as $1 - h > -l$. Then, given that the landlord has to pay the tenant this extra amount of money in any case, he is better off paying it in the form of a raise in the success wage. This result forms the basis of what we call the bargaining power effect of the reform: an increase in the

[22]One could argue that if credit markets were well-functioning banks should be lending to tenants to buy off land from landlords to mitigate this inefficiency. After all, in this model if the tenant owns the land then there are no agency problems. The problem is that after the bank lends money to the tenant to buy off the land, the tenant has to repay his debt to the bank from the stream of output produced from the land itself. Then the bank becomes exactly in the same position as the landlord vis-à-vis the tenant and the same agency problem reappears. See Mookherjee (1995) for a formal analysis of this argument.

[23]This is similar to the Laffer curve in the public finance literature : higher tax rates may reduce labor supply so much that the government may earn less tax revenue.

tenant's bargaining power represented by an increase in m, holding everything else constant, leads to an increase in his share and hence, to better incentives.

The curve $ABCD$ in Figure 3 shows equilibrium effort as a function of the tenant's outside option when eviction threats are absent. In the figure we have set $w = 0$. Let $\underline{m}$ be the critical value of m such that for $m < \underline{m}$ the participation constraint does not bind. For $m < \underline{m}$, effort is shown to be constant (the segment AB) as the landlord will not reduce the success wage and hence effort below some minimum level because of the adverse incentive effects. Over this region the tenant earns rents. Let $\bar{m}$ be the value of the tenant's outside option such that the landlord has to give up all surplus in the relationship to the tenant. So for $m \geq \bar{m}$ effort is at the first-best level (the segment CD) because the tenant is the full-residual claimant. For $\underline{m} \leq m \leq \bar{m}$, effort is at the second-best level and strictly increasing in m (the segment BC).

3.3 Security of Tenure and Effort Incentives

The landlord can typically do better than offering the one-shot contract described above. In the last sub-section we showed that the tenant will earn rents unless his outside option is sufficiently good. But this means that the tenant will strictly prefer to continue being a tenant; therefore the threat of evicting him if the output fails can be used as an incentive device (again unless his outside option was sufficiently good). Let $\overline{V}$ to denote the expected equilibrium life-time utility of an incumbent tenant in the next period. Let M denote the equilibrium life-time expected utility of someone who is currently not a tenant: $M \equiv m/(1-\delta)$ where, as before, m is the per-period value of the outside option. The hypothesis of history independence implies that the landlord cannot precommit anything beyond the current period incentive contract, (h, l), and the probabilities of eviction , $(1-\varphi, 1-\psi)$. Thus the tenant's lifetime utility from next period onwards, $\bar{V}$, is taken as exogenous in this period by both players. Then we have :

> **Result 4:** For the range of values of the outside option for which the tenant earns rents in the one-period model, eviction threats will be used by the landlord as an additional incentive device. As a result, the level of effort will be higher than it is in the one-period model but less than the first-best level. If the value of the outside option is outside that this range, eviction threats will not be used and the results of the one-period model hold.

> **Result 5** : Over the range of values of the outside option for which the tenant earns rents in the one-period model, an improvement in the outside option reduces the level of effort if eviction threats are used.

> **Result 6** : The lifetime expected utility of the tenant is lower when eviction threats are used than in the one-period model.

Again the results have a simple logic. What the possibility of eviction threats does is to allow the landlord to utilize the rents created by the presence of limited liability to substitute away from the more costly way of giving incentives from his point of view, namely, through the success wage. Thus the tenant works despite being paid less because he is afraid of losing the rents that tenancy entails under limited liability. This result captures the negative incentive effects of security of tenure. Within the range of values of m where the tenant earns rents, an increase in m reduces the size of rents and hence the cost of being fired. As a result, eviction threats are less effective in eliciting extra effort. As h is lower in an equilibrium with eviction threats, coupled with a higher effort, the tenant's per-period utility has to be lower. Since the tenant discounts the future more due to the presence of eviction threats, his lifetime utility is lower as well. Accordingly, tenants are better off with greater security of tenure even though it will lower effort (holding m fixed).

The curve A^1BCD in Figure 3 shows equilibrium effort as a function of the tenant's outside option when evictions are permitted. It differs from the corresponding curve $ABCD$ for the one-period model only for the range of values of m such that the tenant earns rents ($m < \underline{m}$). Depicted by the segment A^1B, it shows that eviction threats raise effort relative to the one-period model when the tenant earns rents, and the lower are these rents (as m goes up), the less effective eviction threats are in eliciting extra effort.

3.4 Tenancy Reform and Investment Incentives

The way we have modelled the production technology so far ignores any role of investment. It is often argued that tenurial insecurity discourages investment by the tenant and this usually forms the strongest efficiency (as opposed to redistributive) argument in favor of tenancy or land reform (see Myrdal, 1968). But this argument typically fails to answer the question as to why the landlord himself cannot undertake such investments directly (given that he is less likely to be credit-constrained than the tenant), or indirectly, by giving incentives to the tenant through suitable contractual means. To analyze this issue carefully we find it useful to distinguish between the following types of investments. Some forms of investment like installing irrigation equipment, adopting a new technology (e.g. high-yield variety seeds), flattening the land, building soil partitions, planting trees, and digging ponds are relatively easy to contract on directly. On the other hand, many of the other forms of investment like the decision about how much to experiment with new techniques, care and maintenance of land, or the use of manure (the effect of which lasts more than one period) are likely to be non-contractible. Here, security of tenure and the guarantee of a fixed crop share in all future periods will increase the tenant's incentive to undertake such investments.

We can modify our benchmark model to introduce these alternative types of investments. Consider a variant of our benchmark model of section 3.1 where we introduce a *contractible* investment input. The tenant chooses effort e (which is subject to moral hazard) as before, but

now there is an investment input x in the production process. Without loss of generality we assume that the level of x is a one-shot decision affecting the productivity of land permanently (say, adopting a new technology) and hence continue to use a one-period model. The production technology takes the following form : if the tenant chooses an input level e, the output is either 1 with probability $e^{\alpha}x^{1-\alpha}$ or 0 with probability $1 - e^{\alpha}x^{1-\alpha}$ where $\alpha \in (0,1)$.[24] The cost per unit of the input is a constant, ρ. In general, the landlord and the tenant could split up the cost of the input by the amounts ρx_l and ρx_t where x_l and x_t refer to the landlord's and tenant's share respectively. Because x is contractible, so is the total expenditure on it. Hence we can pose the problem as one where the landlord is the party that chooses x.[25] We show that the marginal profit to the landlord from increasing x is exactly equal to its marginal social return, *given* the supply of effort by the tenant. However since e is going to be undersupplied x will also be too low in equilibrium and an increase in m which increases e (Result 3), will also increase x (since x and e are complements). Thus we have

> **Result 7:** An improvement in the tenant's outside option increases the marginal return on contractible investments which are complementary with effort.

If instead investment is non-contractible, the ability of the landlord to commit to a long-term contract affects the tenant's incentive to invest on the farm. For example, suppose the tenant undertakes some non-alienable land-specific investment. If the landlord cannot commit not to use the threat of eviction to claim a higher share of the fruits of this investment after it is sunk (say, by increasing the rent), then anticipating this ex ante, the tenant will invest less than the efficient level. This effect can be modeled similarly to the analysis of the hold-up problem in the incomplete contracting literature (see Hart, 1995 for a review).[26] We use a simple two-period extension of our benchmark model of section 3.1 to illustrate this point. In the first period the model is as before, but now the tenant can make a land-specific investment of amount x which increases the productivity of the land in the second period in the following way : output is $Y_H = 1 + x$ with probability e and $Y_L = x$ with probability $1 - e$. This investment costs $\frac{1}{2}\gamma x^2$ to the tenant. We assume for simplicity that the second period's payoff is not discounted, i.e., the discount factor is 1. If x was contractible then the landlord could simply 'buy' it from the tenant at the efficient level (namely, $x = \frac{1}{\gamma}$) independent of the tenancy relationship. Even though x is not contractible ex ante, the efficient level of investment can still

[24] We take a Cobb-Douglas production function for simplicity. Our analysis readily extends to the class of production functions $p(e,x)$ where the elasticity of each input in the production process does not depend on the level of the other input. For a more general analysis, see Banerjee and Ghatak (1998).

[25] In particular, given that ρx_t is a pure transfer from the tenant to the landlord which must show up in the limited liability constraint, by defining $h' = h - \rho x_t$ and $l' = l - \rho x_t$ the previous analysis will go through.

[26] Similar conclusions emerge if the source of non-contractibility of investment is moral hazard (like it is for effort) instead of the landlord's inability or unwillingness to commit to long-term contracts. The analysis is, however, more complicated (see Banerjee and Ghatak, 1998).

be achieved as long as the landlord can commit to a two-period contract with the incumbent tenant. Let us denote the contract as (r_h, r_l) instead of (h, l) where $r_h \equiv Y_H - h$ and $r_l \equiv Y_L - l$ are the landlord's payoff when output is high and low respectively. If in the current period the optimal contract is (r_h, r_l) (from the analysis of the model of section 3.1), then by committing to retain the current tenant next period and to increase the rent by a fixed amount $\triangle r$ in the next period irrespective of output so that next period's contract is $(r_h + \triangle r, r_l + \triangle r)$, the landlord can make the tenant full residual claimant of the fruits of his investment.

If the landlord *cannot* commit to such a long-term contract with the incumbent tenant, then the level of investment will be inefficient. Notice that once the land-specific investment is sunk on the land, the landlord is better off if he raises the rent on the land by x, the amount by which output goes up due to the investment. The tenant has no bargaining power ex post because he can be replaced by any other tenant. Anticipating this, he will not invest at all. The hold-up literature suggests to avoid this inefficiency the tenant should be the owner of the land. As discussed earlier, this is unlikely to happen if the tenant does not have sufficient wealth, and is credit-constrained. In this case, the vigorous implementation of the tenancy law under the reform may make it possible for the landlord to credibly commit to such contracts.

However, if eviction threats are very effective in eliciting extra effort, then the landlord will not *choose* to offer permanent tenure to the tenant, and pre-commit to future contracts even when he is able to do so. Starting with such a situation, a tenancy law that guarantees security of tenure and a legal crop share to the tenant will increase productivity, but at the cost of the landlord's profits. Hence we have

> **Result 8:** Security of tenure and a higher crop share induces the tenant to increase the supply of non-contractible land-specific investments.

3.5 Generalizing the Results

The results in the previous sub-sections are derived within what is clearly a very special model. In this sub-section we briefly discuss the implications of relaxing some of the assumptions of that model.[27]

3.5.1 If Tenants were Risk-Averse

The simplicity of our analysis so far owes much to the assumption of risk-neutrality. With risk-averse tenants, the analysis is not only more complicated but also the net effect of change in bargaining power could be negative. The extra bargaining power for the tenant may cause the landlord to provide the extra surplus through a raise in the failure wage rather than the success wage in this case (because marginal utility of income is higher in the former state).

[27] In an earlier version of the paper (Banerjee and Ghatak, 1996) we provide a detailed analysis of these cases.

This will weaken incentives. Elsewhere (Banerjee and Ghatak, 1996) we have shown that if tenants are risk-averse, an increase in the tenant's bargaining power will increase his effort as long as the limited liability constraint was initially binding.[28] Also, evidence on contracts from West Bengal discussed in the next section shows that crop-shares indeed increased after the reform - as our predicted by our results.

3.5.2 Tenant Heterogeneity and Competition between Landlords

We have been working under the assumptions that all tenants are identical and there is only one landlord. Both assumptions can be relaxed without qualitatively changing our main results. Suppose tenants vary in terms of some characteristics, such as how much wealth they own, or their ability. It directly follows the analysis in section 3.1 that an increase in the tenant's wealth will increase efficiency. The landlord will now be able to impose a greater penalty on the tenant if output is low, and this will increase effort. Also the higher is the wealth of a tenant, the less likely is he to earn rents. For any given level of the outside option of the tenant, the landlord will be able to transfer more surplus from the tenant to himself without any cost in terms of lower effort. We have not explicitly modeled tenant ability, but it can be done fairly easily by introducing a parameter θ in the production technology that affects the probability of high output given effort, or the cost of effort (either the levels, or the first-derivatives of these functions). Here too, holding other characteristics of the tenant constant, the productivity of the farm and the landlord's payoff will be increasing in tenant ability. To the extent more able tenants are harder to replace, the landlord will be less inclined to use eviction threats against them.

