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Does Sharecropping Affect Productivity and Long-Term Investment?

Evidence from West Bengal's Tenancy Reforms

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Abstract

Although transfer of agricultural land ownership through land reform had positive impacts on productivity, investment, and political empowerment in many cases, institutional arrangements in West Bengal—which made tenancy heritable and imposed a prohibition on subleasing—imply that early land reform benefits may not be sustained and gains from this policy remain well below potential. Data from a listing of 96,000 households in 200 villages, complemented by a detailed survey of 1,800 owner-cum tenants, point toward binding policy constraints and large contemporaneous inefficiency of share tenancy that is exacerbated by strong disincentives to investment. A conservative estimate puts the efficiency losses from such arrangements in any period at 25 percent.

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Does sharecropping affect productivity and long-term investment?

Evidence from West Bengal's tenancy reforms

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1. Introduction

The economic rationale for redistributive land reform is that providing cultivators with secure ownership rather than insecure use rights and making them residual claimants to their output increases incentives to exert non-contractible effort and make long-term investments. While impacts of sharecropping on productive efficiency have been studied in a large literature, results diverge widely, largely due to the difficulty of accounting for endogenous contract choice and the challenges involved in identifying longer-term effects on investment. The present study considers a setting that differs from those explored elsewhere, in that the decision to enter into a share contract can plausibly be argued to be exogenous. This allows us to derive reliable estimates of the productivity effects of sharecropping, both in the short and the longer term.

Land reform has long been high on West Bengal's political agenda and measures to provide land rights to some 4 million households in 1978-82 are widely seen as having yielded significant benefits. However, the most significant intervention in this context, tenancy reform, fails to give beneficiaries full ownership rights. It thus combines two elements with potentially countervailing effects: on the one hand, anti-eviction clauses protect sitting tenants and make tenancy heritable, thus increasing tenants' investment incentives and net wealth. On the other hand, regulations outlawing cash rental, together with restrictions on subleasing, are likely to reduce efficiency and investment incentives, reducing the productivity benefits of land reform. As a result, benefits from land reform could be below their potential and the net impact of this policy may be ambivalent.

A reliable and precise estimate of land reform regulations' productivity effects could inform policies to increase the benefits from this measure in ways that can be directly linked to policy recommendations for West Bengal. In light of the widespread incidence of share cropping globally, it will also be of interest beyond the case at hand. We discuss implications, noting that some features of our setting, especially the long-term nature of the relationship, would imply that what we obtain are conservative estimates.

Our empirical analysis relies on a 2008/9 survey of some 9,000 parcels, owned by about 2,000 owner-cum tenants who had benefited from tenancy reforms in 1978-82, in 200 villages from 10 West Bengal districts. Household-level listing data on production and investment for all 40,000 producers in the survey villages suggest that owner-cum tenants' levels of productivity and investment are below those of pure tenants as predicted by theory, increasing confidence in the external validity of the results. Plot-wise data

on productivity and use of key inputs allow us to explore the extent to which these parameters differ between tenanted and owned plots by the same household. Beyond contemporaneous productivity impacts, we assess whether tenancy reduces incentives to invest in soil conservation and irrigation.

We find that levels of non-contractible input use and output are significantly lower on tenanted as compared to owned plots by the same household. The difference in revenue is estimated to amount to some 20%, with application of fertilizer and family labor lower by 28% and 11%, respectively, though no statistically significant impact is found on use of seeds, a more observable input. Using land under tenancy rather than full ownership also reduces investment incentives; tenanted plots are 26% less likely to have received investment in land improvements during the last 8 years and 7% less likely to have private irrigation attached to them. A conservative estimate for the total output loss due to tenancy is close to 25%; higher than most of the estimates in the literature. This is in line with the fact that hypothetical land prices for tenanted land are 43% below those for land unencumbered by such restrictions.

