LAND REFORM AND FARM PRODUCTIVITY IN WEST BENGAL[1]

Pranab Bardhan[2] and Dilip Mookherjee[3]

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Abstract

We revisit the classical question of productivity implications of sharecropping tenancy, in the context of tenancy reforms (Operation Barga) in West Bengal, India studied previously by Banerjee, Gertler and Ghatak (JPE 2002). We utilize a disaggregated farm panel, controlling for other land reforms, agriculture input supply services, infrastructure spending of local governments, and potential endogeneity of land reform implementation. We continue to find significant positive effects of lagged village tenancy registration rates. But the direct effects on tenant farms are overshadowed by spillover effects on non-tenant farms. The effects of tenancy reform are also dominated by those of input supply programs and irrigation expenditures of local governments. These results indicate the effects of the tenancy reform cannot be interpreted as reduction of Marshall-Mill sharecropping distortions alone; village-wide impacts of land reforms and agricultural input supply programs administered by local governments deserve greater attention.

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[2]Department of Economics, University of California, Berkeley

[3]Department of Economics, Boston University

1 Introduction

The effect of tenancy on farm productivity is a classical question in economic analysis of institutional arrangements and their implications for production efficiency. Adam Smith and Alfred Marshall argued that sharecropping may be associated with a static allocational inefficiency, while John Stuart Mill pointed to the possible dynamic inefficiency of tenurial insecurity in the French *metayage* system.[4] These hypotheses imply that land reforms centering on regulation of sharecropping can raise agricultural productivity.

Recently there have been some careful empirical studies on the effect of tenancy on farm productivity. Bell (1977) and Shaban (1987) tested competing models of sharecropping with farm-level data, and have affirmed deleterious productivity effects of sharecropping. More recently Besley and Burgess (2000) and Banerjee, Gertler and Ghatak (2002) have studied the impact of land reform programs in India. In contrast to the earlier work of Bell and Shaban, they employ official government data at relatively high levels of aggregation. Besley-Burgess examine the effects of land reform legislations in a panel of different Indian states. Banerjee-Gertler-Ghatak study the effect of implementation of a given tenancy reform (*Operation Barga*) in the state of West Bengal on rice yields in a panel of different districts, and interpret the effects in terms of reduction of Marshall-Mill sharecropping distortions. This program registered sharecropping contracts, protecting sharecroppers from eviction, and legislating minimum shares accruing to the tenant.[5]

These studies are subject to a number of potential concerns. Land reforms can have various other effects on agricultural productivity apart from the Marshall-Mill impacts on sharecropper incentives. They may reduce the willingness of landlords to lease out their lands, who may decide to leave their lands fallow or cultivate it themselves. Landowners may also be induced to sell off their lands, resulting in a change in the distribution of farms in favor of owner-cultivated farms. Registered sharecroppers may be able to use their lease documents as collateral to obtain access to formal credit. This may reduce their own

[4] For a short history of the classical debates on this question, see Johnson (1950). For a survey of the more recent theoretical literature on sharecropping see Singh (1989) and Bardhan and Udry (1999).

[5] Further details of the program are provided in Section 2 below.

credit costs, apart from exerting possible general equilibrium impacts on informal interest rates within the village. It may also reduce the prevalence of interlinked transactions, with implications for prices received for outputs sold by farmers or for farm inputs procured. Wider access to institutional credit may enable small farmers to form irrigation cooperatives. Productivity improvements in tenant farms may diffuse throughout the village by processes of social learning.

Patterns of local governance may also be altered by the change in power of rural elites, resulting in improved targeting of farm input supply services to small farmers. Moreover, the effects of the land reforms could be confounded with many other changes occurring in local governance or market contexts at the same time. It is possible that villages in which tenancy reforms were vigorously implemented were also those in which the panchayats (elected local governments) played an active role in redistributing land, and in providing other essential agricultural inputs to farmers.

The use of agricultural statistics published by the government also raises concerns that analyses based on such data are prone to substantial measurement error. Considerable doubt has been raised about the reliability of agricultural output data of the West Bengal state government. Boyce (1987) and Datta Ray (1994) describe how the state government has often shifted between agricultural statistics collected from sample surveys and crop cutting surveys initiated by Mahalanobis in the 1940s, and those based on subjective 'eye estimates' from the state Directorate of Agriculture.

Moreover, in the West Bengal context the extent of cultivable land directly affected by the tenancy reforms appears too small to explain the magnitude of observed changes in agricultural yields in terms of reduced Marshallian distortions.[6] In our sample less than 5% of cultivable land area was involved directly in the tenancy reform, and less than 4% of farms leased in land. These are consistent with evidence concerning the incidence of tenancy from other sources such as the National Sample Survey and the state Agricultural Censuses.[7] The extent of tenancy seems too small to explain why yields averaged across all

[6]In most other Indian states the extent of tenancy reform appears even smaller compared with West Bengal.

[7]While the incidence of tenancy was reported to be between 25 and 35% in the 1940s and 1950s (e.g.,

farms doubled over the period, or why the proportion of cultivable area allocated to high yielding rice varieties rose from 5% in 1982 to 44% by 1995. Even the 20% aggregate yield increase estimated by Banerjee-Gertler-Ghatak seems too large to be explained by a reform that seems to have affected such a small proportion of cultivable land.

There is also a concern that the Banerjee-Gertler-Ghatak estimates may have been biased owing to possible endogeneity of program implementation. The tenancy registration rates were driven by a combination of supply-side and demand-side factors, and it is hard to deny the role of the latter given that the decision to register was ultimately a decision made by tenants concerned. Hence the observed registration rates could have reflected in part increased demand for registration that may have been correlated with productivity improvements arising from reasons unrelated to the program.

The purpose of this paper is to address these concerns. First, we perform a more disaggregated analysis of the effects of the tenancy reform in West Bengal on yields at the farm level, controlling for farm fixed effects. This allows us to examine impacts on productivity of tenant and owner cultivated farms, separating direct effects on the former from spillover effects on the latter. In addition we distinguish productivity effects within farms from those arising from changing composition of operational holdings across size categories and tenancy status.

Second, we do not rely on figures for aggregate agricultural production published by the state government at either district or state levels, or used in public reviews of its past achievements. Our data is drawn from cost of cultivation surveys of a stratified random sample of farms drawn from the major agricultural districts of the state. The surveys were carried out for the sole purpose of estimating agricultural costs by the state agriculture

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the 1940 Land Revenue Commission, or a 1958 Government of West Bengal report), it seems to have declined considerably thereafter. The National Sample Survey estimates of proportion of operational holdings under tenancy was 25% in 1953-54, 13% in 1982, and 10.4% in 1992 (approximately 70% of which involved sharecropping). This is consistent with a Government of West Bengal estimate of 7.8% land under tenancy in 1998. According to their own estimates, about 50–70% sharecroppers were actually registered, so the amount of area affected by Operation Barga was of the order of 5–6%. Our sample estimate is that 6.1% operational land was registered under the program by 1998. And of this 2.4% had already been registered by 1978.

department.[8] To minimize error in measuring program implementation rates, we collect data concerning these for each village from the local land records office, instead of relying on district level aggregates compiled on the basis of reports submitted by these offices to higher levels of the state government.

Third, we control for other land reforms implemented and agricultural input supply efforts of local governments. We collect data on land titles delivered to the landless from the local land records office, and on the supply of subsidized credit, agriculture minikits (containing seeds, fertilizers and pesticides), village road and irrigation facilities from offices of concerned bank branches, local panchayats, and block development offices of the government. We supplement these with village community surveys to obtain the village-level distributions of land, occupation, literacy and caste status in two years corresponding to the beginning and end of the period (1978 and/or 1983, and 1998).[9] We additionally include controls used by Banerjee-Gertler-Ghatak: local rainfall, price of rice, state-government provided canals and roads, besides farm-specific and common year effects.

Finally, we use results from our prior analyses (Bardhan-Mookherjee (2004b,2006b)) of political economy of the land reform and panchayat programs to control for possible endogeneity of land reform implementation and delivery of agricultural input supply services.

We find a positive, statistically significant impact of implementation of Operation Barga on yields at the farm level. There is a positive direct effect on yields of tenant farms, but this is imprecisely estimated: the statistical significance is not robust with respect to the regression specification. There is also some evidence of sharecropping distortions from comparisons of factor allocation between sharecropped and owned plots, after controlling for unobserved plot heterogeneity. But these distortions arise for some crops and not others.

[8] These cost estimates were aggregated and sent subsequently to Central government bodies responsible for setting agricultural prices on a cost-plus basis.

[9] Voter lists for these election years were used as the basis of creating a list of households in consultation with senior members of each village community; the land, literacy, occupational and caste status of each household for the corresponding year was subsequently identified by these community members based on their knowledge and recall. The land distribution constructed in this way match closely with the distribution of operational land holdings published by the National Sample Survey and the state Agricultural Censuses when aggregated upto the district level: see Bardhan and Mookherjee (2006b, Table 3) for further details.

In contrast, the spillover effects of the program on all other farms in the village are large, statistically significant, and robust with respect to specification. These estimates are also robust with respect to controls for possible endogeneity bias. The quantitative estimate of Operation Barga on average farm yields is of the order of 5%, a quarter of the size estimated by Banerjee-Gertler-Ghatak. For tenant farms *per se*, our quantitative estimate ranges between 8 and 20%, depending on the specification.

Moreover, the estimated productivity effect of the tenancy program was small in comparison with farm input supply programs delivered by local governments. The supply of agricultural minikits in particular had large effects on adoption of high-yielding rice varieties, whereas the tenancy program had no significant effect on proportion of rice acreage allocated to HYV rice. Provision of subsidized credit and of local irrigation facilities also had a substantially larger impact on farm productivity than Operation Barga.

Our results therefore indicate that the role of incentive distortions at the level of individual farms was modest, in comparison with spillover effects of the program, and delivery of complementary farm input services. While confirming the positive effects of tenancy reforms found earlier by Banerjee-Gertler-Ghatak, our analysis suggests the need to interpret these in terms of village-wide (general equilibrium or governance) impacts, rather than the Marshall-Mill (partial equilibrium) incentive effects. The precise nature of these wider village-wide impacts need to be better understood. Towards the end of the paper we speculate on a number of possible channels — such as impacts on prices or availability of key factors of production, or village governance — and the evidence we have so far concerning their role.

The paper is structured as follows. Section 2 describes the data and provides some descriptive statistics. Section 3 explains the institutional context of reforms in land relations and local governance in West Bengal, as well as our empirical identification strategy. Section 4 summarizes underlying theories, and then presents the main empirical results. Section 5 discusses possible channels of village-wide impacts, and Section 6 concludes.

