EMPOWERMENT AND EFFICIENCY: TENANCY REFORMS IN WEST BENGAL

ABHIJIT V. BANERJEE, PAUL GERTLER AND MAITREESH GHATAK

-Presented by

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INTRODUCTION

- In agrarian economies land is the principal asset. Stark inequality in property rights over land has deep ramifications on the standard of living of large masses.
- Such inequalities prevail in most parts of LDCs and were observed in West Bengal, the research locale.
- Here, the issue of distribution of land has figured in a big way in all political movements right from the days of the freedom struggle.
- The present paper concerns itself with the impact of a massive change in property rights over land through government policy in 1977 on efficiency.

Situation Before the Reform

- Existence of a landlord class
- Prevalence of sharecropping and fixed rent tenancy with dominance of the former
- Sharecroppers traditionally entitled to half the produce in most areas, as opposed to legally stipulated 75%
- Contracts mostly unregistered, tenants could be evicted anytime
- Apathy of government to enforcement of existing tenancy legislation

THE INTERVENTION

- Newly elected Left government plugs legal loopholes in 1977
- From 1978 it begins a massive village-to-village drive called Operation Barga to register unregistered sharecroppers
- Uses village level political organizations to organize and empower tenants so that landlords can't intimidate them
- Government tries to ensure that disputes are handled fairly in law courts

THE IMPACT

- Ownership rights unchanged
- However, nature of contract changes in that eviction of tenants becomes almost impossible. Their outside option has increased.
- Situation remains unchacteristically peaceful for such a massive change
- Conceptually, two opposing effects on productivity can be isolated:
- a. Bargaining power effect
- b. Security of tenure effect

OUR PLAN OF ACTION

- Theoretically model the impact of Operation Barga through the two distinct opposing effects
- As the net impact is unclear, carry out an empirical exercise to find out what has actually happened

THE MODEL

- An infinitely lived landlord owning a plot of land hires a single infinitely lived tenant from amongst many such available persons willing to accept such an offer.
- Tenants have a reservation payoff of m and a wealth of w.
- Landlords and tenants have same discount factor $\delta<1$
- Output can take two values, Y_h =1 or Y_l=0 with probability e and 1 – e respectively

- The tenant chooses effort e which costs him
  $c(e)=\frac{1}{2}ce^2$ $c>1$
- Our assumptions are:

  1. e is non-observable and hence non-contractible

  2. Output depends only on e

  3. Past and present realizations of output are contractible

4. Landlord faces a limited liability constraint

5. Landlord and tenant are risk-neutral

Landlord plays an extensive form game with his potential tenants.

- We assume that the landlord's strategies are history independent, so a contract in the no-eviction case must specify h and l where they stand for payment to the tenant in the event of high and low output respectively.
- Alternative characterization in the form of a linear contract

MODEL WITHOUT EVICTION

- To find what contract the landlord will offer, we must

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

s.t. $h \geq -(1+w)$

$l \geq -w$ (LLC)

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

$e = \arg\max_{e \in \{0,1\}} \{eh + (1-e)l - \frac{1}{2}ce^2\}$ (ICC)

- From ICC, optimal contract must have $h > l$
- $l \geq -w$ implies $h \geq -(1 + w)$
- The social surplus is

  $S = e - ce^2/2$

  This is maximized at $e = 1/c < 1$

  We could write the ICC as

  $e = (h - l)/c \in (0,1)$

- Our problem can be written as

  max $\pi = (h - l)/c - (h - l)^2/c - l$, h & l being choice variables

  <u>CASE 1</u>

  LLC binds, PCC doesn't bind

  Solving, we get $h - l = ½$, $e = 1/2c$

  This case can be parameterized as

  $m + w < 1/8c$

CASE 2

PCC binds, LLC doesn't bind

$h - l = 1$, $e = 1/c$

The case is parameterized as $m + w \geq 1/2c$

CASE 3

PCC and LLC both bind

$h - l = \sqrt{(2c(m + w))}$, $e = \sqrt{(2(m + w)/c)}$

RESULT 1

$$e = \begin{cases} 1/2c & \text{if } m + w < 1/8c \\ \sqrt{(2(m + w)/c)} & \text{if } 1/8c \leq m + w \leq 1/2c \\ 1/c & \text{if } 1/2c \leq m + w \end{cases}$$

This result illustrates that with rise in m the cropshare of the tenant rises due to “bargaining power” effect and he is incentivised to put in higher effort.