A direct implication is that, the benefits from land reform when it was introduced in the late 1970s notwithstanding, relaxing the constraints that lead to widespread sharecropping could increase productivity. Options to increase the productivity of West Bengal's rural sector and thus ensure sustainability of land reform impacts may include support to transfer of full ownership to current users. Our analysis suggests that this would not require large subsidies as in the absence of other constraints tenants could pay out landlords' interest and still be better off. Beyond West Bengal, our findings imply that policies limiting contractual choice will have costs in terms of foregone productivity. Research to explore lower-cost alternatives to achieve the objectives pursued by such measures and study of ways in which the contracting parties adjust to minimize observed efficiency losses would be desirable.

The paper is organized as follows. Section 2 sets the stage by reviewing land reform in India, highlighting the conceptual basis and empirical estimates of the 'Marshallian inefficiency', and laying out key hypotheses and estimation strategy. Section three provides descriptive evidence from a comprehensive listing of some 90,000 households and a detailed follow-up survey of about 2,000 owner-cum tenants in West Bengal. Section 4 discusses econometric results on productivity- and investment- effect of share tenancy in the cross section and, using household fixed effects, the owner-cum tenant sample. Section 5 concludes by drawing out implications for policy in West Bengal and beyond.

2. Motivation and analytical strategy

Land reform can be justified socially if it increases incentive for investment in non-contractible inputs. Indeed, land reform in West Bengal, one of the few Indian states that decisively pursued implementation of this policy in the late 1970s, is widely credited with having caused a spurt of agricultural growth in the

immediate post-reform period. We analyze short- and longer-term effects of the measures introduced to make such reform feasible politically, in particular prohibition of any land leases except share rental contracts. Specific estimation strategies and hypotheses are discussed in light of the literature on share cropping to argue that rigorous empirical evidence will be of relevance beyond the specific case at hand.

2.1 Land reform in India: Conceptual basis and implementation experience

While the negative long-term impacts of unequal asset distribution have long been recognized (de Janvry 1981, Deininer and Squire 1998), attention recently focused on the distribution of resources and political power as key determinants of institutional development with far-reaching impacts on socio-economic and human development (Acemoglu and Johnson 2005; Nunn 2009). Different types of land institutions affected economic and social outcomes over the long term in India (Banerjee and Iyer 2005; Iyer 2010), Central America (Nugent and Robinson 2010), Brazil (Naritomi, Soarez, and Assuncao 2009), and the US (Libecap and Lueck 2011).

Especially if highly unequal asset distributions had been maintained by coercion or other non-economic means, broader political and economic changes often made it difficult to maintain them, creating a need for reform (Baland and Robinson 2008; de Janvry 1981; Rozelle and Swinnen 2004; Swinnen 1999). How reform was implemented had far-reaching implications for productive performance: while it often increased incentives for land-related investment and productivity of land use (Lipton 2009), failure to implement the measures quickly led to prolonged phases of insecurity and strife with negative impacts on land-related investment, productivity, and broader economic development in many cases (Binswanger, Deininger, and Feder 1995).

Land reform was high on India's immediate post-independence policy agenda after 1948, resulting in a swift and successful abolition of rent collecting intermediaries (*zamindars*). Two other measures which the 1955 Land Reform Act introduced were (i) the ability to expropriate any land held by a household above a given ceiling to vest it with the state for subsequent redistribution to the poor; and (ii) tenancy laws that provided sitting tenants with permanent and registered use rights. Both remained controversial, difficult to implement,[1] and had undesired adverse side effects as landlords not only evicted tenants to prevent them from becoming eligible for such reforms (Appu 1997) but also failed to enter into new lease agreements.[2] Overall reform impacts are thus ambiguous, depending on state level implementation (Besley and Burgess 2000; Deininger, Jin, and Nagarajan 2009; Ghatak and Roy 2007). Enforcement was a key reason: although the law provided tenants with permanent and inheritable use rights, landlords' ability to take back land for 'personal cultivation' created a loophole that was routinely used as a pretext

[1] As the Indian constitution makes land a state subject, implementation of laws in this area is the responsibility of individual states.
[2] Estimates from India's national sample survey, the share of households participating in land rental markets decreased from 26% to 11% nationally and from 35% to 14% in West Bengal (World Bank 2007).

to evict tenants. To enjoy their legal rights, tenants had to formally register them but intimidation by landlords -who often also controlled the local government authorities where registration had to take place- and lack of knowledge prevented many from doing so (Chattopadhyay 1979).