2 Background and Data Description

Summary statistics concerning the villages in our sample are provided in Tables 1 and 2. The 89 villages are located in 57 village government (Gram panchayat (GP)) jurisdictions. Each GP consists of ten to twenty elected members of a council governing administration of the jurisdiction of the GP, which usually consists of eight to fifteen villages or *mouzas*. On average each district comprises 20 blocks and 200 GPs. Each district (or Zilla) has a single Zilla Parishad (ZP), the top tier of the panchayat system, and each block has a Panchayat Samiti (PS), the middle tier. The top official at each level is an ex-officio member of the next higher level; other officials at each tier are elected directly by voters. For most part, we focus on the GPs as they are the main implementing agencies at the ground level (e.g., with respect to selection of beneficiaries of various developmental schemes and infrastructure projects within villages).

The twenty year period witnessed four successive elected bodies in each GP, each with a five year term (which we sometimes refer to as a timeblock). The Left Front coalition won an absolute majority in approximately three-fourths of the elected GPs, with a mean seat proportion of 69%. The main opposition party was the Indian National Congress and its various off-shoots (such as the Trinamul Congress which broke away for the 1998 elections). Most electoral constituencies witnessed a contest between the Left and either the Congress (or the Trinamul Congress): there were hardly any three-way contests. In most cases, these two parties collectively garnered more than 90% of all elected positions. The dominance of the Left Front was greater at higher tiers; e.g., the mean Left share in ZP positions during the period was 86%.

Table 2 shows the principal demographic and asset distribution changes in the sample villages between 1978 and 1998. The number of households almost doubled, the result of population growth, household subdivision and in-migration.[10] Illiteracy rates fell, especially among the poor (landless or marginal landowners). The incidence of non-agricultural

[10] A household survey we have recently carried out in 2004, shows that approximately half of all households residing in 1967 had subdivided during the period 1967–2004, and approximately one quarter of all households residing in 2004 had migrated into their current locations since 1967.

occupations among household heads rose from 41% to 51%.

The distribution of cultivable non-*patta* land (i.e., excluding land distributed through the land reforms) changed in various ways. On the one hand, landlessness (measured by proportion of households not owning any agricultural non-*patta* land) increased. The proportion of households without any such land or with marginal holdings below a hectare (2.5 acres) increased by almost 10%. In this sense poverty increased. On the other hand, the distribution of land among landowners became more equal, resulting from splitting of large landholdings (via market sales of land and household sub-division). The proportion of land in small holdings (below 2 hectares) rose by 17%.

Table 3 indicates the extent of land reform implemented in our sample by 1998. There were two principal programs. The first involved redistribution of land, where land owned by households in excess of legally mandated ceilings was vested by the government, and distributed in the form of small land plots to landless. Approximately 5.4% of cultivable land was distributed to 15% of the population in the form of registered land titles (*pattas*). Most of the vesting had been carried out prior to 1978.[11] According to the state government's own admission, it had been unable to markedly increase the extent of land vested; hence its main role was in the distribution of vested land. Hence it is appropriate to measure the extent of this program by the extent of cultivable land distributed in the form of *pattas*.

The other program was Operation Barga, where sharecroppers were encouraged to register their contracts; registration protected them from eviction and imposed a minimum share that must accrue to the cultivator. In our sample approximately 6% of cultivable land involved leased lands on which tenants (*bargadars*) were recorded. However, 2% had already been registered by 1978, so the incremental area covered by the program since 1978 was 4%. The proportion of households registered by 1998 was 4.4%.

Aggregating the two programs, about 11.5% of operational land area was affected, and 20% of all households benefited. This was one of the largest land reform initiatives within India in recent memory.[12] Also distinctive was the involvement of *panchayats* in this process,

[11] We were able to get data on the time pattern of vesting in 34 villages, where we found 70% had been vested prior to 1978.

[12] For instance, Appu (1996, Appendix IV.3) estimates the proportion of land distributed in Karnataka,

who were instrumental in mobilizing mass participation in village meetings to identify the ownership of land among households in each village, selecting suitable beneficiaries for distribution of *pattas*, identifying sharecroppers and encouraging them to register.[13]

These land reforms were complemented with creation of a three tier system of *panchayats* or elected local governments, who were delegated responsibility for delivery of various input supply services and local infrastructure. The principal responsibilities entrusted to the *panchayats* included implementation of land reforms, of the two principal poverty alleviation schemes (the Integrated Rural Development Program which gave subsidized credit to the poor, and employment programs such as Food for Work (FFW), National Rural Employment Program (NREP), Rural Labour Employment Guarantee Program (RLEGP) in the 1980s which were merged into the *Jawahar Rozgar Yojana (JRY)* from 1989 onwards), distribution of subsidized agricultural inputs (in the form of minikits containing seeds, fertilizers and pesticides), local infrastructure projects (including roads and irrigation), and miscellaneous welfare schemes (old-age assistance, disaster relief, housing programs for the poor etc.). The bulk of the funds (78% in our sample) for these programs were devolved to the GPs under various schemes sponsored by the central and state government. The funds percolated down from the central government to GPs through the state government, its district-wide allocations, and then down through the upper tiers of the panchayats at the block and district levels. Upper tiers of the panchayats thus affected allocation across different GPs, while the main role of the GP was to select beneficiaries of these schemes within their jurisdiction.

Table 4 depicts trends in agricultural inputs provided by the GPs in our sample villages between 1982–95.[14] The 1980s witnessed larger supplies of IRDP credit and minikits compared with the 1990s. One out of every nine households received minikits in the 1980s, containing seeds, fertilizers and pesticides. The bulk of employment funds were spent by

Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh by 1992 was less than 1%, and in Bihar Orissa, Haryana, Kerala less than 2%, compared with 6.7% in West Bengal.

[13] See Lieten (1992) for a description.

[14] These averages use operational land area in different villages as weights, the reason the numbers reported here differ from the unweighted averages reported in BM (2004a, 2006b).

GPs on building and maintenance of local roads; these employment programs created 2-4 mandays of employment per household every year. There was also expansion of areas irrigated by state canals. Greater expansions were witnessed in medium and small irrigation projects, many of which were managed by panchayat officials. Spending on irrigation by the panchayats was highest during the early part of the period, fell sharply throughout the 1980s, and stabilized thereafter. A similar trend was observed for GP spending on local roads, except that there was an upturn towards the end of the period.

The last two rows of Table 4 provide for the sake of comparison the average land reforms implemented at these corresponding years: these peaked in the first half of the 1980s and tailed away thereafter, coming to a virtual standstill from the late 1980s onwards.

Table 5A shows average allocation of cropped area across different crops in our farm sample, and their respective yields (measured by value added per acre). Rice accounted for two-thirds of cropped area, with HYV rice accounting for 28% on average across the entire period. HYV rice yields were two and a half times those of traditional rice varieties. Only potatoes generate a higher return (measured by value added per acre) than HYV rice; however the short potato season (which lasts just two winter months) limits the acreage devoted to this crop. Other cash crops such as jute and tobacco generate high yields, followed by pulses, vegetables and oilseeds, with wheat generating the lowest yields.

Table 5B shows changes over time in cropping patterns and incomes. The most spectacular change was in rice yields which increased by more than 150%. Part of this is explained by widespread diffusion of high yielding varieties (HYV) of rice, with acreage devoted to such varieties expanding from less than 10% or total rice acreage in 1982 to 39% by 1990, and 66% in 1995. In real terms, farm value added per acre more than doubled. Wage rates for agricultural workers rose by 66%, and employment more than doubled. Since the poorest sections of the rural population are landless and rely mainly on agricultural labor, incomes of the poor rose significantly during this period.

3 Identification Strategy: Political Economy of Panchayat Program Implementation

Since our analysis concerns the effects of programs implemented by the West Bengal panchayats, it is necessary to provide some background information concerning political motivation of panchayat officials. This is both interesting for its own sake, besides explaining the basis of our identification strategy.

3.1 Explaining Land Reform Implementation

In an earlier paper we have argued that political competition between the two main political rivals, the Left Front alliance and the Congress party, played a role in motivating incumbent GP officials to implement land reforms (Bardhan-Mookherjee 2004b) . This was rationalized by a quasi-Downsian model of two-party electoral competition with rent-seeking or capture by local elites, based on Grossman and Helpman (1996). Greater political competition, measured by a narrower difference in average voter loyalty between the two parties, motivates incumbents to implement more land reform in order to secure greater support from voters (the vast majority of which are landless or marginal landowners). Conversely, when one party secures a bigger advantage over its rival, its elected officials are more susceptible to influence of local elites, who pressure them to implement less reforms.

This hypothesis contrasts with the pure Downsian model where political competition does not matter, and ideology-based models which predict higher implementation rates when a larger fraction of GP seats is secured by the Left Front (which is ideologically more committed to land reform, and whose constituents comprise the landless and marginal landowners).

Table 6 presents estimates of regressions for different measures of land reform implemented, according to the following specification:

$$L_{vt} = \max[0, \beta_v + \beta_1.q(LF_{vt}) + \beta_2 LF_{vt} * I_{v,1978} + \beta_4 X_{vt} + \delta_t + \epsilon^1_{vt}] \qquad (1)$$

where L_{vt} denotes land reform implemented in village v in year t, LF_{vt} denotes the corresponding fraction of GP seats composed of Left Front candidates, $q(.)$ denotes a quadratic function, $I_{v,1978}$ denotes the land inequality in village v in the initial year 1978, representing the historical power of landed elites, and X_{vt} denotes distribution of land, literacy and caste in the village in year t formed by interpolation between 1978 and 1998. The different measures of land reform are (*pattaland, bargaland*, the proportions of cultivable land distributed as land titles or registered under Operation Barga respectively, and *pattadar, bargadar* the correponding proportions of households receiving land titles or registered as a sharecropper. Since in many years there were no land reforms implemented at all in any given village, the regression has to incorporate endogenous censoring.[15]

In contrast to the ideology-based hypothesis, Table 6 shows no evidence of any tendency for land reforms to increase monotonically with the Left share of local GP seats. With the exception of the *pattaland* regression, there was an inverted-U relation instead, statistically significant in the *bargadar* regression. In the latter regression, the second-last column shows the top turning point of the U appeared at approximately 50% Left share. In other words, once the Left commanded an absolute majority in the local GP, further increases in its seat share reduced rather than increased the proportion of households registered under Operation Barga. This indicates the effect of political competition on reform implementation.

Additional confirming evidence against either a pure ideology or Downsian hypothesis is a significant negative interaction between Left share and (either of two measures of) 1978 land inequality. In villages with a more unequal land distribution to start with, increases in Left share significantly reduced every measure of land reform implementation. The quasi-Downsian hypothesis provides a natural interpretation of this finding: higher land inequality implies greater proneness of political parties to capture by landed elites. Given the general dominance of the Left, an increase in Left share represents reduced political competition between the two parties, which permits greater capture of elected officials, resulting in less land reform. The role of electoral competition is further indicated by significant election or pre-election year spikes in *Barga* registration rates.