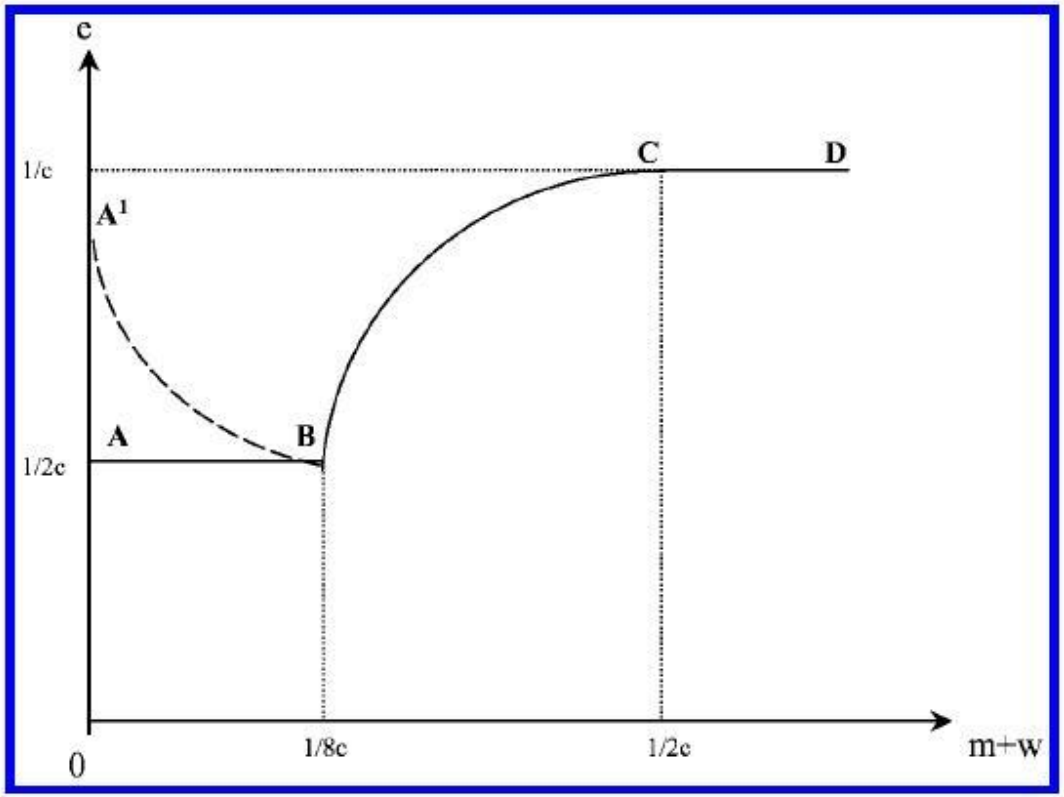


FIG. 1

MODEL WITH EVICTION

- Now a contract has to specify four numbers:

  h, l, ϕ and ψ where the last two symbols stand for the probabilities of the tenant continuing in the event of high and low output respectively.

  Let V be tenant's lifetime utility of incumbent tenant, M the equilibrium lifetime utility of a person who's not a tenant, so $M = m/(1 - \delta)$

- V must satisfy the Bellman equation:

$V_0 = \max_{\{e\}} \{eh + \delta[\phi e + (1-e)\psi](V - M) + \delta M - (1-e)w - ce^2/2\}$ ……..(1)

The new ICC is :

$h + w + \delta(V - M)(\phi - \psi) = ce$ ……..(2)

In the optimal dynamic contract $\phi = 1$, $\psi = 0$

So ICC becomes $h + w + \delta(V - M) = ce$ ……(3)

- But in stationary equilibrium $V_0 = V$
- So $V - M = (eh - (1 - e)w - ce^2/2 - m)/(1 - \delta)$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

From (3) & (4),

$$V - M = \frac{1}{2}ce^2 - w - m \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

The new PCC is $V \geq M$ ……..(6)

- In any equilibrium in which eviction threats are used, PCC must not bind and LLC must bind.
- Landlord has to maximize

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

s.t. ICC (3) and LLC

Using ICC and LLC the objective function is rewritten as

$$\max_{\{e\}} \{1-ce+\delta(V-M)\}e+w$$

- Maximizing this we get

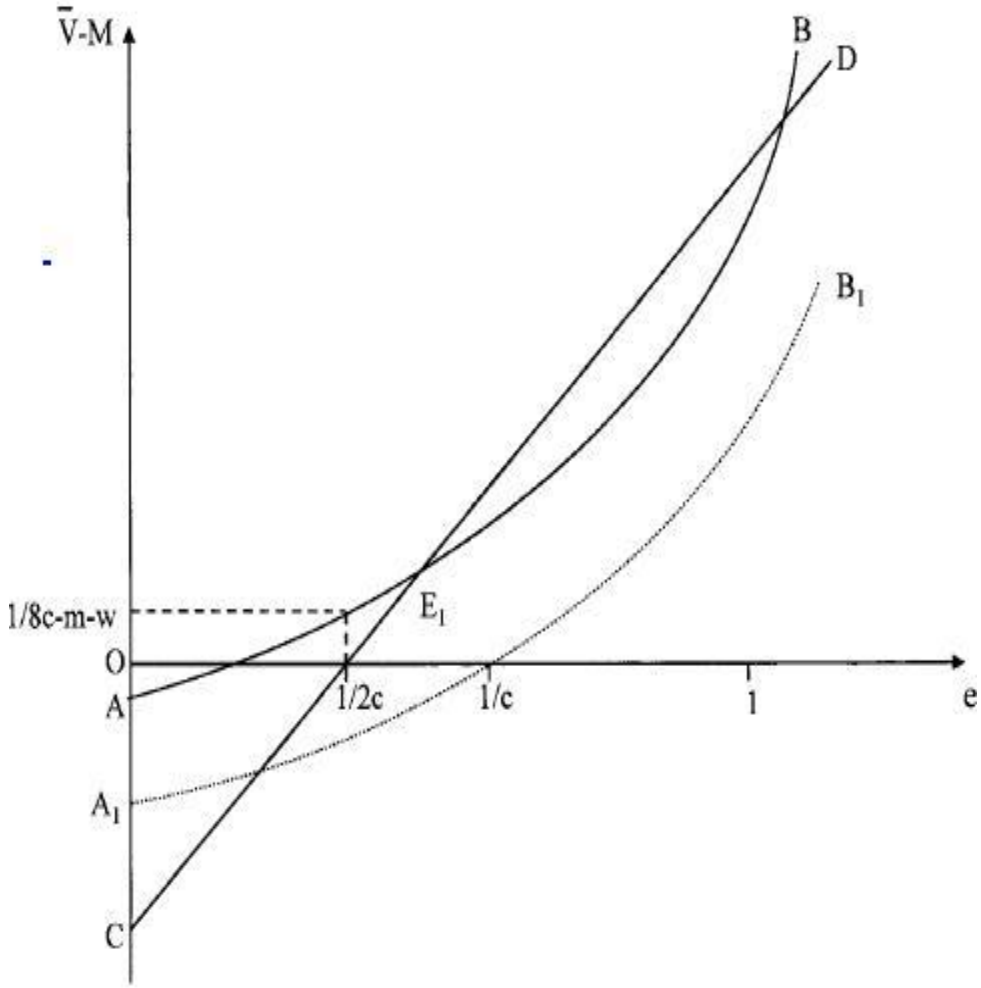
  $1 - 2ce + \delta(V - M) = 0$ .....(7)