In West Bengal, the 1978 election of the Left Front created the preconditions for more effective land reform implementation. While outright transfer of property rights to tenants was not feasible politically, an aggressive program to register tenants was implemented shortly after 1978 (Lieten 1996). This effort, driven by local-government, was relatively equitable and benefited some 4 million households (Bardhan and Mookherjee 2010). By resolving earlier uncertainty, it increased investment incentives, precipitating rapid productivity growth (Rawal 2001). Although data do not always allow isolating reform effects from impacts of other interventions, studies find positive impacts, with estimated gains of between 51% and 63% (Banerjee, Gertler, and Ghatak 2002). Others point towards large general equilibrium effects but differences in the magnitude of impacts between tenancy reform and transfers of vested land, i.e. land expropriated from land owners who held land in excess of the ceiling (Bardhan and Mookherjee 2008).

Conceptually, tenancy reform, the subject of this study, comprises three main elements (Bandyopadhyay 2003). First, registered tenants (*bargadars*) are protected from eviction as long as they pay rent; in fact, share tenancies (*bargas*) are made heritable. Second, fixed rent contracts are outlawed and ceilings, of 25% or 50% depending on whether the landlord supplies inputs, are imposed on the share rent a tenant can be charged. Finally, the transfer of tenanted land (*barga*) by the tenant to third parties via sub-leasing is not allowed. A detailed study of the productivity impacts of such measures is of relevance not only for West Bengal but also allows us to obtain an unbiased estimate of the productivity-impact of sharecropping.

2.2 Conceptual basis and empirical estimates of the size of the 'Marshallian inefficiency'

In a world of perfect information, complete markets, and zero transaction costs, the distribution of land ownership will affect welfare but will not matter for efficiency as market transactions allow everybody to attain an optimum farm size (Feder 1985). Imperfections in labor as well as credit and insurance markets change this and, together with contracting parties' attributes and transaction costs related to contract enforcement, will affect productivity outcomes from land rental (Carter and Zimmerman 2000). Most importantly, although cash rental would maximize productivity under ideal conditions, share contracts may arise if there is non-observable effort or limited liability and tenants are risk averse (Otsuka, Chuma, and Hayami 1992; Shetty 1988). Although characterized by lower productivity than fixed rent, share

tenancy may then be chosen as a second best option in specific environments (Basu 1992; Ghatak and Pandey 2000).[3]

A large number of empirical studies aimed to quantify the 'Marshallian' inefficiency of sharecropping with variation in results that can be partly explained by differences in methodology (Otsuka and Hayami 1988). Even studies controlling for household fixed effects come to widely different conclusions, with estimates ranging from a productivity loss of 16% (Shaban 1987) to impacts that, while statistically significant, appear to be of limited economic relevance (Jacoby and Mansuri 2009).[4] Obtaining credible estimates requires that, in addition to controlling for unobserved household characteristics, two challenges be addressed. First, contractual arrangements vary with tenants' capital endowments (Laffont and Matoussi 1995), ability (Lanjouw 1999), farming experience (Chaudhuri and Maitra 2001; DeSilva 2000), and the relevance of permanent structures or the need to preserve soil fertility (Dubois 2002; Ray 2005). Thus contract choice will be endogenous in many settings. Moreover, beyond its short-term impact, sharecropping may have longer term effects. Specifically, in a long-term relationship, the ability to develop reputation will, as in any repeated game, decrease the level of inefficiency observed in any given period. On the other hand, the fact that neither party can fully appropriate the surplus from long-term investment will reduce investment incentives by landlords and tenants compared to a situation where one party owns the land. Even if, in a given setting, it is a second best outcome, a reliable quantitative estimate of the productivity impact of sharecropping can provide an upper bound for the benefits from, say, eliminating the conditions (e.g. credit market imperfections) giving rise to such arrangements.