[15] Hence Table 6 reports TLAD (trimmed least absolute deviation) regressions with village fixed effects (Honore (1992)).

3.2 Explaining GP Composition

The preceding regressions give rise to the question: what determines the composition of a GP? One might expect GP election outcomes and subsequent land reforms to be jointly determined e.g., by distribution of local voter preferences. We argue that GP composition were largely influenced by distribution of voter loyalties to the two principal parties based on a variety of state and national factors.

Table 7 provides GP-panel regressions according to the following specification:

$$LF_{vk} = \gamma_v + \gamma_1 LF_{v,k-1} + \gamma_2 Z_{vk} + \gamma_3 Z_{vk} * LF_{v,k-1} + \gamma_4 X_{vk} + \eta_k + \epsilon_{vk} \qquad (2)$$

where LF_{vk} denotes the fraction of GP seats secured by the Left Front in election k, as a function of its strength among current incumbents (i.e., those elected in the previous election $k-1$), Z_{vk} is a vector of state and national level determinants of the strength of the Congress party likely to affect relative voter loyalties, and interactions between these and local incumbency. These include measures of the nationwide popularity of the Congress, such as the proportion of seats secured by the Congress party in the national Parliament.[16] As a measure of economic performance of the incumbent that most concerns voters, it also includes the rate of inflation of a cost of living index in the nearest of four centers of the state where this is computed by the state government (Asansol, Ranigunj, Jalpaiguri and Kolkata), and growth rates of factory employment in the concerned district.

The first and last columns of Table 7 show that outcomes of GP elections closely mirrored district-level vote share differences between the two parties in preceding elections to the state legislature, after controlling for local distributions of land, literacy and caste. Hence local GP composition closely tracks composition of elected representatives at the district level to the state legislature. Other columns show that the presence of Congress in national Parliament and the regional inflation rate were significantly correlated with village panchayat election outcomes. The effects of these state and national factors differed according to historical incumbency: in traditionally Congress dominated areas, a rise in Congress

[16]This variable also captures the ability of the Congress to influence policies of the Central government towards West Bengal, including construction of infrastructure and other central government projects in select constituencies, which can affect voter loyalty to the Congress.

presence in national Parliament or a fall in the inflation rate caused the Congress to become more entrenched, with the opposite effect in traditionally Left Front areas. In contrast to the effect of these broader factors influencing voter loyalties, changes in local land, literacy or caste distributions had no statistically significant effect on panchayat election outcomes.

These results form the basis of our identification strategy. Combining equations (1) and (2), we obtain a reduced form for land reform implementation in terms of state and national level determinants of relative voter loyalty to the two parties, along with local incumbency patterns:

$$\begin{aligned} L_{vt} = \quad & \theta_v + \theta_1 q(LF_{v,t-l}) + \theta_2 q(Z_{vt}) + \theta_3 q(Z_{vt} * LF_{v,t-l}) + \theta_4 LF_{v,t-l} * I_{v,1978} \\ & + \theta_5 Z_{vt} * I_{v,1978} + \theta_6 Z_{vt} * I_{v,1978} * LF_{v,t-l} + \theta_8 X_{vt} + \epsilon^3_{vt} \end{aligned} \tag{3}$$

where $t-l$ refers to the previous GP administration. Fluctuations in political and economic events at the regional, state or national level (interacted with local incumbency patterns) in preceding election years provide exogenous sources of temporal variation in Left share at the local GP. These are unlikely to be uncorrelated with time-varying village-specific fluctuations in voter preferences for land reform. In addition, specification tests imply that local incumbency, lagged Left seat share, is also a valid instrument for current Left seat share, and therefore for the extent of land reform implemented.[17]

3.3 Farm Extension Programs and Local Infrastructure

In the case of programs other than the land reform, we use the scale of the program at the level of the state as an independent determinant of the amount of resources reaching a given panchayat in any given year. Variations in these program scales reflected fluctuations in the finances of the state government and its relation with the Central government. In a previous paper we have also shown how fluctuations in political competition at either the local GP level or at the district Zilla Parishad level influenced the extent of IRDP credit and fiscal grants reaching a given village (Bardhan-Mookherjee 2006b, Tables 5–8). Hence

[17] The Arellano-Bond specification of zero second order serial correlation in the residuals of regression in the second column of Table 7 is not rejected at 10%.

the same set of instruments that help predict GP composition and thereby land reform implementation, also help predict the volume of resources flowing into villages under the IRDP, employment generation and infrastructure programs.

4 Estimating Effects of Tenancy and Tenancy Reform on Farm Yields

4.1 Effect of Land Reforms: Theoretical Hypotheses

The effect of land reforms on farm productivity have been the topic of a large literature in development economics. The classic arguments concern Marshallian inefficiencies arising from sharecropping, where the share paid to the landlord acts as a tax on the tenant's effort. Sharecropper registration can raise farmer incentives by capping this implicit tax rate. Other incentive effects arise from removing the right of landlords to evict tenants: the direction of these are ambiguous, owing to conflicts between different effects. Eviction threats can be used by landlords as an incentive device, the removal of which could dull tenant incentives. On the other hand, security of tenure may promote longer time horizons for the tenant and thereby increase investment incentives. These issues are discussed in Bardhan (1984), Dutta, Ray and Sengupta (1989) and Banerjee, Gertler and Ghatak (2002). In addition, registered sharecroppers were eligible to apply for production loans from formal credit channels, which could reduce their interest costs substantially (owing to significant differences in interest rates between formal and informal credit sources).[18]

The incentive effects of redistributing land ownership have also been discussed in previous literature (Bardhan (1973), Berry and Cline (1979), Eswaran and Kotwal (1986), Binswanger *et al* (1993), Mookherjee (1997)). In general, the effect depends on the extent of economies or diseconomies of scale. Given the advantages of family labor cultivation over hired labor, and the relative lack of important sources of scale economies (such as mechanization) in rice cultivation, one might expect small farms to be more productive than large

[18] We have learnt this from interviews with government and bank officials, as well as sharecroppers. We do not, however, have data on access and costs of credit.

farms. While such a pattern has frequently been empirically observed, it is possible that they reflect differences in unobserved soil characteristics between small and large farms. If more productive lands are more prone to fragmentation, small farms may be expected to have more fertile soils, in which case observed yield differences between small and large farms overstate the effect of land redistribution programs.

In the West Bengal context however, the *patta* program mainly concerned distribution of titles to land that had previously been vested (from those holding surplus land above legislated land ceilings). For a subsample of 40 villages for which these data were available, we found that over 70% had been vested prior to 1978. Distribution of already-vested lands would enable them to be actively cultivated instead of lying fallow, in which case one would expect a rise in production yields. Of course these yield improvements would be negligible if the transferred lands were of inferior quality or of very small size. The average size of land parcels distributed was approximately half an acre, compared with an average size of 1.5 acres for plots registered under Operation Barga. Moreover, while the latter were cultivable by their very nature, approximately half of all pattas distributed consisted of non-cultivable land. We have also been told by bank officials and farmers that we interviewed that farmers were not eligible for bank loans on the basis of the *pattas* received in the land reform program, mainly owing to the uneconomically small size and poor quality of the land parcels concerned. Therefore the productivity impact of the *patta* program could be expected to be less significant than the effects of Operation Barga.

4.2 Estimates of Tenancy Effects on Farm Yields

We now utilize the farm panel to investigate the presence of sharecropping distortions, using the methodology of Shaban (1987) and Braido (2006) to compare yields and factor allocation across sharecropped plots and owned plots in ICRISAT data from South and Central India .

It should be recalled from Table 3 that the incidence of tenancy in West Bengal appears to be low. This is additionally confirmed by the cost of cultivation data: less than 10% of the farms in the sample leased in any land. Table 8 presents proportions of farms in any given year that leased in any land: this is below 4% in every year. The breaks in the series in the years 1986 and 1991 correspond to the selection of different farm samples for the timeblocks starting in those years. Within the timeblocks, there appears to be no trend in the incidence of leasing.

Tables 9A,B present estimates of sharecropping distortions. We use the specification in Braido (2006) for evidence concerning underapplication of inputs in farms that leased in land in the cultivation of HYV and non-HYV rice respectively, controlling for potential differences in unobserved soil characteristics on leased and owned plots respectively, apart from farm fixed effects and year dummies. The methodology is most clearly illustrated in the case of a Cobb-Douglas specification of the production function:

$$Q_{pft} = A_p^{\alpha_a} L_{pt}^{\alpha_l} I_{pt}^{\alpha_i} \epsilon_{pft} \tag{4}$$

where Q_{pft} denotes the output of plot p operated by farmer f in year t, as a function of plot area A_p, family labor input L_{pt} applied to the plot in year t, purchased inputs I_{pt}, and all other productivity-relevant factors ϵ_{pft} which can include plot, farmer and year effects, apart from the 'knowledge' possessed by the farmer in that given year. The parameters $\alpha_a, \alpha_l, \alpha_i$ denote elasticities of output with respect to size, family labor and purchased inputs respectively: they lie between 0 and 1 and add up to unity in the case of constant returns to scale. Letting s_{pft} denote the share of output on this plot accruing to the cultivator (which is less than one for sharecropped plots and equals one for owner-cultivated plots), and $P^o_{ft}, w_{ft}, P^i_{ft}$ denoting output price, shadow wage of family labor and input prices facing the farmer in year t, the farmer decides on family labor and input allocations across plots to maximize

$$s_{pft} P^o_{ft} Q_{pft} - w_{ft} L_{pt} - P^i_{ft} I_{pt} \tag{5}$$

This gives rise to first order conditions for labor and purchased input allocations:

$$\frac{L_{pft}}{Q_{pft}} = \frac{\alpha_l s_{pft} P^o_{ft}}{w_{ft}} \tag{6}$$

$$\frac{I_{pft}}{Q_{pft}} = \frac{\alpha_i s_{pft} P^o_{ft}}{P^i_{ft}} \tag{7}$$

It is evident that input allocations will increase both with a higher share of output s_{pft} accruing to the cultivator, as well as a higher plot-specific productivity ϵ_{pft}. For instance, we can solve for the optimal input application:

$$I_{pft} = [P^o_{ft} s_{pft} A_p^{\alpha_a} \alpha_l^{\alpha_l} \{\frac{\alpha_i}{P^i_{ft}}\}^{1-\alpha_l} \epsilon_{pft}]^{\frac{1}{1-\alpha_l-\alpha_i}} \tag{8}$$

Both a higher share accruing to the cultivator, as well as higher plot-specific productivity, will be associated with a higher output yield per acre. Regressions of output yields that control for farmer fixed effects but not plot fixed effects, as in Shaban (1987), cannot disentangle sharecropping effects from unobserved plot heterogeneity. This is a particular problem if one expects leased in plots to be of poorer quality, compared with owner-cultivated plots.