  $\Rightarrow e = (1 + \delta(V - M))/2c$ .....(8)

  Solving (5) & (8) simultaneously, we get equilibrium values of e and V – M . We show it graphically.

  From (3) & (7),

  $h - l = ½ - \delta(V - M)/2$


V̄-M
B
D
B1
E1
1/8c-m-w
O
A
1/2c
1/c
1
e
A1
C

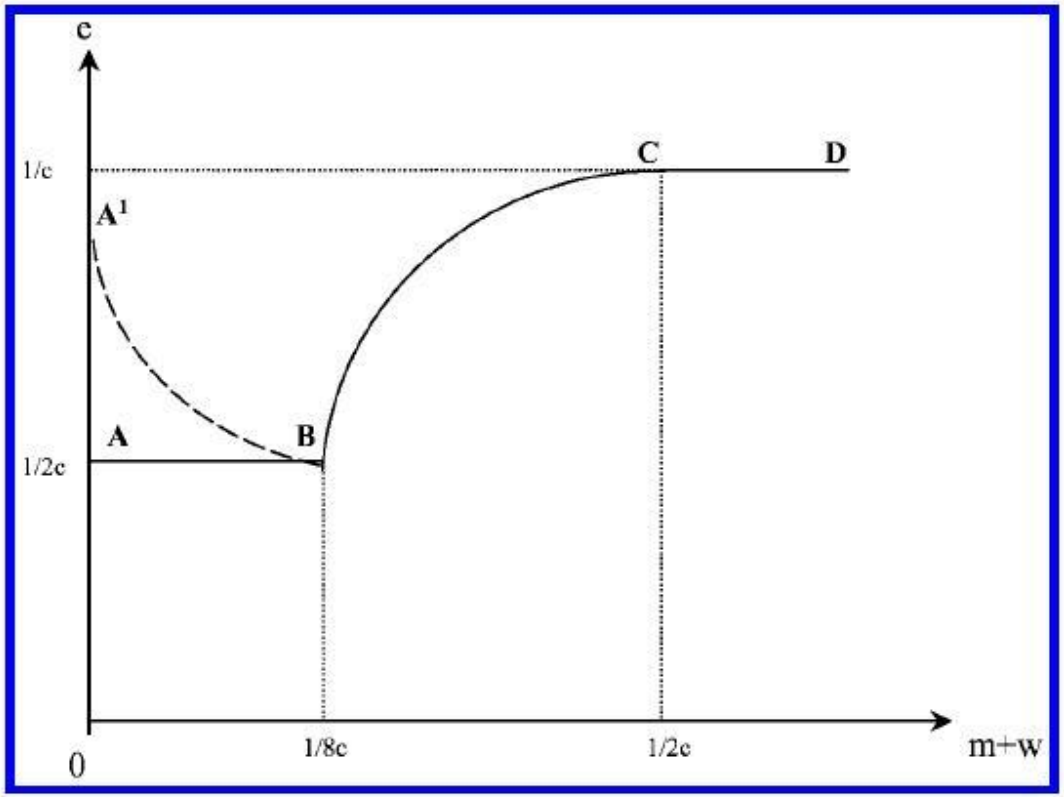


FIG. 1

RESULT 2

When evicting the tenant is an option the optimal choice of e and h – l coincides with the no-eviction case as long as $m + w \geq 1/8c$. For $m + w < 1/8c$, the value of e chosen with evictions is strictly higher than corresponding value without evictions. Moreover, in this range a higher value of m is associated with a lower choice of e but a higher choice of h – l.

RESULT 3

An improvement in the tenant's outside option increases the marginal return on contractible investments that are complementary with effort. Security of tenure and a higher crop share induce the tenant to increase the supply of non-contractible land-specific investments.

EMPOWERMENT AND EFFICIENCY: TENANCY REFORMS IN WEST BENGAL-An Empirical Overview

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A Quick Summary:

Theoretically the net impact of operation Barga, which empowered tenants without giving them full ownership, was shown to be a combination of two effects:

- Bargaining Power Effect
- Security Of Tenure Effect

An increase in the outside option of the tenant compelled the landlord to pay the tenant more as an incentive to make him work harder- Bargaining Effect.

- Disallowing eviction reduced efficiency. But greater security of tenure encouraged the tenant to invest more.

(Increased bargaining power meant that tenant expected to get a higher share of the additional output resulting from investment)

Aggregate data shows that tenants responded positively to that reform.

- About 65 percent of all sharecroppers were registered compared to 15 percent in the pre-reform period.
- The proportion of tenants getting more than 50% of output increased from 17 % to 39% post reform.
- The increase in share was greater for registered tenants than unregistered.