Next, suppose we relax the assumption that there are many tenants and only one landlord and allow for many landlords in the village who compete for tenants in the land-rental market. The supply and demand of land for lease is going to determine the equilibrium value of m. An individual landlord is going to take m as given and offer an incentive-compatible contract to his tenant which gives the latter an expected payoff of at least m. The threat of eviction can still be effectively used in a competitive equilibrium if the market-clearing value of m happens to be less than $\underline{m}$.[29] If some tenants are either richer or more able than the rest, all landlords will prefer to have them as tenants and therefore there will be more competition for them. Consequently, these tenants will have better outside options than the rest and eviction threats will not be very effective against them. Eviction threats are therefore likely to be used only vis-à-vis those tenants who have a large number of close substitutes.[30]

[28] See also Mookherjee (1996) for a detailed analysis of this issue.

[29] The logic is similar to that in efficiency wage models (e.g., Shapiro and Stiglitz, 1984) : if wages affect work incentives then they may not also clear the market. This implies unemployment can exist in a competitive equilibrium and the threat of firing can be used as an incentive device.

[30] Alternatively, if moving is costly or if the tenant's output contains some information about his type, being evicted will be costly for a tenant and hence this could enable the landlord to use eviction threats as an incentive

3.5.3 If Production Required the Landlord to Provide Some Inputs

As Eswaran and Kotwal (1986) have emphasized, landlords too may provide important inputs into the production process, such as management. If these inputs are non-contractible,[31] then a reduction in the landlord's share may reduce the supply of these inputs which will tends to reduce output. However, if this problem is serious enough to actually reduce output on balance (recall that the corresponding increase in the tenant's share will tend to increase output) the tenant and the landlord can agree to an increase in the landlord's share in return for a lump-sum payment to the tenant.[32] On the other hand, if these inputs took the form of credit, then it is possible that after the reform the landlords were less willing to lend to tenants because it could not longer threaten recalcitrant or defaulting tenants with eviction from the land. Indeed, for this reason it is possible that for poorer tenants the negative incentive effect of security of tenure dominates the positive bargaining power effect in the post-reform period. To the extent the reform had a significantly negative effect on productivity for such tenants, the landlord could make them a side-payment and cultivate the land using some other contractual form (say, owner cultivation). To the extent such transfers take place, and our survey indicates that they did, the positive effect of the tenancy reform on productivity would be higher than what our analysis so far suggests.

3.5.4 Other extensions

In a previous version of this paper we considered a number of other extensions of the model. For example, we show that our results do not change significantly if we consider different equilibrium concept to analyze the landlord-tenant game. It is well-known that if players are patient, then by employing history-dependent strategies greater efficiency can be achieved. For this reason we analyzed the best stationary *history-dependent* equilibrium of this game. In this equilibrium the landlord and tenant agree on a stationary path of contracts and deviations lead to reversion to the repetition of the one-shot optimal contract.[33] It turns out that while this equilibrium is always more efficient than the best *history-independent* equilibrium, it falls short of full efficiency even when the tenant is very patient. Also, the comparative static properties of this equilibrium with respect to changes in the tenant's outside option m closely parallels the results derived above.

It is possible that the reform had indirect effects that go beyond its effect on the contractual relationship between a given landlord and an incumbent tenant. For example, by making the land-rental market less active it could negatively affect the process of matching plots of lands

device. Again, this cost will be smaller for richer and more able tenants.

[31] Contractible inputs like seeds and fertilizers are also provided by the landlord in many cases but the *Barga* law explicitly provides for a higher share for the landlord in cases where the landlord provides all such inputs.

[32] This assumes that the landlord is not cash-constrained but this seems reasonable given that he owns land.

[33] This is the equilibrium that was studied by Dutta, Ray, and Sengupta (1989) in their afore-mentioned paper.

of different qualities with tenants of different ability. On the other hand it is often argued (see Boyce, 1987) that collective action within rural societies (for example, with respect to water management) is severely handicapped by the extreme inequality in the distribution of political and economic power within the society. To the extent Operation Barga affected this distribution of power, it is likely to have contributed to the alleviation of such collective action problems.

4 The Effect of Operation Barga on Security of Tenure and Contracts

In this section we examine the evidence on the impact of Operation Barga on security of tenure and crop-shares enjoyed by sharecroppers in West Bengal. To do so, we surveyed a stratified random sample of 480 sharecroppers from 48 villages in West Bengal. The survey asked each farmer detailed questions about various aspects of the landlord-tenant contractual relationship before and after the reform. Here we report some results from that survey.[34]

4.1 Security of Tenure

One of the intended effects of the reform was to improve the security of tenure. We find that in this respect the reform was very successful. The data indicate that tenure was not very secure in the pre-form period. Seventy-four percent of tenants surveyed indicated that in the pre-reform period their leases were mostly of unspecified duration subject to arbitrary termination by the landlord. Eviction threats were common. Table 1 presents the percentage of tenants who knew of evictions and who were threatened with eviction in the pre-reform period. Eighty percent reported that landlords used eviction threats in their village while 30 percent indicate that they or their fathers were actually threatened. In both cases, 40-50 percent of tenants confirming the presence of eviction threats, said these threats were related to low production. The other main reasons that eviction threats were used were in various types of disputes between the landlord and the tenant. The latter suggests that eviction threats were used as a bargaining instrument.

After the reform, eviction threats have more or less disappeared. As Table 2 indicates ninety-six percent of all respondents reported that evicting registered tenants was difficult or impossible and sixty-seven percent reported that it was difficult or impossible to evict unregistered tenants. Part of the reason may be that even a unregistered tenant can register himself if he anticipates an attempt to evict him; indeed, a large majority of all tenants in our survey said it is possible for an unregistered tenant to register anytime he wants.[35]

[34] See Banerjee and Ghatak (1996) for a more detailed discussion of the survey.

[35] The law anticipated the possibility of pre-emptive eviction by the landlord. Accordingly it was stipulated

Finally, actual evictions in the post reform period are very rare: only 30 percent of respondents indicated that they know of any tenant evicted in his village in the last ten years.

While registration guaranteed security of tenure, not all sharecroppers chose to register. Around 69 percent of the 480 tenants interviewed were registered, a number close to the overall state registration rate (65 percent) at the time of the survey. The majority of those who did not register indicated that it was because they had good relations with the landlord. Specifically, they indicated that they were dependent on the landlord for consumption and production loans or help in the event of an emergency, or were personally related to the landlord.

4.2 Crop-shares

Crop shares rose significantly after the reform. Figure 4 compares the distribution of shares for the major rice crop, *aman*, in the pre-reform period to the post-reform period. There was a large shift from below 50 percent and 50 percent to above 50 percent and fixed rent. Moreover, shares rose for both registered and unregistered tenants.[36]

5 The Effect of Operation Barga on Productivity

In this section, we develop methods for estimating the effect of Operation Barga on agricultural productivity in West Bengal. Evidence from the survey suggests that eviction threats, while present in the pre-reform period, were not very extensively used by landlords as an incentive device. As Table 1 indicates, 12 percent of all tenants indicated they or their fathers faced eviction threats due to low production. Hence we expect the net effect of the reform was to increase productivity due to the effect of increased bargaining power of tenants on the crop-share, and the effect of higher security of tenure on investment incentives. But while we were able to examine the effect of the reform on the security of tenure and the change in crop-shares using farm-level data on contracts, the lack of comparable farm management data forces us to turn to aggregate district-level panel data to evaluate the productivity effects. Our empirical objective is to estimate the effect of district registration on district yields. We begin in subsection 5.1 by deriving the empirical specification. In subsections 5.2 and 5.3, we discuss our two alternative identification strategies. Subsection 5.4 is devoted to the description of the data, and subsection 5.5 to the discussion of the estimation results.

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that land will be immediately restored to the tenant with compensation for the period during which he did not have access to the land if he is unlawfully evicted so long as he applies to be registered within two years after eviction (and the landlord fails to prove that the person didn't cultivate land belonging to him for at least one year). See S19B, The West Bengal Land Reforms Amendment Act, 1980.

[36]Other field-surveys by Kohli (1987) and Chadha and Bhaumik (1992) based on smaller sample sizes also report a significant increase in crop-shares of tenants after the reform.

5.1 Empirical Specification

5.1.1 Farm Productivity

Our starting point is a reduced-form productivity equation derived from a structural profit-maximizing model of a tenant farmer. Production depends on the tenant's non-contractible inputs (e.g. effort), contractible inputs (e.g. fertilizer and seeds), publicly provided inputs (e.g. irrigation and roads), and rainfall. Farmers choose effort and contractible inputs to maximize profits subject to the agricultural production function, the parameters of the tenancy contract, prices, public inputs and rainfall. We assume a Cobb-Douglas specification for farm i's profit-maximizing output per hectare (yield) at time t :

$$Y_{it} = A(c_{it}, \theta_i) \left(\prod_{j=1}^{n} P_{jt}^{\alpha_j} \right) \left(\prod_{k=1}^{N} X_{kit}^{\beta_k} \right) r_{it}^{\gamma} e^{\varepsilon_{it}} \tag{1}$$

where A is the X-efficiency of the farm, c_{it} is a vector of contract parameters (e.g., crop-share, probability of eviction for different values of output etc.), θ_i represents fixed characteristics of the tenant and the farm (e.g. wealth, ability, land quality), the P_{jt} are market prices of contractible inputs (we set the output price equal to 1), the X_{kit} are publicly available inputs provided by the government (e.g. canal irrigation available for the farm and roads for transport of produce to market), r_{it} is the amount of rainfall on the farm during period t, and ε_{it} is a zero mean random productivity shock.

The change in the X-efficiency parameter A captures the net effect of the two contractual responses to the reforms. The first is the effect of improved crop share of tenants on the supply of non-contractible inputs (e.g., effort). The second is the net effect of the permanency of tenure on the choice of inputs (both current inputs and investments).

In section 4 we found that tenants renegotiated their contracts and obtained better terms after they had the opportunity to register whether or not they chose to register. Therefore, we need to account for both types of tenant farmers in the analysis. Let A^n denote the efficiency of a tenant-farm in the pre-reform period. Further, let A^r and A^u denote the efficiency of tenant-farms whose contracts were renegotiated after the reform, with the former referring to a farm cultivated by a registered tenant and the latter, by an unregistered tenant. Finally, let A^o denote the efficiency of an owner-cultivated farm whose productivity should be unaffected by the reform.

5.1.2 District Productivity

Since the data on total output are at the district-level, we have to aggregate the individual farm productivity model to that level. The reforms reached tenants in the form of opportunities to register with the land bureaucracy. The government, however, could not make the opportunity to register available to all tenants at the same time within and across districts. Instead, as

we discuss in detail in the identification section below, registration opportunities expanded through districts on a village by village basis.