Nevertheless, one can discern the existence of sharecropping distortions from regressions corresponding to equations (6) and (7). Dividing input allocations by the output causes plot-specific productivity to drop out, and depend solely on output shares accruing to the farmer, besides prices of factors and outputs. Sharecropping distortions can therefore be discerned by comparing input allocations per unit of output across leased and owned plots by any given farmer.

Data on factor prices are not available for a large number of farm-years. Nor are shadow wages available or easily estimated. However, data on expenditures on inputs is available for every year. We can rewrite (7) in terms of expenditures on purchased inputs per unit output value:

$$\frac{P^i_{ft} I_{pft}}{P^o_{ft} Q_{pft}} = \alpha_i s_{pft} \tag{7'}$$

An additional problem is that our farm data is organized by crops rather than by plots, and we know only whether some of the land allocated to that crop was leased in or not, but not the precise area that was leased in, nor the shares accruing to the farmer. We therefore regress input expenditures per unit of output for specific crops on a $0-1$ dummy for whether or not some land was leased in for the cultivation of the corresponding crop by the farmer in any given year.

The first two columns of Tables 9A and 9B show results of the log-linear regression corresponding to equation (7'), for HYV rice and non-HYV rice respectively. The regression includes farmer and year dummies. Column 1 of Table 9A shows that farms applied significantly less purchased inputs in HYV rice cultivation in years that they leased in land. This difference cannot be attributed to differences in soil quality between leased and owned plots, nor to differences in ability between farmers that do and do not lease in land. It indicates existence of a Marshallian distortion in HYV rice cultivation.

The second column of Table 9A adds an interaction between the leasing dummy and the proportion of cultivable land registered in the village under the Barga program until the preceding year. To the extent that Barga registration raised shares accruing to sharecroppers, this interaction represents the effect of the program on the sharecropping distortion. Ideally, we should have used a Barga registration variable representing whether that particular tenant had been registered, but this information is not available to us. We therefore use the registration rate in the village as a proxy for the probability that the tenant in question is registered. This is a reasonable proxy since the farm sample was drawn randomly in each village, stratified by size of operational holdings. Moreover, one would expect strong spillover effects of village registration rates on tenants that did not actually register, given a higher option value of making the effort to register (which is likely to be easier in a village where a lot of land has been registered by others). As the underlying theory predicts, what really matters for the distortion is the allocation of bargaining power between the landlord and the tenant, which depends intrinsically on the outside options of the latter.[19]

The second column of Table 9A shows a positive interaction between the lease dummy and the lagged Barga registration rate in the village on input expenditures per unit output of HYV rice.[20] But it is statistically insignificant.

Columns 3–6 of Table 9A thereafter run regressions in the style of Shaban (1987) for HYV rice yields on the lease dummy, controlling for farmer and year effects. The existence of a sharecropping distortion would result in lower application of inputs per unit area cropped, and thus in a lower yield. This would be expected to be compounded if leased in plots were of inferior quality than owned plots. It is surprising therefore to find that these regressions do not show a lower yield on leased plots compared with owned plots: the coefficient of the lease

[19]See Mookherjee (1997) for further elaboration of this.

[20]The latter is measured by the proportion of cultivable land registered.

dummy is positive and statistically insignificant in column 3. Adding an interaction with the Barga registration rate in the village does not change this result, as shown in column 4. Moreover the interaction effect is negative and statistically insignificant, contrary to what one would expect if Operation Barga had reduced sharecropping distortions.

Columns 5 and 6 add controls for purchased input and family labor allocated per unit area. This removes the effect of the sharecropping distortions. In column 5 we find a positive and statistically significant effect of the lease dummy, suggesting that productivity was higher on leased plots, controlling for input application. This indicates that either leased plots were of superior quality compared to owned plots, or endogeneity of the leasing decision, a problem ignored by most existing literature. For instance, a farmer may decide to lease in land in times of greater need for income or in times of greater ability to apply labor (e.g., if the farmer and his family are in better health or have more hands available within the family for work on the farm). Either of these factors could have caused productivity to increase when the family leased in land, which could have been neutralized by the sharecropping distortion in application of purchased inputs, to generate an insignificant overall impact of leasing on productivity. Nevertheless, if Operation Barga had reduced the intensity of the sharecropping distortion, one would have expected to see a significant positive interaction between the lease dummy and the village registration rate, and this is not shown in any of the regressions reported in Table 9A.

Table 9B displays corresponding results for non-HYV rice. There we find no significant difference in either input applications or value of output per unit cropped area. The interaction between leasing and Barga registration rates is now positive and larger in magnitude in columns 4 and 6, but they remain statistically insignificant.

4.3 Impact of Operation Barga on Farm Value Added Per Acre

A problem with the yield regressions reported in columns 5 and 6 of Tables 9A,B is that they include input allocation decisions that are jointly determined along with crop yields, resulting in endogeneity bias. Biased estimates of input elasticities would generate corresponding biases in the effects of leasing, given that input allocations and leasing are correlated with one another. One way of overcoming this problem is to subtract expenditures on purchased inputs from the value of output, i.e, use value added per acre as the dependent variable rather than output value per acre. This is analogous to estimating a reduced form version of the farm profit function. The Marshallian incentive distortion would be reflected in lower application of family labor on leased plots, which would tend to generate lower value added per acre on leased plots.

We know from some of the literature on agency problems with respect to hired labor in conjunction with credit market imperfections may cause farms to rely on family labor as far as possible (Eswaran and Kotwal (1986)). Given family size, increases in farm size cause increasing reliance on hired labor, which therefore tends to increase agency problems and lowers farm profits. We therefore need to include controls for farm size in the regression to capture this effect.

Table 10 provides estimates of the effect of leasing and of Operation Barga on farm value added per acre, which include controls for farm size and its square, apart from farm and year effects. For the sake of parsimony we show regressions corresponding to value added per acre for the farm as a whole, aggregated across all crops. This is regressed on variables reflecting tenancy status of the farmer in any given year, and interaction of tenancy status with the lagged Barga registration rate in the village. The first and third columns use a dummy variable representing whether or not the farmer in question leased in any land in the current year. As discussed above, the leasing decision is also potentially endogenous, as it may reflect availability of complementary non-market factors such as quality or quantity of family labor. Cropped area may also be endogenous for the same reason.

To control for possible endogeneity of the leasing decision, the second column replaces the current lease dummy by the fraction of years in the sample that the farmer appears that it leased in land. By construction this is a farm-related variable that does not change across years, and represents differences in the average extent of leasing across farms. The interaction of this variable with the extent of Barga implementation in the village represents variations in the effect of the program across tenant and non-tenant farms.

The third and fourth columns of Table 10 present IV estimates of the regression in the first column. The third column uses instruments for the extent of Barga implementation in the village, as it appears in its interaction with the current lease dummy. The fourth column uses in addition instruments for the lease decision and cropped area: we use one-year-lagged lease and acreage. These are valid instruments only if farm fixed effects soak up all the serial correlation in productivity residuals. These IV estimates also cause one year of data per farm to be dropped, a significant reduction in sample size. Hence the controls for potential endogeneity of leasing and farm size are not particularly reliable.

Table 10 shows that the effect of leasing and its interaction with Barga implementation in the village now has the signs that would be expected from the Marshall-Mill theory, but these effects are statistically insignificant. The IV estimates in the fourth column are substantially larger than the OLS estimates, but the precision of the estimates is low. The first three columns indicate a tendency for farm yields to fall with farm size; this result is reversed when farm size is instrumented in the fourth column. The OLS negative size-productivity relationship may therefore reflect unobserved heterogeneity of soil quality, if expansions of cropped area occur on inferior quality land.

4.4 Including Spillover Effects on non-Tenant Farms, and Adding Controls for Farm Extension Programs

We next include possible spillover effects of Operation Barga on non-tenant farms, as well as controls for other land reforms and development programs implemented by GPs. We add the Barga registration rate as a regressor, in addition to its interaction with leasing. The former represents a common effect of Barga registration on the profitability of all farms in the village in future years, via general equilibrium, governance or learning spillovers. We also add as controls the distribution of land titles (*pattas*) to poor households, and various farm input supply and infrastructure programs administered by GPs: specifically cumulative lagged values of: (a) proportion of cultivable land distributed in the form of *pattas*; (b) minikits distributed in the village per household, (c) IRDP credit subsidy delivered per household, (c) log of the cumulative expenditures (in constant 1980 prices) per household on local irrigation and road projects, and (d) cumulative mandays of employment generated per household. Additional controls include annual rainfall at the nearest weather station, the log of the rice price received by the farmer, canals and roads provided by the state government in the district, apart from farm and year effects. The regression specification is:

$$V_{fvt} = \beta_1 L_{fvt} + \beta_2 L_{fvt} * B_{v,t-1} + \beta_3 A_{fvt} + \beta_4 A^2_{fvt} + \beta_5 B_{v,t-1} + \beta_6 P_{v,t-1} + \beta_7 E_{v,t-1} + \gamma_f + \delta_t + \epsilon_{fvt}$$

where L_{fvt} denotes the dummy for whether farm f in village v in year t leased in land, $B_{v,t-1}$ denotes cumulative proportion of agricultural land registered under Operation Barga in village until year $t-1$, $P_{v,t-1}$ the cumulative proportion of cultivable land distributed in the form of *pattas*, $E_{v,t-1}$ is the cumulative per capita delivery of extension services to the village until year $t-1$. The coefficients $\beta_5, \beta_6, \beta_7$ represent spillover effects of village development programs delivered by GPs on future profits of all farms in the village, in contrast to β_2 which is the direct effect on farms leasing in land owing to a reduction in sharecropping distortions.

Table 11 presents the OLS estimates of this regression. We see now that inclusion of the village controls representing different government interventions results in a substantially higher coefficient on the interaction of leasing with Barga implementation. In two versions of this regression, the coefficient is significant at 10%. The effects of the lease dummy by itself however remains insignificant, while the acreage effects become stronger.

More surprising is the strong significance of the spillover effects of the Barga program, the delivery of kits, credit and local irrigation. These represent common effects of these interventions on profitability of all farms in the village, most of which we know (from Table 8) were not leasing any land at all. The estimated spillover effect of tenancy registration on non-tenant farms is larger than the direct impact on the tenant farms.

Table 12 presents the same results, except that it replaces the leasing variable that varies from year to year for any given farmer, by the fraction of years in the sample that the farmer in question leased in. The results are quite similar to those in Table 11. Hence the results of Table 10 are unlikely to hinge much on potential endogeneity of leasing decisions varying from year to year. The estimated spillover effects remain largely unaffected.