There is evidence based on Operation Barga that explains around 28 % of the subsequent growth of agricultural productivity

Crop share of tenants before and after the reform is shown in the graph below:

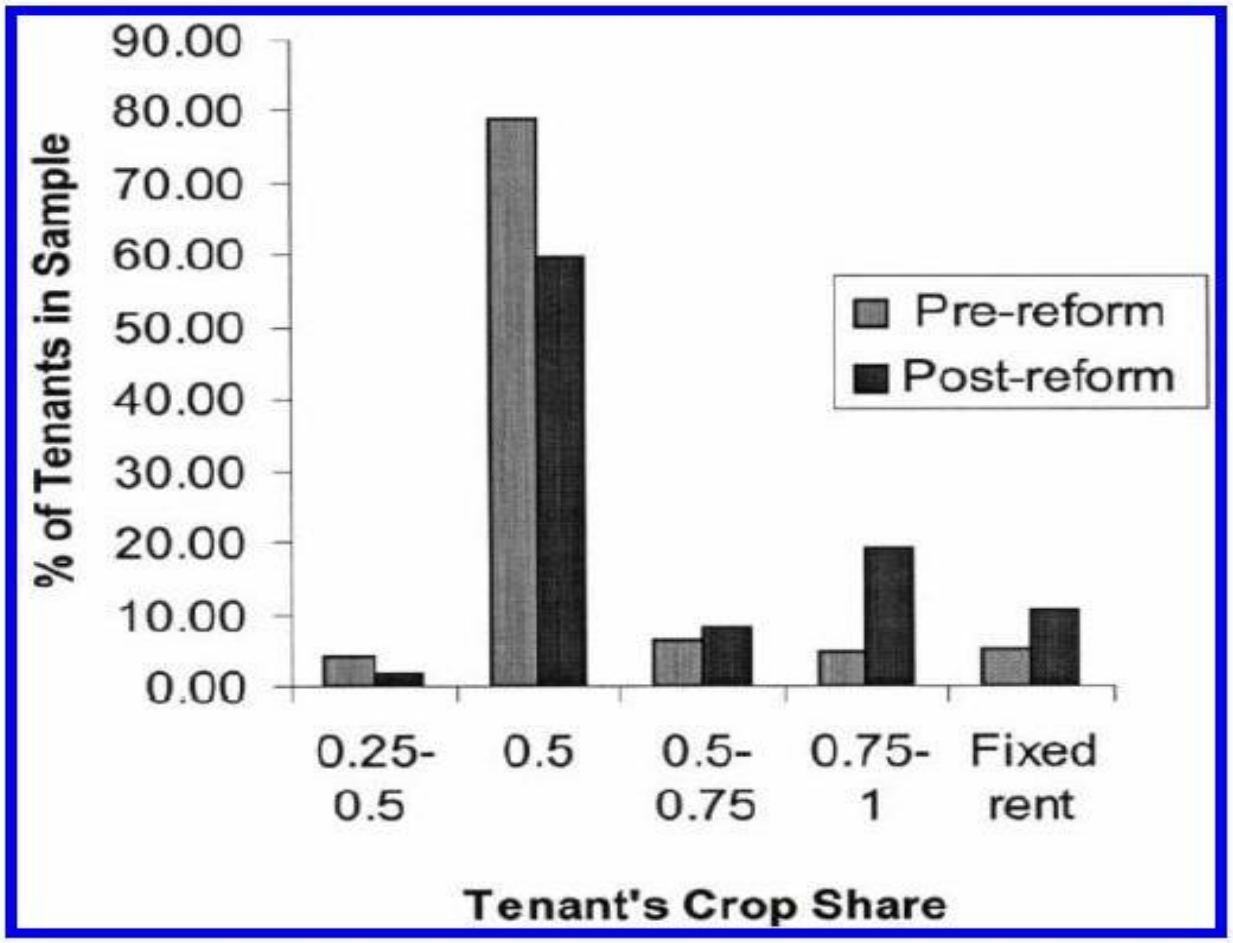

FIG. 3.—Crop share of tenants before and after the reform

Objective

As long as the outside options are held fixed, eliminating the possibilty eviction reduces effort and other noncontractible current inputs but,

once the possibility of eviction eliminated, a higher m increased supply of inputs.

Since operation Barga

- Eliminated eviction
- Increased outside option,

Its net effect could have been **positive** or **negative**.

Our objective is to estimate the effect of the change in property rights brought about by Operation Barga on agricultural productivity in West Bengal

Quasi Experimental Approach

- Here Bangladesh is used as a control.

  To check whether Bangladesh can be considered as a control or not:

- Prior to independence, except for economic and political boundaries, the two regions are very similar as far as agro-climatic conditions, prevalence of tenancy and agricultural tenancy are concerned.

  Hence we can conclude that any technological shocks to agricultural yield to be similar between these two regions.

- Rice is the main component of agricultural production both in West Bengal and Bangladesh.