Average district X-efficiency at any point in time depends on the proportion of farmers who were tenants, the proportion of tenants who had the opportunity to register, and the proportion of people who chose to register (henceforth, the take up rate). Formally, let s_d be the share of land that is cultivated by sharecroppers in district d, v_{dt} be the share of sharecroppers who have been offered the opportunity to register in district d, and λ_d the take-up rate. Then the *average* X-efficiency of district d in period t is:

$$A_{dt} = s_d \left\{ v_{dt} \left(\lambda_d A^r + (1 - \lambda_d) A^u \right) + (1 - v_{dt}) A^n \right\} + (1 - s_d) A^o \tag{2}$$

In principle we would like to identify the effect of the reform by examining the effect of registration opportunities on district level productivity. However, there is no information on the proportion of tenants who were offered such opportunities. There is however, time specific information on the proportion of registered tenants. Therefore, we rewrite (2) in terms of the proportion of tenants registered, $b_{dt} = \lambda_d v_{dt}$. Thus the average X-efficiency is

$$A_{dt} = s_d \left\{ b_{dt} \left(A^r + \frac{(1 - \lambda_d)}{\lambda_d} A^u - \frac{A^n}{\lambda_d} \right) + A^n \right\} + (1 - s_d) A^o \tag{3}$$

Rearranging terms and taking the log we get:

$$\ln A_{dt} = \ln \left\{ 1 + \frac{s_d}{1 - s_d} b_{dt} \left(\frac{\lambda_d A^r + (1 - \lambda_d) A^u - A^n}{\lambda_d A^o} \right) + \frac{s_d}{1 - s_d} \frac{A^n}{A^o} \right\} + \ln(1 - s_d) A^o \tag{4}$$

Since $\ln(1 + x) \simeq x$ when x is small, we rewrite (1) in log form as:

$$\ln y_{dt} = a_d + \delta b_{dt} + \sum_j \alpha_j \ln p_{jt} + \sum_j \beta_j \ln x_{jt} + \varepsilon_{dt} \tag{5}$$

where $a_d = \frac{s_d}{1 - s_d} \frac{A^n}{A^o} + \ln(1 - s_d) A^o$ and $\delta = \frac{s_d}{1 - s_d} \frac{\lambda_d A^r + (1 - \lambda_d) A^u - A^n}{\lambda_d A^o}$.

The coefficient δ measures the effect of the reform on agricultural productivity. The numerator of the coefficient is the average X-efficiency of sharecroppers offered registration opportunities minus the X-efficiency of sharecroppers not offered registration opportunities. This is just the marginal increase in productivity from registration opportunities. The marginal increase is measured relative the X-efficiency of owned-cultivated farms. The marginal increase is also weighted by one over the take up rate. This converts the units from change in productivity due to a change in registration opportunities to change in productivity due to a change in the registration rate. In principle, δ could vary by district if the take-up rates and the relative importance of sharecropping vary by district. However, we do not have long enough time series variation within districts to estimate district specific slopes with much precision. Instead, we can estimate the average effect of the reform across all districts. In this case, our specification could be interpreted as a random-coefficients model.

Another limitation is that district-wise data on output prices and input prices are available for a very limited number of years. However, their movements over time are not very different across districts because the state and federal governments control both input and output prices (Misra and Puri, 1997). Most inputs (e.g., fertilizer, seeds) are distributed by public sector agencies and subsidized by the federal government. Moreover, the government through various agencies procures a large part of the crop for public-distribution, export and storage purposes.

While there is little cross-sectional variation in prices, there still is substantial time series variation. To control for this, we include year dummy variables to capture the common movements of prices over time in the districts. The year fixed-effects also control for any other unobserved time-varying factors that are common to districts such as technological change.

Therefore the equation to be estimated is:

$$\ln y_{dt} = a_d + \psi_t + \delta b_{dt} + \sum_j \beta_j \ln x_{jt} + \gamma r_{dt} + \varepsilon_{dt} \tag{6}$$

where ψ_t are the year-specific intercepts.

5.2 Identification Using Inter-District Variation in Registration

The objective of the exercise is to measure the impact of the reform on agricultural productivity. Ideally, we would like to compare the productivity of one set of randomly chosen villages where the opportunity to register was offered with another set where it was not offered. Our method of using the registration rate to identify the effect of the reform departs from this ideal method for three reasons. First, the sequence of villages offered registration was not necessarily chosen at random. Second, we do not actually observe the progression of such *opportunities* - we just observe the proportion of sharecroppers who actually registered. Finally, the progression of registration opportunities could have been correlated with the progression of other (omitted) programs.

We take two approaches to identification based on inter-district variation in registration. Our first and main approach is to use a fixed-effects estimator. In the first subsection, we argue that the major source of variation in the registration rate is supply-side frictions that limited the ability of the government to make registration opportunities available everywhere at once. Then in the second sub-section we draw on institutional facts to argue that the supply of registration opportunities were allocated based on fixed-characteristics of districts so that a fixed effects estimator is likely to control for the endogeneity of the registration rate. However, we cannot completely rule out that some of the variation in the registration rate is through demand. While most of the variation in demand is due to fixed characteristics of tenant farmers, some of it may be due to idiosyncratic productivity shocks. In this case, fixed-effects fail to control for the endogeneity of the registration rate. Our second approach, then, is to use an instrumental variables fixed effects estimator using the lagged registration rate as the instrument.

5.2.1 Sources of Variation in the Registration Rate

As the institutional description above makes clear, registration camps were a crucial determinant of the registration rate. While it was possible to register without the presence of a camp, it was much more difficult (Chattopadhyay et al, 1984 and Bandyopadhyay, 1997). Indeed, more than 76 percent of the registered respondents to our survey of sharecroppers indicated that the role of government officials and the arrival of settlement camps was the single-most important factor leading to their registration decision. The rest cited the help of the village government and peasant organizations (16.5 percent) or the threat of imminent eviction (7.5 percent). Among those who had not registered by the time of the survey, a considerable number (30 percent) indicated that were having difficulties because of weak implementation of the tenancy law in their villages. This is consistent with our argument that variation in the aggregate registration rates primarily reflect changes in the availability of the opportunity to register.

The implementation of the settlement camps proceeded more slowly than expected and at different paces across the districts. The administration initially expected that the program would be able to register most of the sharecroppers within a year. However, due to unanticipated operational problems affecting the implementation of the camps, this goal was soon realized to be overly optimistic (Ghosh, 1986). The process therefore had to be stretched over many years.

These operational frictions were typical of a situation where a very centralized and hierarchical bureaucracy was trying to implement a program of this magnitude across a large and diverse geographical area involving numerous individuals and requiring coordination between many official and unofficial agencies. The unprecedented floods in 1978 were another major factor in slowing down the registration process by making field-level settlement operations difficult to undertake as well as by diverting the attention of the bureaucrats and the village governments (Lieten, 1992). The logistical problems were compounded by the backward infrastructure, and by the new and unfamiliar methods of the settlement camps (Chattopadhyay et al, 1984). Further, landlord resistance slackened the progress of registering and burdened the government with legal expenses. Indeed, the program was shut down for several of months in 1979 to clear the legal obstacles created by landlords (Ghosh, 1981).

For our identification strategy to work it is crucial that these time variations in the spreading of access to registration opportunity operated differentially across districts. Then the fact that registration opportunities were made available in some districts faster than in other provides us with treatment and control districts. There are several reasons why we would expect this to be the case. First, the districts had different bureaucratic resources, and physical infrastructures translating into differential efficiencies of the operation of settlement camps. Second, various shocks to the process of registration due to natural and other causes (e.g., floods, legal obstacles) operated differentially across districts. Third, the government initially

allocated more resources to districts with a greater concentration of sharecroppers and where pre-Operation Barga registration rates were relatively low (Chattopadhyay et al, 1984 and Bandyopadhyay, 1997). Fourth, the geographic distribution of sharecroppers within a district varied from district to district so that the marginal cost of making registration opportunities varied across districts. Finally, differences in the political strength of parties belonging to the Left Front, the power of the landlords, and the history of peasant movements meant that there was a lot if difference in the political support to the reform process at the local level (Chattopadhyay et al, 1984).

Evidence from our 1995 survey of sharecroppers supports the hypothesis that the supply of opportunities did not arrive at all the villages at the same time. There is a fair amount of variation among villages in terms of peak year of registration (Figure 5). While 1980 had the highest number of villages experiencing peak registration, some villages peaked as late as in 1994, sixteen years after the launching of the program.

Figure 6 shows the inter-district variation in the time path of the registration rate. The arguments in this section suggest that a large part of the observed variation in the registration rate across time and districts is likely to be attributable to frictions on the "supply side" of registration opportunities.

5.2.2 Supply-Side Sources of Endogeneity

While supply-side frictions explain much of the variation in the registration rate, the distribution of registration opportunities was not random. If the government introduced registration opportunities in districts of high or low productivity first, then the registration rate would be correlated with unobserved productivity characteristics and our estimates of would be inconsistent. Indeed, as we mentioned, the institutional descriptions of the registration process suggests that more resources were allocated to districts that had greater concentrations of sharecroppers and lower initial registration rates. Note however that these are time-invariant factors. Therefore, the district fixed effects control for this source of bias.

A similar problem could occur if the order of villages selected within a district was based on productivity (level or growth potential). For example, perhaps bureaucrats chose to go to villages where the reform would have the maximum impact first. The Land Revenue Commissioner in charge of implementing OB, Mr. Bandyopadhyay, indicated that villages, like districts, were chosen solely on the basis of concentration of sharecroppers.[37] This is conformed by Chattopadhyay et al (1984) who report that the registration rate was positively correlated with the concentration of sharecroppers at the village level. Chattopadhyay et al also report that registration was uncorrelated with other village characteristics such as irrigated area as a fraction of cultivated area and distance from railway station. This suggests that

[37]Private communication from Mr. Bandyopadhyay, 1997.

the selection of villages within a district was unlikely to have been correlated with unobserved productivity factors.

5.2.3 Demand-side Sources of Endogeneity

While the friction-driven variations in the supply of registration opportunities were clearly important, registration is ultimately a choice. As the discussion of evidence from the survey in section 4 suggests, a tenant's decision to register is likely to be affected by his ability, wealth and relations with the landlord, and other characteristics that are associated with his dependence on the landlord (e.g., for loans) or his bargaining power. The wealthier, more able and more enterprising tenants are likely to be more productive and adopt productivity enhancing technology. These individuals may also be more likely to register. Therefore a district which has a higher proportion of more productive tenants is likely to have high output as well as high registration. Consequently, if uncontrolled, this individual unobserved heterogeneity may bias the estimates. However since these individual characteristics are likely to be constant over time, they should not be a problem so long as we allow for district fixed-effects.

We may also worry that changes in market conditions (e.g. prices, wages and technology) that affect productivity may also affect the likelihood of registration. As discussed earlier, these movements in market characteristics over time are largely the same across districts and are therefore captured by the time fixed-effects.

Finally, a small portion of registration decisions could be driven by idiosyncratic shocks i.e., shocks that vary across time and district. For example, a drought or flood would affect productivity and therefore the decision to register. While we explicitly control for total annual rainfall, there could still be some other district-specific productivity shocks (such as the timing of rainfall) that affect the registration choice. In order to control for this source of feedback, we instrument for the registration rate using the lagged registration rate. It is not affected by contemporaneous productivity shocks. At the same time it is likely to be correlated with current changes in registration. Given the slow bureaucratic nature of the implementation process laden with frictions and the village to village campaign strategy of the settlement camps within a district, it is quite likely that momentum generated in registering sharecroppers in a given year is likely to persist over to the next year(s). For example, if a district experienced high registration in a year because it received more resources, had better implementation machinery, and an environment more conducive for registration (political support, geographic distribution of sharecroppers and infrastructure), then it is likely to have high registration in the future as well. Lagged registration is therefore a valid instrument. This assumes no serial correlation in idiosyncratic productivity shocks. This is likely *a priori* given that the main source of yearly fluctuations in agricultural production in West Bengal is the weather, and indeed confirmed by the data where we test for and reject the presence of autocorrelation of the productivity residuals.

5.2.4 Omitted Programs as a Source of Bias

A very different source of potential bias comes from the possibility of there being public programs that were implemented or strengthened at the same time as OB. OB itself did not provide any other public services to sharecroppers other than registration opportunities and the enforcement of the tenancy laws. However, during this period as part of the government's overall reform package the role of local governments (panchayats) was significantly enhanced in the implementation of various public programs at the village level. As already mentioned they were also involved in assisting the settlement camps in charge of implementing OB. It is likely that both OB and other public programs were better implemented in districts that had better bureaucracies and/or more active local governments. To the extent these represent fixed-characteristics of these districts, we control for their effect on yields by allowing for district-specific intercepts. Otherwise, the coefficient on OB would include the impact of these other programs. Now there were three major programs undertaken during this period.

First, there was a major expansion of infrastructure in West Bengal. We control for public investment in infrastructure by including measures of the availability of public irrigation and roads within districts. However, there may have been other programs influenced by the better implementation that are not captured by these variables.