Table 13 examines robustness of the estimates in Table 11 to possible endogeneity of program implementation. As explained in the previous Section, the instruments include state and national factors affecting competitive strength of the Congress party in local elections indicated in Table 7, in conjunction with local incumbency patterns. Squares of these variables are also included as instruments, owing to the nonlinearity of Barga implementation with respect to the Left share shown in Table 6. Other GP interventions are instrumented by the scale of the corresponding program at the level of the state, apart from the same variables affecting political competition.

Table 13 shows the IV estimates of the spillover effects are substantially larger than the OLS estimates. The estimated differential impact of tenancy registration on yields of tenant farms is however unchanged; it remains on the borderline of statistical significance. Table 14 reports the corresponding estimates when the leasing decision and area cropped are also instrumented by their one year lagged values. The effect of leasing *per se* is now statistically significant at the 10% level. The differential impact of Barga implementation on tenant farmers is now substantially larger than the OLS estimate, but it remains statistically insignificant, owing mainly to the associated rise in the standard errors. The spillover effect of the Barga program is now smaller than the direct effect on tenants, as one would expect from theory, but it remains significant in columns two and three at the 5% level. The same is true for the spillover effect associated with the minikits distributed; the effects of credit and local irrigation remain unaffected.

To doubly verify the strength of the spillover effects, Table 15 reports the same regression as Table 13, for the subsample consisting of owner-cultivators alone. We see that the results do not change much, particularly the IV estimates. Hence Operation Barga had a significant impact on the productivity of farms that did not lease in any land at all.

Table 16 reports corresponding OLS regressions at a higher level of aggregation: average yields in the village (computed using the village sample of farms and weighting their respective yields with their relative cropped areas). This includes the effect of changing composition of cropping across farms of differing size and tenancy status, apart from productivity improvements occurring within farms. It includes the distribution of cropped area in the village between marginal farms (with operational holding below 2.5 acres), medium (between 2.5 and 5 acres) and big farms, the proportion of these respective areas operated by tenant farms, and interactions of the latter with the extent of Barga implementation in the village. We see that the distribution of land across operational holdings in different size categories did not have a significant effect. Negative effects of leasing appear only for medium sized farms, and it is only for this category that Barga implementation has a significant impact. This effect is now statistically significant, and is substantially larger than the previous estimates. This suggests substantial heterogeneity across different size categories in the direct productivity effects of Operation Barga on tenant farms. The marginal significance of the average impact estimated in earlier regressions probably resulted from failing to account for this heterogeneity.

Table 17 reports the IV estimates corresponding to Table 16. Now the differential impact of Barga implementation on medium-sized tenant farms is smaller and less precisely estimated. The village-wide spillover effects however are quite similar in size and significance to what we saw in the farm-level regressions.

To assess the relative significance of the direct and spillover effects, as well as of the Barga program relative to farm input services, Table 18A calculates the predicted impact of different programs on farm yields. We calculate the percent change in value added per acre between 1982 and 1995 in a hypothetical village in which the proportion of land registered under Operation Barga was equal to the weighted average for the entire sample (with weights proportional to operational areas of cultivation). We compare this with the change predicted by a hypothetical change in cumulative supply of kits, credit and panchayat expenditures on irrigation, equal to the weighted average of the observed changes in the sample villages (with weights again taken proportional to operational areas). We see that Barga registration is associated with an increase in farm yields of 5% for non-tenant farms. This estimate would be higher for tenant farms, depending on which estimate of the direct productivity impact on tenant farms we take. Table 13 indicates the direct impact is smaller than the general spillover effect, while Table 14 indicates it may be two to three times larger. This indicates a range of 8 to 20% increase in yields for tenant farmers.

The predicted impact of Operation Barga are dwarfed by those of minikits (over 500%), IRDP credit (over 100%), and matched by local irrigation (6%). The similarity of corresponding regression coefficients suggests that the social rate of return to tenancy registration was comparable to those of other input services. The differences in measured impacts therefore reflect differences in the scales of these respective programs.

Table 18B presents more detailed estimates of the predicted impacts of different programs implemented, using actual changes in program implementation in each village for the duration of each farm sample separately. For each five year time block in which any given village appears in the sample, the change predicted in farm yields in those villages by the actual changes observed in different programs is first calculated, using operational land areas of different farms (averaged across different years) to weight different farms. This is subsequently averaged across different villages in the same time block, using their relative operational areas as weights. The broad results remain unchanged from Table 18A. The impact of the Barga program remains small, that of credit and kits remains roughly the same, and that of GP irrigation expenditures becomes larger. Most of the strikingly large impacts are predicted for the first five years 1981–85, with subsequent impacts tailing off considerably. This suggests that slowing of the agricultural input supply programs help explain part of the observed slowing of productivity growth rates in West Bengal agriculture between the early 1980s until the mid-90s.

5 Interpreting the Village-wide Spillovers

What could these spillovers represent? One possible channel is that the program induced changes in prices of key factors such as credit, seeds or fertilizers. For instance, if registration of tenancy status entitled sharecroppers to obtain credit from banks at interest rates substantially below informal interest rates, informal interest rates within the village for crop loans may have declined. This could generate a spillover to owner-cultivated farms in the same village. Unfortunately the farm data does not include information about actual interest rates paid by farmers, so we cannot directly check for pecuniary externalities through the informal interest rate.

One would expect that smaller, poorer farmers would rely more on informal credit, in which case the increases in productivity ought to have been larger for small farms. Table 19 examines differential effects on productivity and incomes of small (less than 5 acre) and marginal (less than 2.5 acre) farms. These are generally insignificant, with the exception of IRDP credit supply which increased yields of marginal farms relative to other farm sizes. Therefore the benefits of the various programs arose uniformly across farms of disparate size, in contrast to the initial impacts of the Green Revolution in wheat in northern India in preceding decades. This suggests that impacts on credit market imperfections are unlikely to constitute the source of the spillovers.

An alternative indicator of lowered costs of informal credit are the prices of seeds paid by farmers, since informal credit is frequently bundled with purchase of seeds at inflated prices (either directly from lender-traders, or from traders in a triadic relationship with lenders and farmers). The farm data includes reliable data on seed prices actually paid for HYV and non-HYV rice for a reasonably large sub-sample (i.e., containing more than 50%) of farms growing these crops. Table 20 shows a regression of rice seed prices on lagged cumulative bargaland, pattaland and kits supplied. Irrespective of whether we use all kits or only rice kits (i.e., those containing rice seeds) supplied, or whether interaction of program effects with farm size are included, we find no evidence of a significant effect of any of the three programs on seed prices.

An alternative channel of spillover could have been changes in the distribution of land, via the land market or household subdivision. The land reform may have induced a redistribution of land in favor of smaller farms; this would raise average productivity in the village if there were an inverse size-productivity relationship. Landlords may have been motivated to sell off their properties to avoid the prospect of having their tenants getting registered. Households may have been induced to subdivide their properties and cultivate it themselves rather than lease them out. In this case the potential threat of registration of tenants may have indirectly induced an increase in the incidence of owner cultivated farms relative to tenant cultivated farms.[21] The process of selling off or subdividing land may have reduced

[21] However we did not see any tendency for the incidence of tenancy to decline (e.g., in either Table 3 or 8).

the average size of farms; indeed operational holdings per household did fall (Table 2).

However, our results pertain to productivity at the level of individual farms: our regressions controlled for farm fixed effects. The channel described above pertains to a redistribution of land from large to small owners which increases average yields in the village owing to a change in composition of farms in favor of more productive ones. They cannot explain why the productivity of any given farm should increase, unless the average size of farms were falling as a result of the reforms, in the presence of a negative size-productivity relationship.

Table 21 shows regressions of farm cropped areas with respect to various programs implemented in the village. The first column shows that total cropped area increased significantly following barga registration. This was accounted for by equal increases in areas allocated to HYV and traditional rice varieties, and a small decrease in area devoted to potatoes. Area allocated to HYV rice and potatoes increased in response to higher minikit supplies and higher rice prices, while these had no effect on areas allocated to traditional rice varieties. Hence there is no evidence that the programs led to a reduction in the operational size of farms.

Table 21 does however throw light on one reason for the large impact of minikit distribution on farm yields, compared with the tenancy registration program: they were associated with a larger increase in HYV rice adoption rates. Operation Barga was associated with a uniform increase in acreage of both traditional and HYV rice, whereas minikits increased acreage under HYV rice disproportionately. In contrast to the effects of Operation Barga, minikit supplies therefore raised the proportion of rice area allocated to high yielding varieties. The estimated impact of minikit supply on area allocated to HYV rice was almost ten times larger than the effect of Barga registration.[22]

[22]With 10% land registered, the area allocated to HYV rice increased by approximately .07 acres, while the increase in minikits supplied was of the order of 1 minikit per household, implying an increase in HYV rice area by approximately 0.7 acres.

6 Concluding Comments

To summarize, we have found effects of Operation Barga on rice yields and farm value added per acre, somewhat smaller in magnitude compared with Banerjee-Gertler-Ghatak, using data from an independent source at a disaggregated farm level, with controls for endogeneity of program implementation and other concurrent panchayat programs. The quantitative magnitude of these effects were small compared to those of agricultural kits, credit and local irrigation facilities delivered by panchayats. We found some evidence that the program raised yields on tenant farms, but this evidence was less reliable, owing to the low incidence of leasing. The impact of the program on growth of farm yields was smaller than the impact of farm input supply programs owing partly to the small scale of the program, related in turn to the low incidence of leasing.

Our results therefore support the conclusions drawn by Banerjee-Gertler-Ghatak concerning the benign impact of tenancy reform on farm productivity. Our quantitative estimate of the effect is somewhat smaller than theirs. This is likely for two reasons. One, they were predicting yields at a much higher level of aggregation, therefore including effects of the reforms on composition of farms between different size categories and tenurial status. Second, we controlled for many other programs administered by local governments that were correlated with implementation of Operation Barga.

At the same time our results also provide support to those who are skeptical that Operation Barga could have explained much of the observed rise in agricultural yields in West Bengal between the late 1970s and mid-1990s. The predicted impact of the program on average farm yields at the level of the village was only 5%, substantially smaller than the effect of farm input supply programs administered by local governments. Tenancy registration was indeed associated with a significant productivity effect on tenant farms, which diffused to other farms in the village. But the incidence of leasing being very low, the aggregate impact of this was small. The larger effects of the farm input supply programs stemmed from the much larger scale of those programs, since they were not restricted to tenant farms alone.

Our results also provide a different interpretation of the effects of tenancy reform. Traditional literature has focused on the Marshall-Mill incentive effects alone. Wider impacts of tenancy reform need to be incorporated and studied. We were surprised by the large spillover effects of the reforms to non-tenant farms; they need to be better understood. We have not yet found any evidence of pecuniary externalities operating through possible effects of the program on credit access of the poor. Such effects should have been manifested by larger impacts of the program on smaller farms that ought to be more credit-constrained than large farms; such differential impacts were not observed. Neither was there any tendency for seed prices to decline following stepped up implementation of any of these programs.