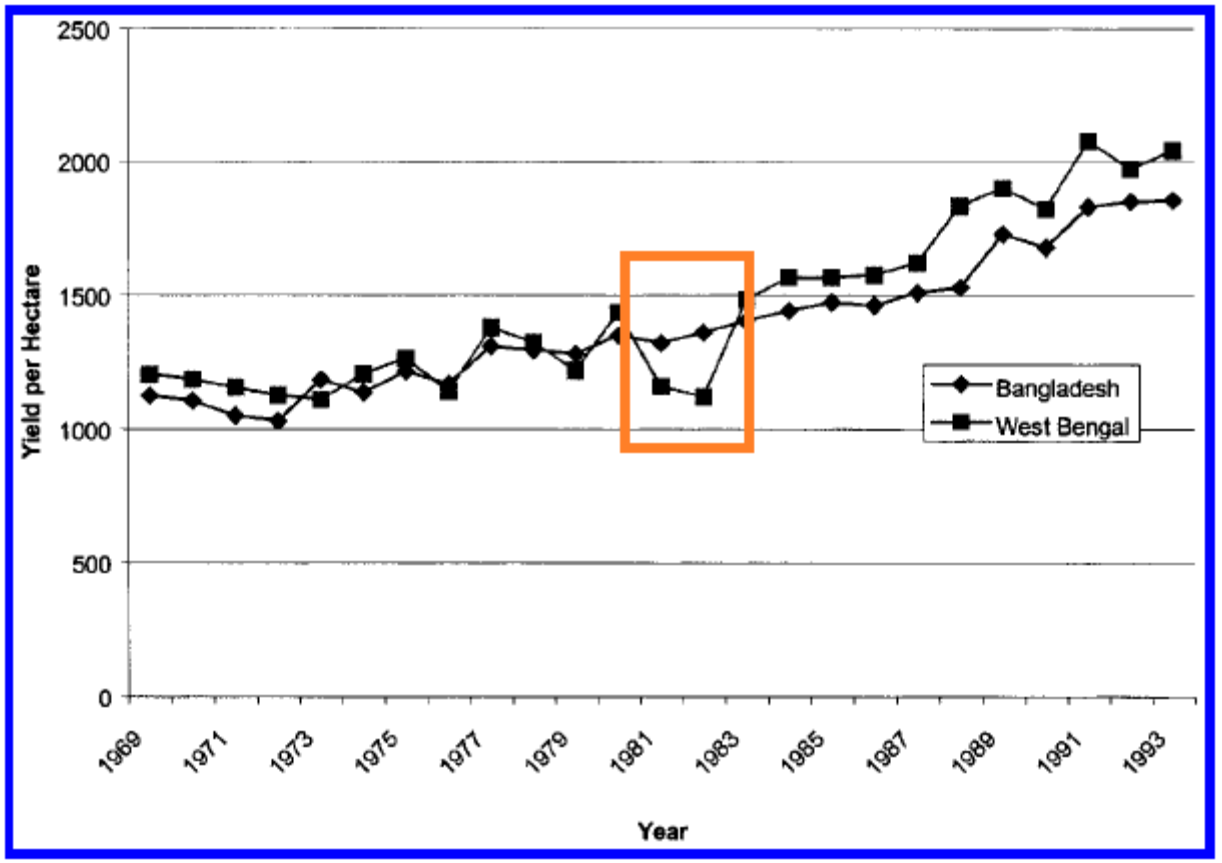

FIG. 4.—Rice yield in West Bengal and Bangladesh, 1969–93

Observations:

- As is evident from the figure above agricultural productivity was growing at almost at identical rates in the two states,in the period before operation Barga.
- In the post –Operation Barga period ,rice yields in West Bengal are substantially higher in all years except for 1981 and 1982,when West Bengal experienced two successive years of severe droughts.
- During the period of study, agricultural productivity in both regions increased as a result of three common factors. Hence the increasing trend.
- The factors are:
  - Arrival of Green Revolution permitted by the spread of locally suited HYV
  - Fall in price of fertilizers
  - Increase in small scale private irrigation.

- However even though the rate of adoption of HYV rice was faster in Bangladesh compared to West Bengal,the rate of growth in rice productivity was higher in West Bengal .

This difference is what the author has attributed to the implementation of Operation Barga

Methodology

- Difference-in-difference estimation procedure is used.

Treatment Districts - Districts from West Bengal

Control Districts - Districts from Bangladesh

The model can be specified in regression form as:

$$\ln y_{dt} = \alpha_d + \psi_t + \beta \times \text{treatment}_d \times \text{post}_t + \sum \phi_j X_{jdt} + \epsilon_{dt}$$

- The dependent variable is the log of the rice yield per hectare in district d ,year t.
- The coefficient β is the difference-in-difference estimate of the impact of operation Barga on rice yields.

Counterfactual Assumption of the Model

- The treatment district would grow at the same rate as the control district if there were no intervention.

VALIDITY OF THE ASSUMPTION

While this assumption is not testable we can test whether the assumptions holds in the preintervention period.

To conduct the test we regress changes in log yields over the period 1969-78 against an indicator of whether the district is in west bengal and year dummies. The hypothesis is rejected if the coefficient of West Bengal is significantly different from zero. The results are presented in the following table:

DIFFERENCE-IN-DIFFERENCE MODELS OF LOG OF RICE YIELD PER HECTARE (1969–93)

	DIFFERENCE	LEVEL	
	(1969–78)	1969–93	Excluding 1981–82
	(1)	(2)	(3)
West Bengal (=1)	.004	...	...
	(.17)		
West Bengal × (1979–83)[a]	...	-.09***	−.01
		(3.75)	(.38)
West Bengal × (1984–88)	...	.05**	.05**
		(1.99)	(2.00)
West Bengal × (1988–93)	...	.05*	.05*
		(1.77)	(1.78)
District fixed effects F-statistic	...	44.55	42.61
Year fixed effects F-statistic	4.26***	29.75***	31.81***
R^2	.12	.80	.81
Sample size	256	717	659

NOTE.—t-statistics are in parentheses.

[a] These variables are obtained by interacting a dummy variable that takes the value one if a district is in West Bengal and zero if it is in Bangladesh with another dummy variable that takes the value one if the observation is in the indicated time period (1979–83 in this case) and zero otherwise.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

*** Significant at the 1 percent level.

Results

- We cannot reject the hypothesis that growth was the same in both control and treatment districts in the pre-Operation Barga period.
- We split the postreform period into three periods of equal length to accomodate variation in the speed of registration as well as taking into account that the effect through increased investment would take time to materialize.