Second, the Left Front government started a subsidized loan program for registered sharecroppers. However, the program had very limited success in terms of coverage and sustainability owing to the standard problems of public sector lending in rural areas with high transaction costs and low repayment rates (Kohli, 1987). Indeed, 87% of the respondents to our survey indicated that they never received a loan from either a government or a commercial lending institution.

Finally, the administration also distributed a limited amount of surplus land (i.e. above the land-ceiling as specified by the land-reform laws in India) collected by earlier administrations in some areas to the landless and poor peasants. Over the entire period (1977-93) of our analysis the land distributed in this manner constituted around 2% of the net cropped area of the state. Most of the work (around 70% of total land redistributed up to 1993) had been done before the Left Front took office and therefore before the implementation of OB (Gazdar and Sengupta, 1997).

5.3 Identification Using Bangladesh as a Control

An alternative identification strategy is to use district-level panel data from the neighboring country of Bangladesh as controls. Bangladesh did not introduce tenancy reform and therefore provides exogenous variation in policy reform. Figure 7 shows rice yields of West Bengal and Bangladesh over the period 1977-93. Both regions started at similar levels prior to the introduction of the reform. While rice yields increased in both regions, West Bengal's performance

was distinctly better compared to Bangladesh during the entire post-reform period. With the exception of 1981 and 1982 when West Bengal suffered two major droughts in successive years, the latter being one of the worst in recent history, its performance was better than Bangladesh in every year starting with 1980. However, for Bangladesh to be a valid control, it must be similar to West Bengal in other respects. Prior to Independence in 1947, Bangladesh and West Bengal were part the of same state, Bengal, in undivided India. Today, they have similar agro-climatic conditions, prevalence of tenancy and agricultural technology. (Boyce, 1987) Also, the populations of Bangladesh and West Bengal share the same language and culture. Except for religion and political boundaries, the two regions are very similar. Any differences due to religion and other fixed characteristics are captured through the district fixed-effects. We also control for common shocks to these two regions in a given year, variation in rainfall and public inputs. This approach has the advantage of solving the issue of the endogeneity of the registration rate. However it is possible that Operation Barga was not the only source of time and district-varying differences in productivity between West Bengal and Bangladesh during this period. Other important differences, such as in macroeconomic policy, may confound with the estimated effect of the reform.

5.4 Data

We estimate the model using a district-wise panel from 1979 through 1993 constructed from data from official government sources. Specifically, we have 15 years of information from 14 West Bengal and 15 Bangladesh districts.[38] The data include information on the aggregate yield of all crops, rice yield, the percentage of sharecroppers registered at the beginning of the year, area covered by public irrigation, length of roads constructed and maintained by the public works department, and annual total rainfall.[39] The first two in the list are the dependent variables and the others are independent variables. Descriptive statistics for the two samples are reported in Table 3.

The Bangladesh data are less complete than are the West Bengal data. These countries use different weights and base-years for the index of aggregate yield of all crops and hence are non-comparable. Therefore for the pooled sample we estimate the model for rice yields only. Also, information on roads before 1984 is not available for Bangladesh. We estimate the pooled

[38]From the West Bengal districts we excluded Calcutta, which is almost completely urban, and Purulia, for which the data on registration is not available for a considerable number of years. From the Bangladesh districts we excluded eight districts for which data on one or more of the crucial series are not available for a large number of years mainly due to changes in the administrative boundaries of these districts.

[39]The data on production, irrigation, roads and rainfall for West Bengal are from Economic Review(1977-93) and Statistical Abstract (1990) published by the Government of West Bengal. Data on sharecropper registration were obtained from the Statistical Cell, Department of Land Reforms, Government of West Bengal. Data on Bangladesh are from Statistical yearbook of Bangladesh, Dacca : Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, [1977-93].

model both with and without roads as an explanatory variable (in the former case dropping the 1979-83 observations for Bangladesh).

The dependent variables are the natural log of total output yields and rice yields. Rice is the main component of agricultural production in West Bengal and Bangladesh and is planted in over 70 percent of cropped area. The West Bengal all crop yield index increased more than 69 percent over the 15 year panel period. Rice yields increased more than 67 percent in West Bengal and about 45 percent over the same period in Bangladesh.

The independent variables also show substantial growth over the same time period. In West Bengal, the registration rate increased from 23 to 65 percent between 1979 and 1993.[40] The increase in public investment in rural infrastructure is reflected in the expansion in the area under public irrigation by 28 percent. This brought the fraction of cropped area receiving public irrigation from a low 5 percent to 25 percent at the end of the period. The corresponding increase in the length of roads was by about 9 percent.

5.5 Estimation and Results

The results of the estimation of equation (6) based on the West Bengal sample are reported in Table 4. The first two columns report the fixed effects and instrumental variables fixed effects estimates using the natural log of the yield of all crops as the dependent variable and the second two using the natural log of the yield of rice.[41] The key parameter of interest is the coefficient of registration rate. The estimated coefficient is positive, and significantly different form zero at the 5% level or 1% level in 3 of the 4 models. The instrumental-variables fixed-effects point estimates are generally larger than the straight fixed-effects estimates. However, in all cases, the 95 percent confidence intervals of the point estimates include the point estimates from the other models. These results strongly suggest that the registration rate is positively associated higher agricultural yields and are consistent with the hypothesis that the tenancy reform implemented under Operation Barga increased productivity.

The other estimated coefficients are consistent with expectations. In all models, the district fixed effects and year fixed-effects are both jointly significantly different from zero at the 1% level. Irrigation and roads are positively associated with yields. Total annual rainfall is negatively associated with yields. This is driven by the fact that the main crop, the monsoon season traditional variety of rice, frequently suffers from drainage or flooding problems especially in the mountainous districts of the north and the coastal districts of the south.[42]

[40] Operation Barga started at the end of 1978 (Ghosh, 1986) and data on district-wise registration rates are available from 1979 onwards. At the beginning of the reform, the average registration rate for West Bengal was 17%.

[41] All of the models using the West Bengal sample were also estimated using a sample restricted to the period of 1978-1988 when most of the change in registration occurred. The results were very similar to those reported here and therefore are not included. They are, however, available upon request.

[42] Notice that we control for very sharp fluctuations in the weather, such as a major flood or a drought that

Next we turn to the combined West Bengal and Bangladesh sample. Before turning to the full model, we estimate a difference in difference specification. The difference in difference specification compares the change in a treatment region from before the intervention to after the intervention to the change a control region. In our case, the treatment region is West Bengal and the control region is Bangladesh. This specification has the advantage that the tenancy reform intervention is strictly exogenous. The simple difference in difference estimate of the effect of the reform with West Bengal as treatment and Bangladesh as control is reported in Table 5. We have split the sample in two periods, pre-reform (1977-79) and post-reform (namely, the period for which the reform has been in place for at least a year, i.e., 1980-93). We compute the average rice yield for all districts in these two regions for these two periods and find that controlling for initial differences in the levels of yields between these regions, and the common growth between the two periods, rice yields in West Bengal grew by an extra 6%.

In the simple difference in difference specification, however, the effect of the reform could still be confounded with other programs being implemented at different paces in the treatment and control regions. To isolate the effect of the reform we repeat the same exercise controlling for as many time and region varying factors as possible, namely, public irrigation, rainfall and year-specific common shocks affecting both regions. We are able to do this using a district fixed effects regression. The treatment dummy takes on the value one for the post-reform years in West Bengal, and zero otherwise (i.e., it is the interaction of a West Bengal specific intercept with the variable 'reform' which assumes a value of 0 for the pre-reform years and 1 for the post-reform years). Its coefficient provides a conditional difference in difference estimate of the effect of the reform. The results are reported in Table 6. In the table, the estimated coefficient of the treatment variable provides a conditional difference in difference estimate of 11%.

Finally, we separately estimate equation (6) using the combined West Bengal and Bangladesh sample. The results, reported in Table 7, are very similar to those obtained from the West Bengal sample although by and large the combined sample estimates are slightly larger. The estimated orders of magnitude of the effect of registration on yields are presented in Table 8. The columns correspond to the column headings in tables 4 and 7. The first row reports the effect of the observed change in the registration rate between 1979 and 1993 on agricultural yields. This is calculated by multiplying the regression coefficient of the registration rate δ by the change in registration in West Bengal between 1979 and 1993. Since the dependent variable is the log of yields, the results is interpreted as the percentage change in yields due to the change in registration. The estimates of the effect of observed change in registration on yields from the 8 different models range from a 10.1 percent increase to a 22.7 percent increase. The second row in Table 8 reports the effect of registration on yields as a percentage of the total change in yields in West Bengal from 1979 through 1993. This is calculated by dividing the first row by the overall percentage growth in yields from 1979 through 1993 reported in Table

affect the entire eastern region of India, by the year-specific intercepts.

3. The estimated percent of total growth in yields explained by the change in registration from the 8 different models ranges from 15 percent to 33.9 percent.

While all the models yield reasonably close estimates to one another and suggest that our results are robust, our preferred model is the fixed-effects estimates using the West Bengal sample. There are several reasons for this. First, although we cannot completely rule it out, we do not believe that idiosyncratic shocks drove registration. Second there are some concerns over the appropriateness of using Bangladesh as controls. Using our preferred model, we estimate that Operation Barga increased the yield of all crops by 11.8 percent which was 17 percent of the total increase in yields over the 15 year period. Further, we estimate that Operation Barga increased rice yields by 11.3 percent which was 16.9 percent of the total growth in rice yields. Notice that for rice yields the estimated effect of Operation Barga is very close to the conditional difference is difference estimate of the effect of the reform using Bangladesh as control.

Unfortunately we cannot directly infer the effect of the reform on the productivity of an average sharecropped farm that was offered the opportunity of registration from our estimates. In terms of our econometric model, this expression is $\frac{\lambda_d A^r+(1-\lambda_d)A^u-A^n}{A^n}$. Namely, it is the difference between the average X-efficiency of sharecroppers offered registration opportunities with sharecroppers not offered registration opportunities as a percentage of the average X-efficiency of sharecroppers not offered registration opportunities. To infer this expression from the coefficient of the registration rate, $\delta = \frac{s_d}{1-s_d}\frac{\lambda_d A^r+(1-\lambda_d)A^u-A^n}{\lambda_d A^o}$, we need information on the relative proportion of land under sharecropping $\frac{s_d}{1-s_d}$, the average take-up rate λ_d and the average X-efficiency of sharecroppers relative to owner farmers, $\frac{A^n}{A^o}$. An estimated 30% of land was under sharecropping tenancy at the time the reform was launched.[43] Also, we can use the average registration rate for West Bengal in 1993, 65%, as an estimate of the average take-up rate. Unfortunately, there are very few reliable studies measuring the average X-efficiency of sharecropped farms relative to owner-cultivated farms in general, and certainly for West Bengal. One of the most cited study in the literature on sharecropping tenancy is that of Shaban (1987) who analyzes farm-level data from eight Indian villages and estimated that changing the contractual status of a farm from sharecropper cultivated to owner-cultivated increases productivity by 38 percent controlling for the quality of land and the ability of the cultivator. If we use his estimate, the average X-efficiency of sharecropped farms relative to

[43]There is some controversy over the estimated share of land cultivated by sharecroppers in West Bengal. The main reasons are lack of reliable land-records, the tendency to conceal tenancy to evade tenancy laws and problems of definition of tenancy (e.g. tenants on a long-term lease were defined as owners) (Bardhan, 1976). All available official and unofficial estimates of total cultivated area under sharecropping tenancy in West Bengal at the time of the reform fall within the range of 18-40%. The estimate of 30% for s_d used in our calculations is suggested by the Land Reform Commissioner (Bandyopadhyay, 1997a, 1997b). It is very close to the estimate from the 1951 census (Boyce, 1987), which is considered to be one of the most reliable because it was conducted before tenancy laws were passed in the country. It is also in the middle of the range of later estimates.

that of owner-cultivated farms is 0.72. Using these numbers, the fixed-effects estimate of the coefficient of the registration rate from our basic model using the West Bengal sample suggests that the reform raised the X-efficiency of sharecropped farms by 59% for all crops and 57% for rice.