Learning from neighbors could represent an alternative source of spillovers from tenants to owner-cultivated farms. We have found some evidence that the program raised yields of tenant farmers: these could have diffused to other farms in the village. More research is needed to explore this in greater detail.

Yet other spillovers could arise from changes in governance in the village resulting from a changed balance of political power between big landowners and small or marginal landowners, which may have helped reduce elite capture of panchayats, and directed resources preferentially in favor of more productive small farms. Including controls for the pro-poor targeting ratios of farm input supply programs, however, did not change the results. Moreover, the changes in farm productivity witnessed seemed to arise more or less uniformly across different farm sizes. The changed balance of political power within the village may also have resulted in lower bribes paid to non-panchayat or outside input suppliers (such as fertilizer distribution centers or banks) that may be colluding with local elites or panchayat officials. The data available makes it difficult to assess these kinds of channels of impact.[23]

The programs may also have led to improvements in the management of common property resources which would generate benefits to a wide cross-section of farms in the village. Improved management of irrigation facilities is a possible example of this. It is well known that this period witnessed substantial increase in tubewell irrigation, many in the form of small private cooperatives. Enhanced access to credit among registered tenants may have

[23]For instance, input expenditures in the cost of cultivation surveys used the assessment of the investigators concerning prevailing (administered or market) prices in the village, which may well have excluded payment of bribes necessary to secure items in short supply.

encouraged the formation of such irrigation cooperatives. We hope to explore such channels in future research.

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TABLE 1: DISTRICT-WISE ALLOCATION OF SAMPLE VILLAGES		
DISTRICT	NUMBER OF VILLAGES IN SAMPLE	LEFT FRONT PERCENT OF SEATS IN GP (average 1978-98)
24 Parganas (N)	6	56
24 Parganas (S)	8	54
Bankura	5	87
Birbhum	6	56
Bardhaman	8	84
Cooch-Behar	8	85
Hooghly	6	70
Howrah	4	79
Jalpaiguri	5	74
Malda	2	60
Midnapur	8	78
Murshidabad	6	46
Nadia	5	79
Dinajpur	4	51
Purulia	8	62
WEST BENGAL	89	69

TABLE 2: VILLAGE CHARACTERISTICS IN SAMPLE VILLAGES, 1978 AND 1998

	1978	1998
Number of households	228	398
Operational land-household ratio (acre/hh)	1.54	0.87
% households landless	47.3	52.3
% households marginal (0–2.5 acres)	35.2	39.1
% households small (2.5–5 acres)	11.2	6.4
% households medium (5–12.5 acres)	4.7	2.0
% households big (12.5– acres)	1.6	0.3
% land small	56.7	73.9
% land medium	23.9	18.5
% land big	19.5	7.6
% poor households low caste	38.3	39.8
% upto small households illiterate	44.1	31.9
% big households illiterate	4.4	3.2
% households in nonagricultural occupation	41.1	51.4
Population-Bank ratio	41.6	23.1

‘Poor’ household is either landless or marginal landowner

‘Upto small’ household is either landless, marginal or small landowner

All land information pertains to distribution of cultivable non-*patta* land owned

Source: indirect household survey;

Population-bank ratio from West Bengal Economic Review, various years

TABLE 3: LAND REFORMS		
	1978 Average	1998 Average
% operational land vested	16.4*	15.3
% operational land distributed *pattas*	1.4	5.4
% hh's receiving *pattas*	4.9	14.9
% operational land leased	2.7	4.2
% operational land with registered *barga*	2.4	6.1
% hh's registered *bargadar*	3.1	4.4
% tenants registered	43.4	51.2
Average across sample villages, weighted by operational land areas		
Source: Block Land Records Offices for land reforms implemented		
Indirect household survey, for distribution of operational land and tenancy)		
*Only available for 34 villages		

TABLE 4: TRENDS IN PUBLIC SUPPLIES OF AGRI. INPUTS				
	1982	1985	1990	1995
Minikits per household	0.11	0.11	0.08	0.06
IRDP[a] per household	36	29	25	18
GP Irrigation Expenditure[b]	5233	4265	1485	2627
GP Road Expenditure[c]	6470[d]	4501	2501	4572
GP Employment Mandays per household	3.9	3.0	2.2	1.9
Area Irrigated by State Canals (hectares)	72793	72168	79774	84672
State Road Length (Km)	1271	1282	1309	1320
cum. % op. land distributed *patta*	4.5	5.8	6.2	6.3
cum. % op. land registered *barga*	1.9	4.2	4.9	5.1
First five rows: Average of yearly flows across sample villages, weighted by operational land areas				
Sixth and seventh rows: stocks at district level, West Bengal government data				
a: IRDP Credit Subsidy, 1980 prices;				
b,c: Expenditure out of Employment Program Funds, 1980 prices; d: for year 1983				
Source: Block Agricultural Dev. Offices, Lead Banks, GP budgets, West Bengal Economic Review				

TABLE 5A: AVERAGE AREA AND VALUE ADDED FOR DIFFERENT CROPS		
	Percent of Total Total Cropped Area Area Devoted	Value Added per acre (1980 prices)
Rice (HYV)	27.5	4137
Rice (non-HYV)	40.0	1925
Potato	3.2	6831
Jute	11.9	3497
Wheat	4.6	1347
Pulses and Vegetables	5.1	2172
Oilseeds	5.9	1808
Tobacco	1.4	3266
Simple Average across sample villages		
Source: Cost of Cultivation Surveys		

TABLE 5B: TRENDS IN FARM PRODUCTIVITY, INCOMES, WAGES				
	1982	1985	1990	1995
Rice Yield Kg/hectare	1414	1932	2758	3647
HYV Rice Area/Rice Area	.08	.15	.39	.66
HYV Rice Area/Total Cropped Area	.05			.44
Value Added/Acre	723	725	1303	1401
Wage Rate	0.62	0.69	0.88	1.01
Hired Labor Annual Hrs/Acre	156	176	249	369
Simple Average across sample villages				
All rupee figures deflated by cost of living index, 1974=100				
Source: Cost of Cultivation Surveys				

TABLE 6: LAND REFORM PANEL REGRESSIONS

	PATTALAND		PATTADAR		BARGALAND		BARGADAR	
% Left	-0.66	-0.35	-0.21	0.64	0.43	1.10	0.51**	0.90***
	(0.62)	(0.63)	(0.40)	(0.50)	(0.94)	(0.71)	(0.30)	(0.23)
% Left Sq.	0.23	0.12	-0.11	-0.15	-1.03	-0.66	-0.51***	-0.59***
	(0.33)	(0.55)	(0.33)	(0.30)	(0.97)	(0.56)	(0.19)	(0.22)
% Left*% 1978 HH's		0.91		-1.12**		-0.82		-0.38
Landless		(0.82)		(0.47)		(0.88)		(0.47)
% Left*% 1978 land		-1.25***		-1.02**		-2.88***		-0.47*
big		(0.40)		(0.50)		(1.08)		(0.25)
% Election year	-0.08	0.14	-0.08	-0.01	0.35	-.04	0.16***	0.00
Dummy	(0.09)	(0.15)	(0.06)	(0.06)	(0.26)	(.03)	(0.05)	(.01)
% Pre-election year	0.13	-0.07	-0.01	-0.08	-0.04	0.36	0.001	0.16***
Dummy	(0.18)	(0.08)	(0.06)	(0.06)	(0.04)	(0.31)	(0.01)	(0.05)
Total Obs.	1755	1755	1755	1755	1755	1755	1755	1755
Censored Obs.	1570	1570	1570	1570	1588	1588	1588	1588
No. Groups	89	89	89	85	89	89	89	89

Trimmed Least Absolute Deviation Regressions, Yearly Data, 1978–98

* Village controls include land distribution, illiteracy rates, proportion low caste.

Also included: timeblock dummies, village fixed effects.

Standard errors in parentheses

***:significant at 1%, ** at 5%, * at 10%

TABLE 7: LEFT SHARE REGRESSIONS

	Cross-Section (OLS)	Panel (Ar-Bond)	Panel (Ar-Bond)	Panel (Ar-Bond)
No. obs. (GPs)	57	221 (56)	221 (56)	221 (56)
F-st(d.f.)	3.11(9,47)	28.00(6,214)	17.90(14,206)	18.41(15,205)
p-value, 2nd order				
ser. corr. diff. res.		.14	.04	.06
Assembly Vote Share	1.32***			0.85***
Difference, District	(0.40)			(0.28)
% Cong Seats		-0.51**	-0.45*	-0.64***
in Parliament		(0.24)	(0.24)	(0.24)
% Cong Seats Parlmt*		0.80***	0.72***	1.01***
Lagged GP LeftShare		(0.23)	(0.23)	(0.25)
Inflation Rate		3.48***	3.77***	3.43***
		(0.91)	(0.85)	0.85)
Inflation Rate*Lagged		-6.97***	-7.34***	-6.60***
GP Left Share		(1.13)	(1.05)	(1.04)

Panel regressions: Arellano-Bond GMM estimator

Controls include distribution of land, literacy, caste; small factory employment growth

robust standard errors in parentheses; ***: significant at 1%, ** at 5%, * at 10%

TABLE 8: PERCENT LEASING IN LAND, BY YEAR		
YEAR	PERCENT LEASING	PERCENT AREA LEASED)
1982	2.13	12.98
1983	3.24	10.34
1984	4.41	13.11
1985	3.38	6.94
1986	0.44	1.2
1987	0.44	1.14
1988	1.02	2.26
1989	0.73	0.89
1990	0.43	2.07
1991	1.17	6.54
1992	2.5	10.33
1993	2.35	3.86
1994	2.41	6.31
1995	1.98	4.27

TABLE 9A: COMPARING HYV RICE INPUT ALLOCATIONS AND YIELDS ACROSS LEASED AND OWNED PLOTS						
	Log(Input Exp /Output Value)		Log(Output Value /Cropped Area)			
Leased Dummy	-.21***	-.22	.06	.05	.09*	.10
	(.08)	(.14)	(.05)	(.09)	(.05)	(.08)
Leased Dummy*		.12		-.19		-1.45
Cum Bargaland		(.10)		(1.95)		(1.75)
Log(Input Exp./					.17***	.19***
Cropped Area)					(.02)	(.02)
Log(Family Lab./					.17***	.17***
Cropped Area)					(.02)	(.02)
No. obs., farms	1828,576	1590,496	1828,576	1590,496	1702,556	1471,478
Within-R sq.	.031	.037	.190	.216	.30	.34
OLS Regresssions						
All regressions include farm and year dummies						
Robust standard errors in parentheses, clustered at village level						
***,**,* denote significant at 1,5,10% respectively						