These results are consistent with the hypothesis that Operation Barga had a positive impact on productivity.

- In the postreform period the share of HYV rice in total cultivated area increased from-

  6% to 18% in West Bengal

  9% to 25% in Bangladesh

- In the same period area under public irrigation increased by

  23% in West Bangal compared to 46% in Bangladesh.

  This made the author **adjust** the simple difference-in-difference estimates for time varying control.

TABLE 3

DIFFERENCE-IN-DIFFERENCE MODELS OF LOG OF RICE YIELD (1977–91)

	WHOLE SAMPLE			EXCLUDING DROUGHT YEARS 1981–82		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
West Bengal × (1979–83)	−.08*** (−2.43)	−.07** (−2.05)	−.05 (−1.58)	.001 (.01)	.002 (.06)	.015 (.47)
West Bengal × (1984–87)	.04 (1.17)	.05 (1.47)	.07** (2.04)	.04 (1.24)	.04 (1.26)	.06** (1.93)
West Bengal × (1988–91)	.08** (2.20)	.12*** (3.28)	.18*** (5.11)	.07** (2.33)	.11*** (2.97)	.17*** (4.95)
Log(rainfall)	...	.01 (.40)	.007 (.32)	...	.019 (.70)	.01 (.46)
Log(public irrigation)	...	.122*** (7.22)	.07*** (4.27)	...	.103 (5.77)	.04*** (2.69)
HYV share of grain cultivation area	...	...	1.04*** (8.18)	...	...	1.05*** (8.21)
District fixed effects *F*-statistic	40.02***	20.14***	14.76***	41.43***	18.8***	14.64***
Year fixed effects *F*-statistic	20.18***	12.14***	7.73***	21.67***	12.41***	6.04***
R^2	.82	.85	.87	.83	.85	.88
Sample size	424	424	424	367	367	367

NOTE.—*t*-statistics are in parentheses.

** Significant at the 5 percent level.

*** Significant at the 1 percent level.

- Under the assumption that there was no differential change in the yields of owner-cultivators between West Bengal and Bangladesh, sharecropper productivity increased by **51**pc during the last period.

(This estimate is obtained by multiplying the coefficient of West Bengal*(1988-91) reported in table 3 by (1-s)/s=3,where s is the proportion of land cultivated by sharecroppers)

Drawbacks Of the Quasi-Experimental Approach

Since quasi-Experimental approach lacks the element of random assignment to treatment or control,the estimates of impact are subject to contamination by confounding variables.

- There might be unobserved differences in government programs between the two countries.

(If unobserved programs also expanded faster in Bangladesh in post-Operation Barga period,our difference-in-difference estimates would give a lower bound estimate)

- The author could not rule out the fact that there were unobservable policies that confound the estimated effect.

Program Intensity Approach

The author thus complemented this analysis with the following alternative approach.

- This approach takes the **district sharecropper registration rate** as a measure of program intensity.
- It then examines whether productivity rises faster in areas with greater program intensity.

First the emperical specification which relates yields to the registration rate is formally derived:

- We have district level yield generated by averaging across registered sharecroppers,unregistered sharecroppers,owner cultivators.In order to interpret the coefficients correctly individual level model is aggregated to generate district-level data.
- We start with a reduced form productivity equation derived from a structural profit maximising model of a tenant farmer.

$$Y_{it} = A(\mathbf{c}_{it}, \theta_i) \left(\prod_{j=1}^{n} P_{jt}^{\alpha_j} \right) \left(\prod_{k=1}^{N} X_{kit}^{\beta_k} \right) r_{it}^{\gamma} [\exp(\epsilon_{it})],$$

Where, Y_{it} is farm i's profit maximising output per hectare at time t.

A :X-efficiency of the farm

c_{it} :vector of contract parameters

θ_i :Fixed characteristic of tenant and farm(wealth,ability)

P_{jt}:market price of contractible inputs

X_{kjt}:input provided by government

r_{it}:amount of rainfall on the farm

ε_{it}:mean random productivity shock

The change in X-effciency parameter A captures:

- The effect of improved crop share of tenants on the supply of non-contractible inputs(eg.effort).
- The net effect of permanency of tenure on the choice of inputs(both current inputs and investments)

- Average district X-Efficiency at any point in time depends on:
- the proportion of farmers who were tenants
- The proportion who had the opportunity to register.
- Proportion of people who chose to register.

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 at time t, and λ_d be the take-up rate. Then the average X-efficiency of district d in period t is

$$A_{dt} = s_d\{v_{dt-1}[\lambda_d A^r + (1 - \lambda_d)A^u] + (1 - v_{dt-1})A^n\} + (1 - s_d)A^o. \quad (10)$$

- A^n: denote the efficiency of a tenant farm in the pre-reform period.
- A^r and A^u: efficiency of a farm cultivated by a registered tenant and the efficiency of a farm which did not register even though it had the opportunity to do so.
- A^0:efficiency of an owner cultivated farm, which should be unaffected by the reform.