Our estimates are consistent with other studies of the impact of changing incentives on agricultural productivity. The two most closely related studies are that of Shaban (1987) which we just mentioned, and of Laffont and Matoussi (1995). The latter use farm-level data to show a shift from sharecropping to fixed rent tenancy or owner cultivation raises output by 50 percent in Tunisia. Other studies of property rights reform also find similar effects on agricultural productivity. Lin (1992) uses province-level data from China and estimates a 42 percent increase in agricultural productivity resulting from a shift to household-based farming from collective farming as part of agricultural liberalization in China in the late seventies. Besley (1995) finds a shift in land property rights from community-based to individual-based raised the probability of investment in land by 28 percent in Ghana. Recent work by Jeon and Kim (1998) show that land reform and abolition of sharecropping tenancy in Korea initiated by the U.S. military administration after the end of the Second World War had a positive effect on agricultural growth.

6 Conclusion

Our theoretical analysis shows that tenancy laws that lead to improved crop shares and higher security of tenure for tenants can have a positive effect on productivity. This will occur if the resulting increase in their incentives to supply various non-contractible inputs dominates the effect of the loss of the landlord's ability to use eviction threats as an incentive device. Evidence from the Indian state of West Bengal suggests that the tenancy reform program called Operation Barga played an important role in the growth of agricultural productivity there. Our estimates suggest that Operation Barga raised agricultural productivity in West Bengal by 17-18% during the period under study. However, aggregate data is clearly unsuitable for a thorough understanding of the effect of the reform on how contracts changed and the resulting effect on productivity at the micro-level. In the future we plan to study these important issues using farm-level survey data on input choice, productivity of tenants and contracts.

7 Appendix

7.1 The Optimal Contracting Problem in the One-Period Game

Given the tenant's outside option m and wealth level w, the optimal contract is a solution of maximizing the landlord's expected payoff:

$$\max_{\{e,h,l\}} \pi = e - \{eh + (1-e)l\}$$

subject to the following constraints:

(i) The limited liability constraint (LLC) requires that the amount of money that could be taken away from the tenant in any state of the world is bound above by his wealth w and realized output :

$$h \geq -(1+w), l \geq -w$$

(ii) The participation constraint (PC) of the tenant requires that (h,l) guarantees an expected payoff equal to m (exogenously given) to the tenant given e :

$$v = eh + (1-e)l - \frac{1}{2}ce^2 \geq m$$

(iii) The incentive-compatibility constraint (ICC) requires that the tenant chooses the effort level e to maximize his *private* payoff given (h,l) as e is not observable, and hence, non-contractible:

$$\begin{aligned} e &= \arg\max_{e\in[0,1]} \left(eh + (1-e)l - \frac{1}{2}ce^2 \right) \\ &= \min\left(1, \max\{\frac{h-l}{c}, 0\}\right) \end{aligned}$$

Notice that the optimal incentive contract (h,l) must have $h > l$ because if $h \leq l$, then from the ICC, $e = 0$ and the landlord gets $-l$ whereas for the same l if he sets $1 \geq h > l$ he gets $e\{1-(h-l)\} - l \geq -l$. This also implies that one of the two limited liability constraints, $h \geq -(1+w)$ can not bind.

The total expected surplus generated by a project is

$$S = e - ce^2/2.$$

Throughout the paper we assume $c > 1$ so that total surplus is maximized at the interior when $e = 1/c \equiv \bar{e}$. Total surplus is then $S = \frac{1}{2c} = \frac{\bar{e}}{2}$. It is easy to see that we can never have $h - l > c$ under an optimal contract. Suppose (h_0, l_0) is an optimal contract such that $h_0 - l_0 > c$. Then $e_0 = 1$ from the ICC, and the respective payoffs are $\pi = 1 - h_0$ and $v = h_0 - \frac{1}{2}c$. Now consider the contract (h_1, l_1) such that $h_1 - l_1 = 1$. Then $e = \bar{e} = \frac{1}{c}$ and $\pi = -l_1$ and $v = l_1 + \max_e\{e - \frac{1}{2}ce^2\}$. By setting $l_1 < h_0 - 1$ the landlord is better off and

since $\max_{e\in[0,1]}\{e - \frac{1}{2}ce^2\} > 1 - \frac{1}{2}c$ by definition the tenant can be made better off as well. This implies that the ICC can be rewritten as

$$e = \frac{h-l}{c} \in (0,1].$$

Let us substitute for e using the ICC and rewrite the optimal contracting problem as :

$$\max_{\{h,l\}} \pi(h,l) = \frac{h-l}{c} - \frac{(h-l)^2}{c} - l$$

subject to:

$$\begin{aligned} l &\geq -w \\ \frac{(h-l)^2}{2c} + l &\geq m \end{aligned}$$

Since π is concave and the constraints are convex for $h > l \geq -w$, the Kuhn-Tucker conditions give the global maximum to this programming problem. Let λ and μ be the Lagrangian multipliers associated with the LLC and the PC respectively. Notice that $\lambda \geq 0$ and $\mu \geq 0$ as increasing w and reducing m relaxes the constraints and increases the landlord's profits. The first-order conditions with respect to h and l are:

$$\frac{1}{c} - \frac{2}{c}(h-l) + \mu\frac{1}{c}(h-l) = 0 \quad (7)$$

$$-\frac{1}{c} + \frac{2}{c}(h-l) - 1 + \lambda - \mu\frac{1}{c}(h-l) + \mu = 0 \quad (8)$$

Adding (7) and (8) we get

$$\lambda + \mu = 1 \quad (9)$$

This shows under an optimal contract (h,l) at least one of the two constraints, the LLC and the PC,must be binding.

If the LLC is not binding then $\lambda = 0$ and $\mu = 1$ from (9). Also, $h - l = 1$ from (7). Substituting in the $ICC, e = \frac{1}{c}$ and from the PC $l = m - \frac{1}{2c}$. This is therefore a 'fixed-rent' contract under which the tenant is the full residual claimant and hence effort is at the first-best level, $\bar{e}$. Under this contract total expected surplus is $\frac{1}{2c}$, equal to the first-best level. So long as $w \geq \frac{1}{2c} - m$, or, $m + w \geq \frac{1}{2c}$, the tenant is able to pay a fixed-fee equal to the landlord's share of the first-best expected surplus in all states of the world and this efficient contract is feasible. Since the PC is binding under this contract, the tenant gets a share m of the first-best surplus and the landlord gets the remaining, $\frac{1}{2c} - m$.

If both the PC and the LLC is binding under the optimal contract then solving them out we get $l = -w$ and $h = \sqrt{2c(m+w)} - w$ and from the ICC, $e = \sqrt{\frac{2(m+w)}{c}}$. Under this contract

total expected social surplus is $\sqrt{\frac{2(m+w)}{c}} - (m+w)$. Notice that for $m+w = \frac{1}{2c}$, the solution in this case coincides with the earlier case. Furthermore, both effort and social surplus are strictly increasing and concave functions of $(m+w)$ for $0 < m+w < \frac{1}{2c}$. Hence for $m+w < \frac{1}{2c}$, effort and surplus are lower than in the first-best, and so is the success-wage. Under this contract, the PC is binding and so the tenant's expected payoff is m, and the landlord's expected payoff is the remaining amount of (expected) surplus, $\left\{\sqrt{\frac{2(m+w)}{c}} - (m+w)\right\} - m$.

Finally, if the PC is not binding under the optimal contract, we get $l = -w$ from the LLC, $h = \frac{1}{2} - w$ from (7) and $e = \frac{1}{2c}$ from the ICC. In this case total expected social surplus is $\frac{3}{8c}$. Notice that for $m+w = \frac{1}{8c}$, the solution in this case coincides with the earlier case. Otherwise, given that both effort and surplus are strictly increasing in $(m+w)$ for $0 < m+w < \frac{1}{2c}$, it follows that they are higher under this case when $m+w < \frac{1}{8c}$, compared to the previous case where the PC is binding. In this case the PC is not binding anymore, and hence the tenant's payoff is obtained by evaluating his expected payoff under this contract, which turns out to be $\frac{1}{8c}$. The landlord's expected payoff is, accordingly, $\frac{1}{4c}$.

To summarize, for $m+w \geq \frac{1}{2c}$, a fixed-rental contract is feasible and we have the first-best effort level. Hence in this case, changes in w have no effect on the contract or the payoffs. Also, increases in m are accommodated by increasing both the success and failure wages by the same amount so as to keep effort constant, and hence in this case the utility-possibility frontier is a 45^0 line.

If $m+w < \frac{1}{2c}$ then an efficient fixed-rental contract as described in the earlier paragraph is feasible but it no longer maximizes the landlord's expected profits. The reason is, so long as the LLC is not binding, the tenant has enough wealth which can be used to make costless side-payments and hence the parties maximize total expected surplus irrespective of bargaining power. But if w is small, it may not be an adequate instrument for the landlord to get as much as possible out of the tenant, especially if m is low so that the landlord's share of the pie is very high. This causes the landlord to take money from the state where it is feasible to do so, namely when output is high. Under this the tenant earns less than his marginal product and this reduces the incentive of the tenant to put in effort and hence reduces the total expected surplus compared to the first best level, but the landlord is better off. Also, in this case effort and social surplus are strictly increasing in w and m. An increase in the tenant's wealth w relaxes the limited liability constraint, the source of inefficiency in this model, and hence increases e. Also, so long as the tenant receives less than the full marginal product of effort, i.e., $1 > h - l$, the landlord strictly prefers the success state to the failure state as $1 - h > -l$. Hence as m goes up, given that the landlord has to pay the tenant some extra amount of money in any case he is better off paying it in the form of a raise in the success wage. This causes e to go up.

However, there is a point after which the landlord's marginal benefit from reducing h in raising the amount of rent is offset by its effect on reducing the chance of getting paid this

higher rent, namely effort. In particular, for $m + w < \frac{1}{8c}$, the landlord is better off offering $h = \frac{1}{2} - w$ which elicits an effort of $e = \frac{1}{2c}$ rather than trying to hold the tenant down to his reservation payoff m. In this case the tenant earns rents because the PC does not bind and by assumption his payoff $\frac{1}{8c} > m + w > m$.

7.2 The Optimal Contracting Problem in the Infinitely Repeated Game

The tenant's expected lifetime utility in the current period from choosing a level of effort e today, $\overline{V_0}$, must satisfy the Bellman equation:

$$\overline{V}_0 = Max_{\{e\in[0,1]\}} \left(eh + \delta[\varphi e + (1-e)\psi](\overline{V} - M) + \delta M - (1-e)w - (1/2)ce^2 \right). \quad (10)$$

By the Markovian assumption the lifetime expected utility from the next period on, $\overline{V}$,is independent of the current choice of e.This yields the incentive-compatibility constraint:

$$h + w + \delta(\overline{V} - M)(\varphi - \psi) = ce. \quad (11)$$

Comparing with the incentive-compatibility constraint in the one-shot game we see that the existence of rents and the tenant's foresight reduces the marginal cost of implementing e by the amount $\delta(\overline{V} - M)(\varphi - \psi)$.

First, we show that $\varphi = 1$ and $\psi = 0$ in the optimal dynamic contract. As long as the tenant is still getting more than his outside option, raising the probability of eviction is preferred by the landlord than to raise h for giving more incentives because it is costless from his point of view. Neither φ or ψ affect the landlord's payoff directly (so long as the participation constraint is not binding), and the only thing they affect is the incentive-compatibility constraint. Hence from (11) we see that ψ should be set at its minimum possible value, 0 to give the maximum punishment to the tenant for failure. On the other hand φ should be set at its maximum possible value, 1. The reason is, at an optimum with eviction threats it is costly from the landlord's point of view to punish the tenant for success both in terms of incentives (from (11)), as well as profits because it reduces the effectiveness of h to provide incentives.