TABLE 9B: COMPARING NON-HYV RICE INPUT ALLOCATIONS AND YIELDS ACROSS LEASED AND OWNED PLOTS						
	Log(Input Exp /Output Value)		Log(Output Value /Cropped Area)			
Leased Dummy	-.06	-.08	.01	-.02	.04	.04
	(.08)	(.17)	(.06)	(.12)	(.06)	(.12)
Leased Dummy* Cum Bargaland		-2.52		2.64		2.24
		(3.16)		(2.28)		(2.19)
Log(Input Exp./ Cropped Area)					.15***	.17***
					(.02)	(.02)
Log(Family Lab./ Cropped Area)					.19***	.19***
					(.02)	(.02)
No. obs., farms	2234,660	1911,572	2236,660	2127,639	2127,639	1812, 552
Within-R sq.	.06	.08	.20	.27	.27	.30

OLS Regresssions

All regressions include farm and year dummies

Robust standard errors in parentheses, clustered at village level

***,**,* denote significant at 1,5,10% respectively

TABLE 10: TENANCY AND REGISTRATION: EFFECT ON FARM VALUE ADDED PER ACRE				
	OLS	OLS	IV(a)	IV(b)
Current Lease	-0.049	-	-.051	-1.24
Dummy (Ib)	(0.065)		(.065)	(.772)
Current Lease*Cum.	.125		.128	2.302
Bargaland (Ia,Ib)	(.186)		(.187)	(1.641)
Frac. Years Leased*		22.635		
Cum Bargaland		(19.272)		
Acreage(Ib)	-.055*	-.056*	-.047	1.157*
	(.032)	(.031)	(.032)	(.694)
Acreage Squared (Ib)	.002	.002	.002	-.064
	(.001)	(.001)	(.002)	(.040)
Number obs., farms	2438,631	2438,631	2420,626	2420,626
Within-R sq.	.08	.08	.08	-2.34
Ia: Instrumented in IV(a) regressions				
Ib:Instrumented in IV(b) regressions				
All regressions include farm fixed effects, year dummies				
Robust standard errors in parentheses, clustered at village level				
***,**,* denote significant at 1,5,10% respectively				

First Stage Results for IV Regressions in Table 10			
	Partial R-square	F	P-value
Current Lease Dummy	.15	20.09	0.00
Current Lease*Cum. Bargaland	.03	1.32	0.16
Acreage	.09	38.93	0.00
Acreage Squared	.08	58.59	0.00

TABLE 11: ADDING SPILLOVER EFFECTS			
	OLS	OLS	OLS
Current Lease	-.027	-.049	-.053
Dummy	(0.054)	(0.056)	(0.056)
Current Lease*Cum.	0.372**	0.309*	0.253
Bargaland	(0.161)	(0.161)	(0.157)
Acreage	-0.101***	-0.100***	-0.096***
	(0.029)	(0.030)	(0.030)
Acreage Squared	0.004***	0.003**	0.003**
	(0.001)	(0.001)	(0.001)
Cum. Bargaland	0.418***	0.440***	0.423***
(Lagged)	(.142)	(.133)	(.128)
Cum Pattaland	0.267**	0.162	0.187
(Lagged)	(.125)	(.118)	(.121)
Cum. Minikits/HH	0.521***	0.508***	0.494***
(Lagged)	(.190)	(.171)	(.167)
Cum. IRDP Credit/HH	6.64e-04**	6.37e-04**	.001**
(Lagged)	(2.53e-04)	(2.57e-04)	(0.000)
Log Cum. GP Irrigation	0.023***	0.040***	0.040***
Exp. (Lagged)	(.007)	(.009)	(.012)
Log Cum. GP Road	-0.015	-0.016*	-0.015
Exp. (Lagged)	(.010)	(.010)	(.010)
Log State Canals		-.004*	-.001
Distt Level		(.007)	(.008)
Log State Roads		2.337***	2.354***
Distt Level		(.503)	(.570)
Cum. Mandays/HH(I)			.048
			(.031)
Number obs., farms	2109,547	2109,547	2085,539
Within-R sq.	.18	.20	.20
All regressions include farm, year dummies; rice price; annual rainfall			
Robust standard errors in parentheses, clustered at village level			
***,**,* denote significant at 1,5,10% respectively			

TABLE 12: USING DIFFERENT MEASURE OF TENANCY			
	OLS	OLS	OLS
Frac. Years Leased*	41.462*	35.855	26.641
Cum Bargaland	(22.109)	(24.239)	(19.547)
Acreage	-0.102***	-0.101***	-0.098***
	(0.028)	(0.029)	(0.029)
Acreage Squared	0.004***	0.003**	0.003**
	(0.001)	(0.001)	(0.001)
Cum. Bargaland	0.415***	0.438***	0.423***
(Lagged)	(.142)	(.133)	(.128)
Cum Pattaland	0.271**	0.163	0.187
(Lagged)	(.123)	(.117)	(.120)
Cum. Minikits/HH	0.521***	0.511***	0.496***
(Lagged)	(.189)	(.170)	(.167)
Cum. IRDP Credit/HH	6.58e-04**	6.33e-04**	.001**
(Lagged)	(2.53e-04)	(2.59e-04)	(0.000)
Log Cum. GP Irrigation	0.023***	0.040***	0.040***
Exp. (Lagged)	(.007)	(.009)	(.011)
Log Cum. GP Road	-0.015	-0.016*	-0.015
Exp. (Lagged)	(.010)	(.010)	(.010)
Log State Canals		-.003	-.001
Distt Level		(.007)	(.008)
Log State Roads		2.318***	2.334***
Distt Level		(.500)	(.568)
Cum.Mandays/HH(I)			.048
			(.031)
Number obs., farms	2109,547	2109,547	2085,539
Within-R sq.	.18	.20	.20
All regressions include farm, year dummies, rice price, annual rainfall			
Robust standard errors in parentheses, clustered at village level			
***,**,* denote significant at 1,5,10% respectively			

TABLE 13: IV ESTIMATES OF DIRECT AND SPILLOVER EFFECTS

	IV	IV	IV
Current Lease	-.019	-.039	-.034
Dummy	(0.054)	(0.057)	(0.058)
Current Lease*Cum.	0.348**	0.332*	0.224
Bargaland (I)	(0.173)	(0.171)	(0.182)
Acreage	-0.099***	-0.095***	-0.096***
	(0.030)	(0.030)	(0.030)
Acreage Squared	0.003***	0.003**	0.003**
	(0.001)	(0.001)	(0.001)
Cum. Bargaland	0.718***	0.831***	0.901***
(Lagged)(I)	(.275)	(.259)	(.238)
Cum Pattaland	0.221	0.070	0.104
(Lagged)(I)	(.143)	(.137)	(.163)
Cum. Minikits/HH	0.705***	0.808***	0.890***
(Lagged) (I)	(.274)	(.258)	(.239)
Cum. IRDP Credit/HH	1.30e-03***	1.23e-03***	.001***
(Lagged)(I)	(4.16e-04)	(3.81e-04)	(0.000)
Log Cum. GP Irrigation	0.022**	0.039***	0.036*
Exp. (Lagged)	(.009)	(.012)	(.019)
Log Cum. GP Road	-0.013	-0.014	-0.026**
Exp. (Lagged)	(.010)	(.009)	(.010)
Log State Canals		-.001	.007
Distt Level		(.007)	(.007)
Log State Roads		2.459***	2.278**
Distt Level		(.618)	(.970)
Cum.Mandays/HH(I)			0.111**
			(.050)
Number obs., farms	2091,542	2091,542	2075,534
Within-R sq.	.18	.20	.20

I: Instrumented in the regressions

All regressions include farm, year dummies; rice price; annual rainfall

Robust standard errors in parentheses, clustered at village level

***,**,* denote significant at 1,5,10% respectively

First Stage Results for IV Regressions in Table 13			
	Partial R-square	F	P-value
Cum. Bargaland	.95	2080.4	0.00
Cum. Minikits/HH	.48	26.16	0.00
Cum. IRDP/HH	.62	60.63	0.00
Cum. Mandays/HH	.36	23.71	0.00

TABLE 14: FULL IV ESTIMATES

	IV	IV	IV
Current Lease(I)	-.647*	-.651*	-.537*
Dummy	(0.349)	(0.331)	(0.295)
Current Lease*Cum.	1.726	0.929	2.015
Bargaland (I)	(5.944)	(5.923)	(4.715)
Acreage(I)	.302	.322	.220
	(0.222)	(0.213)	(0.170)
Acreage Squared(I)	-.013	-.015	-.012
	(0.014)	(0.013)	(0.010)
Cum. Bargaland	0.413	0.588***	0.759***
(Lagged)(I)	(.296)	(.259)	(.235)
Cum Pattaland	0.246	0.055	0.080
(Lagged)	(.159)	(.131)	(.144)
Cum. Minikits/HH	0.386	0.585**	0.774***
(Lagged) (I)	(.334)	(.283)	(.250)
Cum. IRDP Credit/HH	1.02e-03**	9.08e-04**	.001**
(Lagged)(I)	(4.60e-04)	(4.07e-04)	(0.000)
Log Cum. GP Irrigation	0.016*	0.034***	0.032*
Exp. (Lagged)	(.009)	(.011)	(.018)
Log Cum. GP Road	-0.013	-0.017	-0.028**
Exp. (Lagged)	(.013)	(.012)	(.013)
Log State Canals		.008	.012
Distt Level		(.012)	(.011)
Log State Roads		2.701***	2.506**
Distt Level		(.618)	(.970)
Cum.Mandays/HH (I)			0.107**
			(.048)
Number obs., farms	2091,542	2091,542	2075,534
Within-R sq.	-.16	-.14	.00

I: Instrumented in the regressions

All regressions include farm, year dummies; rice price; annual rainfall

Robust standard errors in parentheses, clustered at village level

***,**,* denote significant at 1,5,10% respectively

TABLE 15: PRODUCTIVITY EFFECTS FOR PURE OWNER-CULTIVATORS

	LOG REAL VALUE ADDED PER ACRE	
	IV	OLS
Cum. Bargaland	0.718***	0.416***
(Lagged) (I)	(0.259)	(0.131)
Cum. Pattaland	-0.419	0.143
(Lagged) (I)	(0.608)	(0.141)
Cum. Minikits/HH	0.694**	0.519
(Lagged)(I)	(0.298)	(0.172)
Cum. IRDP Credit/HH	1.22e-3***	5.99e-4**
(Lagged) (I)	(4.17e-4)	(2.58e-4)
Log Cum. GP Irrigation	0.036***	0.037***
Exp. (Lagged)	(0.011)	(0.010)
Log Cum. GP Road	-0.014	-0.015
Exp. (Lagged)	(0.010)	(0.009)
Log State Canals	0.002	-0.000
Distt Level	(0.010)	(0.009)
Log State Roads	2.296***	2.403***
Distt Level	(0.689)	(0.525)
Number obs., farms	1981,516	1993,520
I: Instrumented		
All regressions include farm and year dummies, annual rainfall, log deflated rice price		
Robust standard errors in parentheses, clustered at village level		
***,**,* denote significant at 1,5,10% respectively		