Equation (10) gives us:

$$\begin{aligned} A_{d,t} &= s_d\{v_{d,t-1}[\lambda_d A^r + (1-\lambda_d)A^u] + (1-v_{d,t-1})A^n\} + (1-s_d)A^o \\ \Rightarrow A_{d,t} &= s_d\{\lambda_d v_{d,t-1}[A^r + \frac{1-\lambda_d}{\lambda_d}A^u] + A^n - \lambda_d v_{d,t-1}\frac{A^n}{\lambda_d}\} + (1-s_d)A^o \end{aligned}$$

Substituting $b_{d,t-1} = \lambda_d v_{d,t-1}$ (definition of $b_{d,t-1}$)

$$\begin{aligned} A_{d,t} &= s_d\{b_{d,t-1}[A^r + \frac{1-\lambda_d}{\lambda_d}A^u] + A^n - b_{d,t-1}\frac{A^n}{\lambda_d}\} + (1-s_d)A^o \\ \Rightarrow A_{d,t} &= s_d\{b_{d,t-1}[A^r + \frac{1-\lambda_d}{\lambda_d}A^u - \frac{A^n}{\lambda_d}] + A^n\} + (1-s_d)A^o \end{aligned}$$

Taking out $(1-s_d)A^o$ common, we have:

$$
\begin{aligned}
A_{d,t} &= (1-s_d)A^o\Big[\frac{s_d}{(1-s_d)A^o}\Big\{b_{d,t-1}\Big[A^r+\frac{1-\lambda_d}{\lambda_d}A^u-\frac{A^n}{\lambda_d}\Big]+A^n\Big\}+1\Big] \\
\Rightarrow A_{d,t} &= (1-s_d)A^o\Big\{\frac{s_d}{1-s_dA^o}b_{d,t-1}\Big[A^r+\frac{1-\lambda_d}{\lambda_d}A^u-\frac{A^n}{\lambda_d}\Big]+\frac{s_d}{1-s_d}\frac{A^n}{A_o}+1\Big\} \\
\Rightarrow A_{d,t} &= (1-s_d)A^o\Big\{\frac{s_d}{1-s_dA^o}b_{d,t-1}\Big[\frac{\lambda_dA^r+(1-\lambda_dA^u-A^n}{\lambda_dA^o}\Big]+\frac{s_d}{1-s_d}\frac{A^n}{A_o}+1\Big\}
\end{aligned}
$$

Taking logarithms on both sides:

$$
\ln A_{d,t} = \ln\Big\{1+\frac{s_d}{(1-s_d)A^o}b_{d,t-1}\Big[\frac{\lambda_dA^r+(1-\lambda_d)A^u-A^n}{\lambda_dA^o}\Big]+\frac{s_d}{1-s_d}\frac{A^n}{A_o}\Big\}+\ln(1-s_d)A^o
$$

Let us define the following symbols:

$$\begin{aligned}
\gamma &= \frac{s_d}{1-s_d}\frac{\lambda_d A^r + (1-\lambda_d A^u - A^n}{\lambda_d A^o} \\
\alpha_d &= \frac{s_d}{1-s_d}\frac{A^n}{A_o} + \ln(1-s_d)A^o \\
x &= \gamma b_{d,t-1} + \frac{s_d}{1-s_d}\frac{A^n}{A_o}
\end{aligned}$$

Hence, the last equation can be written as:

$$\ln A_{d,t}\{1+x\} + \ln(1-s_d)A^o$$

When x is small, $\ln(1+x) \approx x$, hence, we have:

$$\begin{aligned}
\ln A_{d,t} &= (\gamma b_{d,t-1} + \frac{s_d}{1-s_d}\frac{A^n}{A_o}) + \ln(1-s_d)A^o \\
&= \gamma b_{d,t-1} + (\frac{s_d}{1-s_d}\frac{A^n}{A_o} + \ln(1-s_d)A^o) \\
\Rightarrow \ln A_{d,t} &= \gamma b_{d,t-1} + \alpha_d \\
\Rightarrow \ln A_{d,t} &= \alpha_d + \gamma b_{d,t-1}
\end{aligned}$$

From Equation (9) we have:

$$\begin{aligned}
Y_{d,t} &= A_{d,t}(\prod_{j=1}^{n} P_{j,t}^{\alpha_j})(\prod_{k=1}^{N} X_{k,d,t}^{\beta_j})exp(\epsilon_{d,t}) \\
\Rightarrow \ln Y_{d,t} &= \ln A_{d,t} + \sum_{j=1}^{n} \alpha_j \ln P_{j,t} + \sum_{k=1}^{N} \beta_j \ln X_{k,d,t} + \epsilon_{d,t}
\end{aligned}$$

Thus, the final form we have, is:

$$\ln Y_{d,t} = \alpha_d + \gamma b_{d,t-1} + \sum_{j=1}^{n} \alpha_j \ln P_{j,t} + \sum_{k=1}^{N} \beta_j \ln X_{k,d,t} + \epsilon_{d,t}$$

- The coefficient gamma measures the effect of the reform on agricultural productivity.
- The numerator is the marginal increase in productivity arising from registration opportunities. The marginal increase is measured relative to the X-efficiency of Owner cultivated farms.

- The author wanted to identify the effect of the reform by examining the effect of registration opportunities on district level productivity.But no information was available on the proportion of tenants who were offered such opportunities.Thus time specific information on the proportion of tenants who actually registered was taken as a proxy for the share of those who were offerd registration.

Thus writing the above equation in terms of the proportion of tenants who have registered,

Identification

- Since the registration rate may be correlated with unobserved productivity shocks for two reasons:

I. The registration rate is a combination of the supply of registration opportunities and the demand of such opportunities.

Demand :A tenant's decision to register is likely to be affected by his ability,wealth,relations with the landlord,his dependency on the landlord for loans.A district with higher proportion of more productive tenants is likely to have high output and high registration.

However, as long as individual characteristics are constant over time, they should not be a problem as long as we allow for district fixed effects

***Supply*:**The geographic distribution of sharecroppers within a district varied across districts,hence marginal cost of making registration opportunities available to tenants varied across districts.