Thus (11) becomes,

$$h + w + \delta(\overline{V} - M) = ce. \quad (12)$$

The participation constraint of the tenant is

$$\overline{V}_0 \geq M.$$

Unlike the one-shot game here the tenant is forward looking and so cares about the lifetime expected utility rather than the current period's utility. As we will see, in an equilibrium with eviction the participation constraint does not bind - otherwise eviction threats carry no force. In a stationary equilibrium $\bar{V}_0 = \bar{V}$, and hence from (10) we get:

$$\bar{V} - M = \frac{eh - (1-e)w - \frac{1}{2}ce^2 - m}{1 - \delta e}. \quad (13)$$

Substituting (12) in (13) we get

$$\bar{V} - M = \frac{1}{2}ce^2 - w - m \tag{14}$$

Next we show that eviction threats are used only if the PC does not bind in the one-period model, i.e., $m < \underline{m}$. Notice that the PC (in terms of life-time expected utility) binds in this model if $\overline{V} - M = 0$ which implies $e = \sqrt{\frac{2(m+w)}{c}}$ from (14). This is the value of equilibrium effort for the range of parameters for which the PC binds in the one-period model. Recall that $\underline{m} = \frac{1}{8c} - w$ is the value of m in the one-shot model such that for $m < \underline{m}$ the participation constraint does not bind and for $m \geq \underline{m}$, the PC binds. Directly substituting $m = \underline{m}$ in (14) and $e = \sqrt{\frac{2(m+w)}{c}}$ we see that $\bar{V} - M$ is indeed equal to 0. Hence if $\overline{V} - M = 0$ then the PC binds in the one-shot model. Also, if $\overline{V} - M = 0$ the ICC of this problem too becomes identical to that of the one-period model and hence the results of that model applies.

Now we are ready to prove the following *:* when m is below $\underline{m}$ eviction threats will be used as an additional incentive device and the value of e will be higher than it is when evictions are not possible, but less than the first-best level. As m increases towards $\underline{m}$, the value of e goes down and the lifetime expected utility of the tenant, $\bar{V}$, is lower when eviction threats are used as compared with the static model. Because the equilibrium is Markovian and we do not allow for savings or investment in the model, the landlord's problem in this case is still largely a static maximization. The only difference with the case analyzed in the previous section comes from the possibility of using the threat of eviction from the land as an incentive device. The key to this possibility lies in the fact, observed above, that in the static equilibrium a tenant who has limited liability might earn some rents. As a result, a tenant strictly prefers not to lose his job. On the other hand since tenants of all types (in terms of wealth) are available in unlimited numbers, the landlord is indifferent between retaining or firing a given tenant. It is therefore credible for him to evict a tenant whose output low and retain a tenant whose output is high. Therefore, we assume that the landlord can commit to an eviction function that specifies the probability of eviction for each realization of output. The landlord's optimal contract choice problem is :

$$Max_{\{e,h,l\}}\ e(1-h) - (1-e)l$$

subject to the participation, incentive compatibility and limited liability constraints. Since only the last two constraints bind at an eviction equilibrium we can rewrite the landlord's objective function as

$$Max_{\{e\}}\ \{1 - ce + \delta(\bar{V} - M)\}e + w \tag{15}$$

The landlord therefore solves which leads to the first-order condition

$$1 - 2ce + \delta(\bar{V} - M) = 0 \tag{16}$$

Notice that the second-order condition of the landlord's problem is satisfied as well.

From (14) and (16) we can solve for e and V as functions of the parameters of the model, m, δ, and c. Our assumptions guarantee that these equations can be solved to get a unique positive real value of e that lies between $\frac{1}{2c}$ and $\frac{1}{c}$.[44] This proves that the effort level is higher with eviction threats compared to the one-shot model but is less than the first-best level.

Similarly we can solve for the other endogenous variables, h and V. Totally differentiating (14) and (16) with respect to m we get,

$$\frac{\partial e}{\partial m} = -\frac{\delta}{2c(1-\delta e)} < 0.$$

Substituting (12) in (16) we see that

$$h = \frac{1}{2} - \delta\frac{1}{2}(\bar{V} - M) - w < \frac{1}{2} - w$$

Hence h is lower in an eviction equilibrium compared to the no-eviction equilibrium. Coupled with a higher effort, the tenant's per-period utility ($v = eh - (1-e)w - \frac{1}{2}ce^2$) has to be lower. Notice that $v = \underline{m}$ in the no-eviction equilibrium, and hence the tenant's expected lifetime utility is $\frac{\underline{m}}{1-\delta}$ which is greater than that in the eviction equilibrium, $\frac{v}{1-\delta e}$ both because the tenant's per-period utility is lower and the effective rate of discount lower ($\delta e(\delta) < \delta$).

7.3 The Optimal Contracting Problem with Investment

7.3.1 Contractible Investment

Since the level of the investment input x is contractible, the landlord can commit to a given level of it. Hence we can solve the landlord's problem in two stages. In the second-stage, the level of x is taken as given ($\bar{x}$), and the landlord offers a contract (h, l) and in response, the tenant chooses the effort level e. In the first-stage the level of x is chosen by the landlord anticipating the choice of h, l, and e in the next stage. In the second stage the landlord solves :

$$\max_{\{e,h,l\}} \pi = e^{\alpha}\bar{x}^{1-\alpha}(1-h) - (1 - e^{\alpha}\bar{x}^{1-\alpha})l$$

[44](14) defines $\bar{V} - M$ as a strictly increasing and convex function of e such that $\bar{V} - M = \frac{1}{8c} - w - m$ for $e = \frac{1}{2c}$, and $\bar{V} - M = \frac{1}{2c} - w - m$ for $e = \frac{1}{c}$. On the other hand (16) defines $\bar{V} - M$ as a strictly increasing and linear function of e such that $\bar{V} - M = 0$ for $e = \frac{1}{2c}$ and $\bar{V} - M = \frac{1}{\delta}$ for $e = \frac{1}{c}$. By assumption we are in a case where $\frac{1}{8c} - w - m > 0$ (the PC is not binding in the one-shot game) and $0 < \frac{1}{2c} - w - m < 1 < \frac{1}{\delta}$ as $c > 1$, $\delta < 1$. Also it must be the case that $\frac{1}{2c} - w - m > 0$ (otherwise a fixed-rent contract achieves the first-best). In addition, when $e = 1$, (14) gives $\bar{V} - M = \frac{c}{2} - w - m$ while (16) gives $\bar{V} - M = \frac{2c-1}{\delta}$ with the former less than the latter as $c > 1$and $\delta < 1$. This shows there does not exist another value of $e < 1$that satisfies (14) and (16).

subject to the incentive compatibility, limited liability and participation constraints :

$$\begin{aligned} \alpha e^{\alpha-1}\bar{x}^{1-\alpha}(h-l) &= ce \\ l &\geq -w \\ e^{\alpha}\bar{x}^{1-\alpha}h + (1-e^{\alpha}\bar{x}^{1-\alpha})l - \frac{1}{2}ce^2 &\geq m. \end{aligned}$$

Let the corresponding Lagrangian be denoted by $\mathcal{L}$ where γ, λ and μ are the Lagrangian multipliers associated with constraints (i), (ii) and (iii). The first-order conditions with respect to h and l are :

$$-e^{\alpha}\bar{x}^{1-\alpha} + \gamma\alpha e^{\alpha-1}\bar{x}^{1-\alpha} + \mu e^{\alpha}\bar{x}^{1-\alpha} = 0 \quad (17)$$

$$-(1-e^{\alpha}\bar{x}^{1-\alpha}) - \gamma\alpha e^{\alpha-1}\bar{x}^{1-\alpha}(h-l) + \lambda + \mu(1-e^{\alpha}\bar{x}^{1-\alpha}) = 0. \quad (18)$$

It is straightforward to check that all the results of section 7.1 go through in this slightly modified version of the model analyzed there.

Now consider the choice of x by the landlord in the first-stage. By the envelope theorem :

$$\begin{aligned} \frac{\partial\pi}{\partial x} &= \frac{\partial\mathcal{L}}{\partial x} \\ &= (1-\alpha)e^{\alpha}x^{-\alpha} - (1-\mu)(1-\alpha)e^{\alpha}x^{-\alpha}(h-l) + \gamma\alpha(1-\alpha)e^{\alpha-1}x^{-\alpha}(h-l) \end{aligned}$$

Substituting $\gamma = (1-\mu)\frac{e}{\alpha}$ from (17) and $(h-l) = \frac{ce}{\alpha e^{\alpha-1}x^{1-\alpha}}$ from the ICC, the last two terms cancel out. Hence, the landlord's choice of x is given by setting the marginal return from x to its marginal cost, ρ, yielding

$$x = \left[\frac{(1-\alpha)}{\rho}\right]^{\frac{1}{\alpha}} e.$$

Since the marginal return from x is increasing in e, which in turn is increasing in m by Result 3, the supply of x is likely to increase after the reform.

7.3.2 Non-Contractible Investment

We assume $w = 0$ and $m \leq \underline{m}$ for simplicity. Accordingly, from the analysis of section 7.1 it follows that in the one-period model, $e = \frac{1}{2c}$, $r_h = \frac{1}{2}$ and $r_l = 0$. Hence in the pre-reform game where the landlord cannot pre-commit to future contracts, his total (two-period) expected payoff is $\frac{1}{2c}$ and that of the tenant is $\frac{1}{4c}$. Let $\bar{s}$ be the legally stipulated crop-share of tenants under the tenancy law (e.g., 75% under Operation Barga). After the reform, under the legal contract $(\bar{s}Y_H, \bar{s}Y_L)$ the effort supplied by the tenant (in both periods) will be $e = \frac{\bar{s}}{c}$ and the level of investment will be $x = \frac{\bar{s}}{\gamma}$. The landlord's total expected payoff under the legal contract is $2(1-\bar{s})\frac{\bar{s}}{c} + (1-\bar{s})\frac{\bar{s}}{\gamma}$. This implies that the legal contract involves a high crop share of the tenant which is at the expense of the landlord's profits. The higher is $\bar{s}$ the more likely it is

that the landlord is worse off under the legal contract (the precise condition is $\frac{(1-\bar{s})\bar{s}}{\frac{1}{2}-2(1-\bar{s})\bar{s}} < \frac{\gamma}{c}$). But if the legal share is not too high, the pure effect of security of tenure will be to increase investment and make both the landlord and the tenant better off.

This brings us to the following question - if the legal contract is able to increase productivity by giving tenure to the tenant and enabling the landlord to pre-commit to future crop shares, then why could not the landlord somehow mimic it in the absence of the law. There are two answers to this.

First, the landlord may want to commit to such contracts but unable to do so in the absence of third party enforcement. In that case the vigorous implementation of the tenancy law under the reform may make it possible for the landlord to credibly commit to such contracts. This can potentially make both the landlord and the tenant better off by supplying them with a commitment technology from outside.

Second, the landlord may not *choose* to give security of tenure and pre-commit to future contracts even if he is able to do so. This will be the case if eviction threats were very effective in eliciting extra effort from the tenant before the reform. Let R denote the rents to the tenant from staying in the relationship in the second period. Under our assumptions, $R = \frac{1}{8c} - m$. From the analysis of section 7.1 we know that effort in the second period will be $e = \frac{1+R}{2c}$ and $r_h = \frac{1+R}{2}$. The landlord's total expected profit is $\frac{(1+R)^2}{4c} + \frac{1}{4c}$. Suppose instead the landlord guarantees tenure to the tenant and pre-commits the second period contract. In this case, the maximum amount by which the landlord can increase the rent in the second period is equal to the net social surplus from investment, $\frac{1}{2\gamma}$. Hence his total expected profit is $\frac{1}{2c} + \frac{1}{2\gamma}$. If R is high (so that eviction threats are very effective) and γ is high (it is costly to elicit investment from the tenant) then profits are higher under the former option. In this case even the legal contract raises investment, efficiency and the tenant's payoff, the landlord will be worse off. The observed landlord reaction against the reform in West Bengal (Ghosh, 1981) suggests that this was more likely to be the case there.