TABLE 16: EFFECTS ON AVERAGE VILLAGE YIELDS

	OLS	OLS	OLS
Frac. Acreage	-.310	-.367	-.321
in Marginal Category	(.304)	(.296)	(.298)
Frac. Acreage	-.194	-.284	-.231
in Large category	(.176)	(.186)	(.177)
Frac. Farms leased	.111	.080	.098
in Marginal Category	(.127)	(.116)	(.107)
Frac. Farms leased	-.264**	-.261**	-.243**
in Medium category	(.123)	(.120)	(.114)
Frac. Farms leased	-.299	-.451	-.483
in Large category	(.276)	(.303)	(.293)
Frac. Marginal Farms	-.853	.101	-.605
leased* Cum. Bargaland	(6.196)	(5.711)	(5.341)
Frac. Medium Farms	3.138**	2.416**	1.922*
leased* Cum. Bargaland	(1.047)	(1.060)	(1.066)
Frac. Large Farms	-8.423	-4.520	-7.286
leased* Cum. Bargaland	(11.096)	(12.133)	(11.230)

Dependent variable: wtd. average of yields of different farms in each village

Continued next page

TABLE 16: continued			
	OLS	OLS	OLS
Cum. Bargaland	0.392***	0.427***	0.385***
(Lagged)	(.146)	(.138)	(.135)
Cum Pattaland	0.105	0.019	0.069
(Lagged)	(.108)	(.112)	(.111)
Cum. Minikits/HH	0.458**	0.436**	.397**
(Lagged)	(.176)	(.170)	(.173)
Cum. IRDP Credit/HH	2.52e-04	2.23e-04	.000
(Lagged)	2.36e-04)	(2.66e-04)	(0.000)
Log Cum. GP Irrigation	0.024***	0.037***	0.039***
Exp. (Lagged)	(.007)	(.012)	(.013)
Log Cum. GP Road	-0.015	-0.015	-0.012
Exp. (Lagged)	(.013)	(.012)	(.012)
Log State Canals		-.009	-.008
Distt Level		(.009)	(.009)
Log State Roads		2.104***	2.088**
Distt Level		(.659)	(.699)
Cum.Mandays/HH			0.043***
			(.026)
Number obs., villages	264,68	264,68	261,67
Within-R sq.	.33	.36	.37
All regressions include farm, year dummies; rice price; annual rainfall			
Robust standard errors in parentheses, clustered at village level			
***,**,* denote significant at 1,5,10% respectively			

TABLE 17: EFFECTS ON AVERAGE VILLAGE YIELDS: IV ESTIMATES

	IV	IV	IV
Frac. Acreage	-.299	-.366	-.328
in Marginal Category	(.297)	(.294)	(.303)
Frac. Acreage	-.181	-.287	-.224
in Large category	(.175)	(.184)	(.173)
Frac. Farms leased	.115	.068	.083
in Marginal Category	(.137)	(.120)	(.099)
Frac. Farms leased	-.242*	-.249**	-.210*
in Medium category	(.122)	(.116)	(.114)
Frac. Farms leased	-.274	-.438	-.507*
in Large category	(.271)	(.295)	(.266)
Frac. Marginal Farms	-.609	1.699	1.801
leased* Cum. Bargaland	(7.117)	(6.250)	(5.227)
Frac. Medium Farms	2.609*	2.106	1.829
leased* Cum. Bargaland	(1.325)	(1.393)	(1.526)
Frac. Large Farms	-10.894	-6.094	-5.674
leased* Cum. Bargaland	(11.695)	(12.097)	(10.850)

Continued next page

TABLE 17: continued			
Cum. Bargaland	0.471*	0.620**	0.683***
(Lagged) (I)	(.271)	(.238)	(.226)
Cum Pattaland	0.129	-0.002	0.018
(Lagged)	(.157)	(.157)	(.169)
Cum. Minikits/HH	0.432	0.525*	.636**
(Lagged)(I)	(.303)	(.286)	(.273)
Cum. IRDP Credit/HH	6.36e-04	6.36e-04	.001
(Lagged)(I)	4.04e-04)	(4.17e-04)	(0.000)
Log Cum. GP Irrigation	0.025***	0.037***	0.035**
Exp. (Lagged)	(.008)	(.013)	(.017)
Log Cum. GP Road	-0.010	-0.009	-0.020
Exp. (Lagged)	(.014)	(.012)	(.012)
Log State Canals		-.009	-.002
Distt Level		(.010)	(.009)
Log State Roads		2.196***	1.919**
Distt Level		(.718)	(.897)
Cum.Mandays/HH(I)			0.093***
			(.047)
Number obs., villages	263,68	263,68	261,67
Within-R sq.	.32	.35	.33
I: Instrumented in the regressions			
All regressions include farm, year dummies; rice price; annual rainfall			
Robust standard errors in parentheses, clustered at village level			
***,**,* denote significant at 1,5,10% respectively			

TABLE 18A: IMPLIED EFFECTS ON FARM VALUE ADDED PER ACRE

	WTD MEAN 1982	WTD MEAN 1995	IV COEFF	PRED. IMPACT VA/ACRE
Bargaland	.019	.051	.714	+5%
Minikits/HH	.11	1.26	.694	+528%
IRDP Credit/HH	36	359	.0012	+144%
GP Irrig. Exp.	4.04	4.74	0.037	+6%

Predicted change of value added per acre implied by estimated coefficients
resulting in a hypothetical village from change in concerned program
equal to weighted average of observed changes in the entire sample between 1982-95

TABLE 18B: AVERAGE PREDICTED EFFECT (% CHANGE) IN FARM VALUE ADDED PER ACRE, DIFFERENT PERIODS

	1981-85	1986-90	1991-1995
Bargaland	.18	.81	.89
Minikits/HH	428.34	79.64	8.58
IRDP Credit/HH	82.56	17.72	9.91
GP Irrig. Exp.	74.21	3.86	1.39

Average of predicted percent change of value added per acre in sample villages implied by estimated coefficients and actual changes observed in those villages;
Operational land areas used as weights

TABLE 19: LAND REFORM AND PUBLICLY SUPPLIED INPUTS: DIFFERENTIAL EFFECTS ON SMALL, MARGINAL FARMS

	Log Farm Value Added Per Acre IV	Log Farm Value Added Per Acre IV
Cum. Bargaland	0.645**	0.686***
(Lagged) (I)	(0.248)	(0.257)
Bargaland*Small	0.012	
	(0.021)	
Bargaland*Marginal		-0.022
		(0.021)
Cum. Pattaland	0.279	0.280
(Lagged) (I)	(0.601)	(0.472)
Pattaland*Small	0.021	
	(0.307)	
Pattaland*Marginal		-0.032
		(0.216)
Cum. Minikits/HH	0.624**	0.646**
(Lagged)(I)	(0.296)	(0.300)
Minikits*Small	0.009	
	(0.026)	
Minikits*Marginal		0.032
		(0.030)
Cum. IRDP Credit/HH	1.22e-3***	1.18e-3***
(Lagged)(I)	(4.53e-4)	(4.16e-4)
IRDP Credit*Small	3.73e-5	
	(8.81e-5)	
IRDP Credit*Marginal		9.27e-5*
		(4.97e-5)

TABLE 19 continued

	Log Farm Value Added Per Acre IV	Log Farm Value Added Per Acre IV
Log Cum. GP Irrigation Exp. (Lagged)	0.038***	0.040***
	(0.010)	(0.011)
GP Irrig Exp*Small	0.0001	
	(0.007)	
GP Irrig Exp*Marginal		-0.003
		(0.009)
Log Cum. GP Road Exp. (Lagged)	-0.004	0.006
	(0.008)	(0.008)
GP Road Exp*Small	0.010	
	(0.009)	
GP Road Exp*Marginal		-0.015
		(0.010)
Number obs., farms	2091,542	2091,542
Within-R sq.	.16	.17

Small: < 5 acres; Marginal:< 2.5 acres;I: Instrumented.

Included: farm,year dummies; state canals, roads; annual rainfall; log real rice price

Robust standard errors in parentheses, clustered at village level

***,**,* denote significant at 1,5,10% respectively

TABLE 20: REFORM EFFECTS ON RICE SEED PRICES				
	HYV SEEDS		non-HYV SEEDS	
Cum. Bargaland	38.12	46.01	-17.13	-36.91
(Lagged)	(34.07)	(45.94)	(92.35)	(65.19)
Cum. Pattaland	-2.55	-4.02	1.76	-0.34
(Lagged)	(2.62)	(3.57)	(2.04)	(0.97)
Cum. Minikits/HH	0.62		-6.33	
(Lagged)	(2.21)		(7.22)	
Cum. Ricekits/HH		-11.60		-33.51
(Lagged)		(9.85)		(37.59)
Cum. Bargaland*		0.21		-1.28
Cropped Area		(.28)		(2.15)
Cum. Ricekits*		1.89		2.27
Cropped Area		(1.87)		(2.35)
Number obs., farms	1056,293	1056,293	1098,278	1098,278
OLS Regressions				
All regressions include farm and year dummies				
Robust standard errors in parentheses, clustered at village level				

TABLE 21: CROPPED AREA REGRESSIONS				
	TOTAL AREA IV	HYV RICE AREA IV	LOCAL RICE AREA IV	POTATO AREA IV
Cum. Bargaland	1.245**	0.738*	0.765**	-0.226**
Lagged	(0.523)	(0.382)	(0.366)	(0.110)
Cum.Pattaland	0.225	0.465	-0.622	0.045
Lagged	(0.678)	(0.466)	(0.695)	(.196)
Cum. Minikits/HH	0.830	0.748**	.125	.264*
(Lagged)	(0.522)	(0.349)	(.455)	(.155)
Cum. IRDP Credit/HH	6.2e-4	1.7e-4	1.2e-4	-1.9e-4
(Lagged)	(6.7e-4)	(5.8e-4)	(7.5e-4)	(1.8e-4)
Log Rice Price	0.257	0.175*	-0.056	-0.057
(real)^b	(0.332)	(0.162)	(.104)	(.046)
Number obs., farms	2071, 539	2099,542	2099, 542	2099, 542
Within-R sq.	.05	.04	.03	.07
b: Deflated using regional CPI for Agricultural Workers				
Other variables in previous tables included				
Robust standard errors in parentheses, clustered at village level				
***,**,* denote significant at 1,5,10% respectively				