If the order of villages selected within a district was based on productivity, estimates will be biased.

I. The progression of registration opportunities could have been correlated with the progression of other(omitted) programs.

While Operation Barga itself did not provide any other services other than registration Opportunities and the enforcement of tenancy laws,there were clearly other programs that were part of Government's overall reform package.Implementation of these programs was possibly correlated with the implementation of Operation Barga.

- Expansion of infrastructure in West Bengal**:** Controlling for public investment by including measures on availability of public irrigation and roads within districts .
- HYV seeds spread during this period**:** It has been controlled for by including the share of gross cropped area planted with HYV seeds
- Bias in Left front districts**:** A Left Front majority district (in 1977) dummy variable interacted with time as an additional control.
- Proximity to Calcutta, which is the administrative centre: The interaction of a southern district dummy variable with time is introduced as a control.
- Registration targeted at high sharecroppers regions: The initial extent of sharecropping interacted with time dummies as additional explanatory variables
- The Government started a subsidised loan program for registered sharecroppers. The administration also redistributed a limited amount of land to landless and poor peasants. But these are not taken as a control in our study.
- There were concern that operation Barga could be picking up general equilibium effects on wages and prices.They are included as control in table6 to address this issue.

TABLE 5

EFFECT OF REGISTRATION ON THE LOG OF RICE YIELD IN WEST BENGAL, 1979–93 (N=210)

	Model 1 (1)	Model 2 (2)	Model 3 (3)	Model 4 (4)	Model 5 (5)	Model 6 (6)
Sharecropper registration (one year lagged)	.43*** (3.46)	.42*** (3.44)	.43*** (3.55)	.35*** (2.69)	.36*** (2.64)	.36*** (2.63)
Log(rainfall)	...	−.07* (−1.67)	−.08* (−1.82)	−.07 (−1.59)	−.08* (−1.74)	−.08* (−1.77)
Log(public irrigation)	...	.02 (1.01)	.01 (.70)	.01 (.60)	.02 (.83)	.02 (.79)
Log(roads)	...	.28*** (2.75)	.25** (2.46)	.21** (1.99)	.19 (1.55)	.22 (1.54)
HYV share of rice area	...	...	.57*** (2.85)	.45** (2.10)	.47** (2.16)	.47** (2.16)
F-statistic:						
South × year[a]	...	...	...	4.73***	4.36***	4.38***
Left Front × year[b]	...	...	...	...	2.64**	2.65**
Sharecropping × year[c]	...	...	...	...	2.64**	.12
District fixed effects	72.23***	15.10***	8.99***	9.01***	8.47***	7.68***
Year fixed effects	28.31***	27.67***	21.60***	17.63***	17.83***	12.17***
R^2	.91	.92	.92	.92	.92	.92

NOTE.—*t*-statistics are in parentheses.

[a] Represents a set of variables obtained by interacting a dummy variable that takes the value one if that district is in southern West Bengal with each year.

[b] Represents a set of variables obtained by interacting a dummy variable that takes the value one if that district had a Left Front majority at the local-level government in 1977 with each year.

[c] Represents a set of variables obtained by interacting the initial extent of sharecropping in a district with each year.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

*** Significant at the 1 percent level.

TABLE 6

EFFECT OF REGISTRATION ON THE LOG OF RICE YIELD IN WEST BENGAL, 1979–87 ($N=126$)

	Model 1a	Model 1b	Model 2a	Model 2b	Model 3a	Model 3b
Sharecropper registration	.44*** (2.71)	.46*** (2.73)	.46*** (2.41)	.48*** (2.89)	.40** (2.34)	.41** (2.29)
Log(real wages)	...	.11 (1.07)	...	.05 (.55)	...	.03 (.31)
Log(price of rice)	...	−.11 (−.98)	...	−.04 (−.40)	...	.001 (.01)
Log(rainfall)	...	...	−.08* (−1.65)	−.08 (−1.52)	−.08 (−1.45)	−.08 (−1.41)
Log(public irrigation)	...	...	.10** (2.34)	.09** (2.30)	.09** (2.19)	.09** (2.14)
Log(roads)	...	...	.10 (.82)	.10 (.78)	.08 (.47)	.08 (.50)
HYV share of rice area	...	...	.66** (2.14)	.59* (1.77)	.49 (1.45)	.47 (1.34)
F-statistic:						
South × year	...	...	...	...	yes	yes
Left Front × year	...	...	...	...	yes	yes
Sharecropping × year	...	...	...	...	yes	yes
District fixed effects	40.93***	29.34***	6.08***	10.20***	4.51**	3.98**
Year fixed effects	24.39***	20.20***	17.71***	4.36**	14.12***	11.29***
R^2	.89	.89	.90	.90	.90	.90

NOTE.—*t*-statistics are in parentheses.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

*** Significant at the 1 percent level.

Results

- From Table 6 it is clear that wages and prices as additional control do not affect productivity as long as year-specific shocks are controlled for.
- The magnitude of the effect of Operation Barga on productivity is estimated by multiplying the coefficient on the registration rate with the change in registration over the period. Here, according to our sample, average productivity of rice increased by 20pc.
- The impact of sharecropper productivity is obtained as 62pc.

Conclusion:

- We concluded from the theoretical analysis that tenancy laws that lead to improved crop shares and higher security of tenure for tenants can have a positive effect on productivity

- Evidence from West Bengal suggests that the tenancy reform program called Operation Barga explains around 28% of the subsequent growth of agricultural productivity there

- However, given data limitations, we cannot separate the direct and indirect effects of Operation Barga.