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Table 1: The Frequency of Eviction Threats in the Pre-reform Period

	Did landlords in your village use eviction threats?	Did landlords ever threaten you or your father with eviction?
Percentage of respondents indicating yes	79.9 %	30.02%
Threatened but never evicted	32.0 %	16.91%
Threatened and evicted	67.9 %	13.11%
Of those indicating eviction threats were used, the main reason was:		
Low production	49.0 %	41.6%
Dispute over share	23.1 %	9.6%
If tenant refused to provide free labor	20.0 %	3.2%
If tenant asked for share of cost	0.00 %	1.6%
If tenant did not till the landlord's land first	0.00 %	2.4%
If tenant did not obey instructions	13.9 %	18.4%
Resumption of land for self-cultivation	4.1 %	23.2%
Number of respondents	478	473

Table 2: The Possibility of Eviction in the Post-reform Period

Percentage of tenants indicating	**How difficult is it to evict a *registered* tenant against his will after the reform?**	**How difficult is it to evict an *unregistered* tenant against his will after the reform?**
Easily possible	0.0 %	1.46%
Possible	2.3 %	23.22%
May or may not be possible	1.3 %	9%
Difficult	65.5 %	65.27%
Impossible	31.0 %	1.05%
Number of respondents	478	480

Table 3: Summary Statistics

Variables	Yield of All Crops (Index: Base 1971=100)	Yield of Rice (Kilograms per Hectare)	Registration Rate (Proportion)	Public Irrigation (Hectares)	Length of Roads[1] (Kilometers)	Rainfall (Millimeters)
West Bengal (210 Observations: 14 Districts from 1979 through 1993)						
Grand Average	140.22	1,620.94	0.54	76,257.03	1190.00	1,880.06
S.D. (Overall)	34.60	482.32	0.19	94,807.97	512.08	821.46
S.D. (Within)	27.78	343.49	0.12	17,840.70	90.38	368.05
Average in 1979	104.11	1,220.82	0.23	66,672.90	1119.00	1,448.50
Average in 1993	176.35	2,040.04	0.65	84,739.70	1217.07	2,067.70
% Change 79-93	69.38	67.10	182.61	27.09	8.76	42.74
Growth Rate	4.03	4.11	2.30	1.68	0.37	1.45
Bangladesh (225 Observations: 15 Districts from 1979 through 1993)						
Grand Average	-	1,543.01	0	120,632.3	687.53	2,312.05
S.D. (Overall)	-	318.36	0	77,458.53	238.83	872.31
S.D. (Within)	-	235.45	0	44,992.23	114.24	467.02
Average in 1979	-	1,281.99	0	78,334.55	583.02	2,210.00
Average in 1993	-	1,853.23	0	169,710.1	809.26	2,663.31
% Change 79-93	-	44.54	0	116.64	38.80	20.51
Growth Rate	-	2.79	0	5.75	5.14	-0.12

Note: The reported numbers are year-wise *averages* computed from the district-level data. The last row in each panel gives the percentage per year average growth rate computed by fitting an exponential time-trend of the form $\ln(y) = a + bt$.

[1] For Bangladesh district-wise data for roads is available only since 1984. So the series on roads has 1984 and not 1979 as the initial point.

Table 4: Estimated Coefficients and *t*-statistics for West Bengal Sample

	Yield of All Crops		Rice Yield	
Variable	**Fixed Effects**	**IV Fixed Effects**	**Fixed Effects**	**IV Fixed Effects**
Registration Rate	0.287**	0.476***	0.270*	0.459***
	(2.11)	(3.18)	(1.84)	(2.84)
ln(Irrigation)	0.037*	0.035*	0.025	0.023
	(1.71)	(1.63)	(1.07)	(1.01)
ln(Roads)	0.294***	0.304***	0.289***	0.299***
	(3.00)	(3.09)	(2.74)	(2.82)
ln(rainfall)	-0.113***	-0.104**	-0.075	-0.066
	(-2.51)	(-2.30)	(-1.55)	(-1.37)
F-Statistic for joint significance of district Fixed Effects	23.57	23.97	13.19	13.58
F-Statistic for joint significance of year Fixed Effects	21.11	19.58	27.6	26.34
Adjusted R^2	0.87	--	0.90	--
Sample Size	210	210	210	210

Note: * denotes significant at 10% level or better, ** denotes significant at 5% level or better, *** denotes significant at 1% level or better.

Table 5 : Difference in Difference Estimates using Bangladesh as Control (Unconditional)

	Before Reform (1977-79)	After Reform (1980-93)	Column Difference
West Bengal	1308.2	1649.52	341.32
Bangladesh	1296.76	1561.64	264.88
Row Difference	11.43	87.87	76.43

Table 6 : Difference in Difference Estimates using Bangladesh as Control (Conditional)

Variable	Rice Yield
	OLS
West Bengal Intercept	0.02 (0.56)
West Bengal*Reform	0.11*** (2.67)
Ln(Irrigation)	0.08*** (15.36)
Ln(rainfall)	-0.10*** (-4.58)
F-Statistic for joint significance of year Fixed Effects	20.13
Adjusted R^2	0.62
Sample Size	480

Table 7 : Estimated Coefficients and *t*-statistics for Combined West Bengal & Bangladesh Samples

	Rice Yield		Rice Yield[1]	
Variable	**Fixed Effects**	**IV Fixed Effects**	**Fixed Effects**	**IV Fixed Effects**
Registration Rate	0.471*** (6.09)	0.547*** (6.735)	0.247** (1.95)	0.438*** (3.15)
ln(Irrigation)	.093*** (5.98)	0.096*** (6.11)	0.027 (1.66)	0.028* (1.65)
ln(Roads)	--	--	-0.02 (-0.54)	-0.008 (-0.20)
ln(rainfall)	0.004 (0.14)	-0.001 (-0.01)	-0.067** (-2.08)	-0.063** (-1.96)
F-Statistic for joint significance of district Fixed Effects	22.21	111.14	21.09	120.15
F-Statistic for joint significance of year Fixed Effects	29.23	27.69	37.51	35.40
Adjusted R^2	0.85	--	0.88	--
Sample Size	428	428	357	357

Note: * denotes significant at 10% level or better, ** denotes significant at 5% level or better, *** denotes significant at 1% level or better.

[1] Includes roads as an explanatory variable. Uses only 1984-93 observations for Bangladesh as a result.

Table 8: Estimated Effects of Registration on Yields

	West Bengal Sample				Combined West Bengal & Bangladesh Samples			
	Yield of All Crops		Rice Yield		Rice Yield		Rice Yield[1]	
	Fixed Effects	IV Fixed Effects	Fixed Effects	IV Fixed Effects	Fixed Effects	IV Fixed Effects	Fixed Effects	IV Fixed Effects
Change in Yields (%)	11.8%	19.7%	11.3%	18.9%	19.7%	22.7%	10.1%	18.1%
Contribution to Total Change in Yields (%)	17.0%	28.6%	16.9%	28.2%	29.5%	33.9%	15.0%	27.0%

[1] Includes roads as an explanatory variable. Uses only 1984-93 observations for Bangladesh as a result.

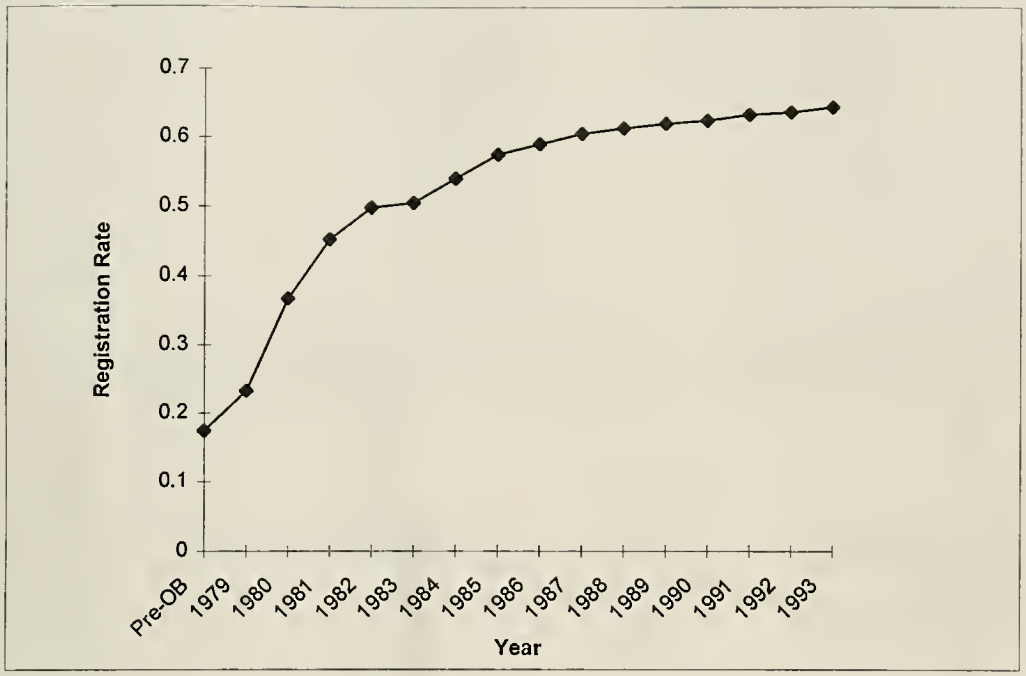

Figure 1 : Percentage of sharecroppers registered in West Bengal, 1978-93.[1]

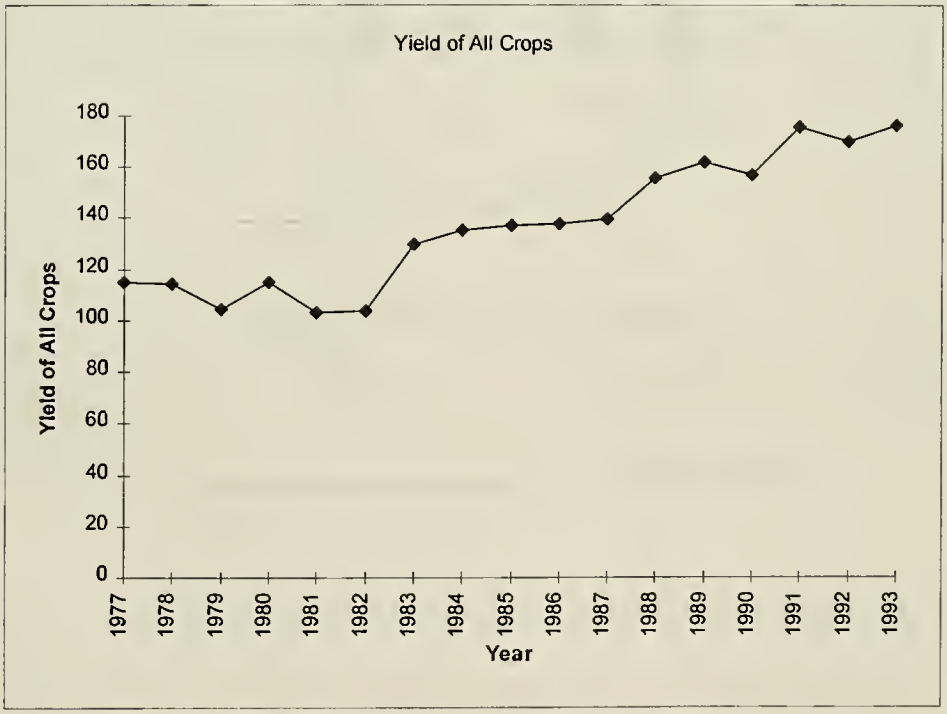

Figure 2 : Yield of All Crops (Base : 1971=100) in West Bengal (1977-93).

[1] Registration rate is defined to be the cumulative percentage of registered sharecroppers at the *beginning* of a year. For the period prior to the reform (which started in 1978), only the cumulative position for the state as a whole is available which is shown against "Pre-OB".

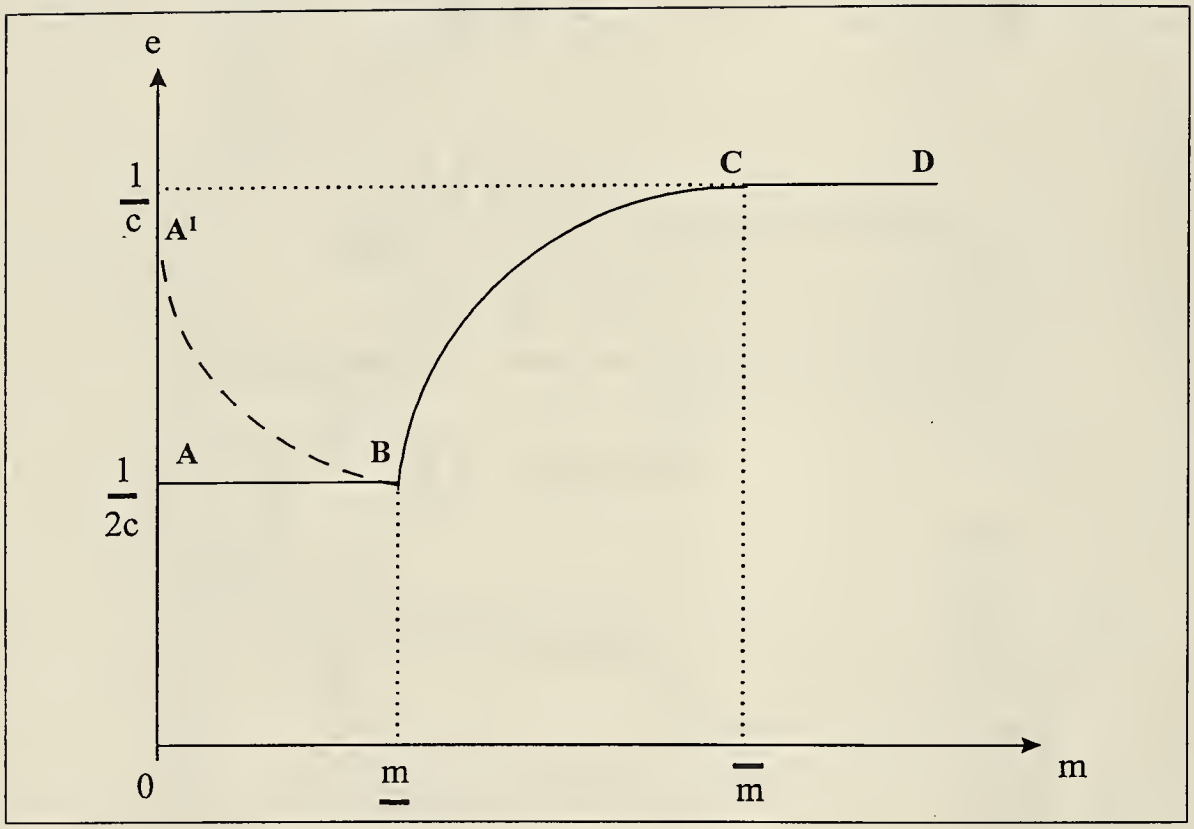

Figure 3 : Effort as a function of the tenant's outside option.

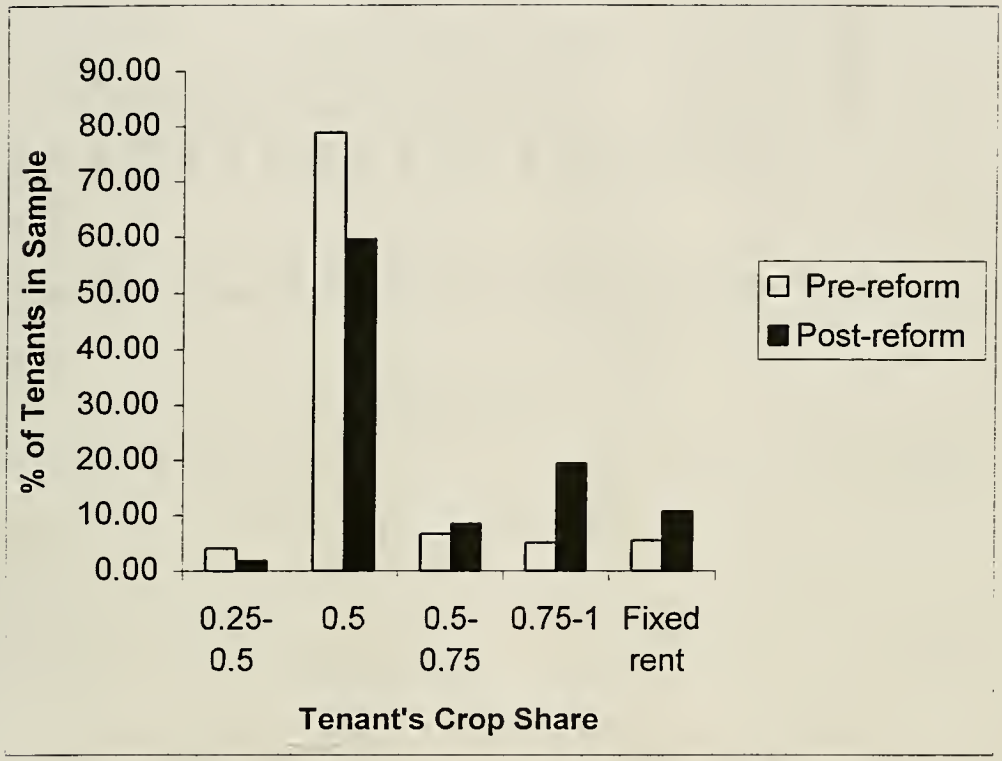

Figure 4 : Tenant's Crop Share for Aman Rice

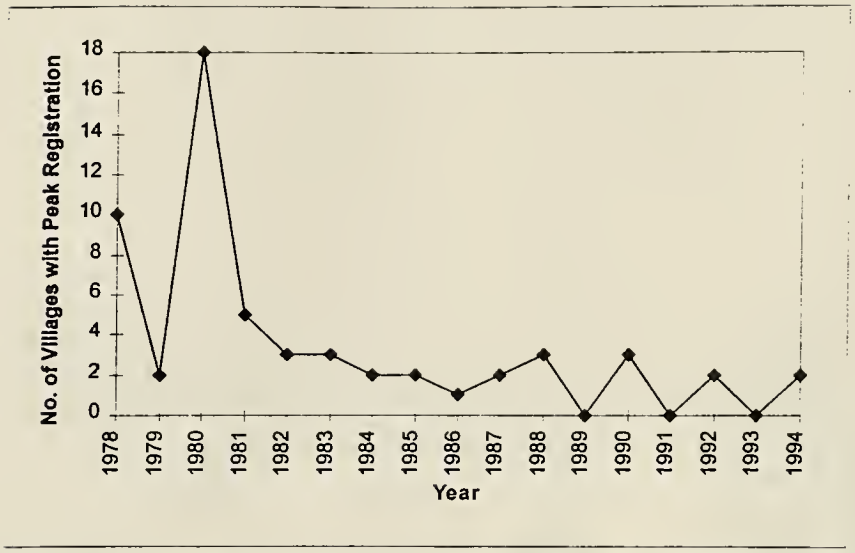

Figure 5 : Number of villages showing their highest number of registrations, 1978-94.

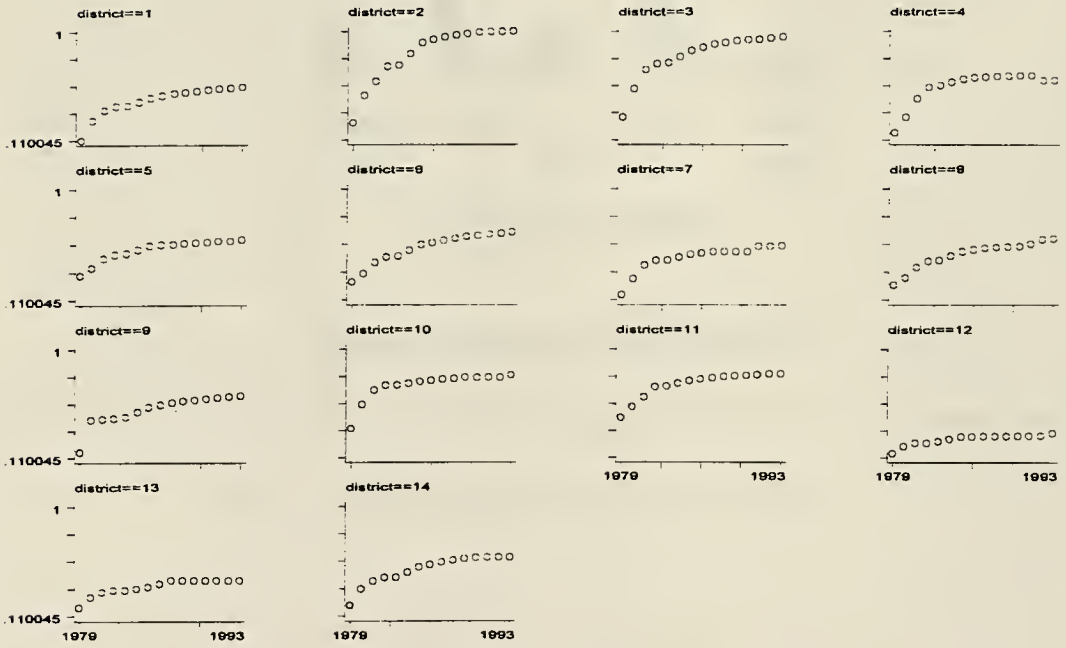

Figure 6 : Registration rate of sharecroppers in West Bengal by district, 1978-94.

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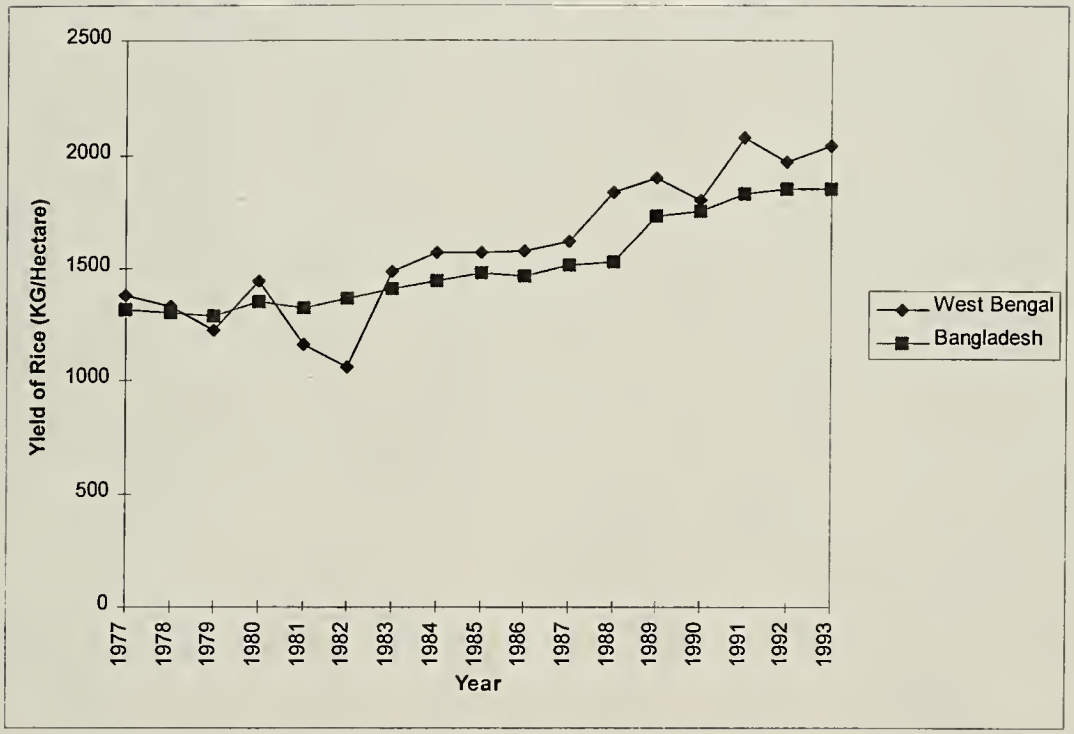

Figure 7 : Yield of Rice (KGs per Hectare) in West Bengal and Bangladesh (1977-93).

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