2.3 Analytical strategy and hypotheses

The fact that, in West Bengal, restrictions on contract choice imposed in 1978 made it undesirable to enter into new lease contracts creates a situation where decisions about share tenancy arrangements and their modalities were made a long time ago and can thus plausibly be considered as exogenous. There are three reasons for this: First, landlords are unlikely to enter into new (formal) lease agreements as any new tenant would become eligible for registration and receive long-term tenancy rights, a notion supported by a precipitous decline in overall incidence of rentals. Second, short-term land transfers by (protected) tenants are precluded by prohibitions on sub-leasing that threaten those leasing out with loss of their use rights. Finally, a 25% or 50% sharing rule, depending on who provides inputs, is the only contractual option allowed by law.

[3] In a labor surplus, subsistence economy, incentive-based informational rents and endogenous credit rationing which both arise from wealth constraints will imply that ownership affects efficiency and that productivity differences between tenants and family farms will be large with high levels of population pressure, few alternative employment opportunities, and intermediate levels of wealth (Mookherjee 1997).

[4] Landlords ability to monitor is identified as a key reason for the small size of the inefficiency, similar to findings from earlier studies (Sadoulet, de Janvry, and Fukui 1997). As it is not costless, analysis of welfare effects would need to account for the opportunity cost of the time landlords spent on monitoring (Ai, Arcand, and Ethier 1997; Arcand and Rambonilaza 1999).

The fact that contractual arrangements respond to exogenous legal constraints rather than being chosen by contracting parties reduces concerns about endogeneity of contract choice that affect most studies in this area. It makes our setting well suited to provide robust estimates of the contemporaneous and long-term productivity effects of share cropping. This is policy relevant because, in the absence of other binding constraints, the productivity losses from share tenancy provide an upper bound for the gains possibly to be realized from eliminating the conditions (legal restrictions or credit market imperfections) causing such arrangements in the first place.

To frame the empirical analysis, we consider how West Bengal's policies may affect productivity and investment. Rent ceilings and the award of permanent use rights to their plots will increase tenants' wealth and bargaining power vis-à-vis landlords, consistent with the observation that tenant registration led to a drop in the proportion of contracts with a landlord share of half and a concomitant increase of those with a 75/25% sharing rule (Banerjee, Gertler, and Ghatak 2002). The implied increase in investment incentives is likely to outweigh any potential negative impacts arising from the reform-induced elimination of eviction threats as a device to increase tenants' incentives for effort supply that may reduce productivity for short-term contracts (Banerjee and Ghatak 2004). Also, the long-term nature of contracts will transform tenant-landlord bargaining into a repeated game, thus increasing the incentive to apply optimum levels of inputs and efficiency of production in any given period. It implies that our results are likely to constitute a conservative estimate of the contemporaneous productivity-impact of share tenancy.

Regarding longer term investment incentives, two factors have to be considered. First, the reform-induced wealth transfer will increase tenants' ability to undertake indivisible investments. At the same time, as output has to be shared, neither party to the contract can reap the full marginal benefits from such investment. Thus, unless parties reach an implicit and enforceable agreement on how to share benefits, investment levels will be below what would be expected under full ownership. The long-term nature of contractual relationships in West Bengal implies that any effects will be lower than what one would expect in a setting where sharecropping contracts are renewed annually and contractual parameters are less constrained.

2.4 Estimation strategy

To quantify the effect of sharecropping on agricultural production revenues and the probability of making long-term land-attached investments, we follow the literature (Bell 1977; Shaban 1987) and use plot level data on production and investment from our sample of owner-cum tenants to estimate

$$Y_{ij} = \alpha_i + \beta R_{ij} + \gamma X_{ij} + \varepsilon_{ij} \qquad (1)$$

where Y_{ij} is the outcome of interest -either value of gross or net revenue excluding family labor and level of input use per acre or an indicator of investment having been made during the past- on plot *j* by cultivator *i*; α_i captures unobserved determinants of productivity by *i* including farming skills, access to technology and credit etc; R_{ij} is an indicator variable for sharecropped plots; and X_{ij} is a vector of observable plot characteristics including size, soil type or quality, access to irrigation and drainage, and distance from the operator's homestead.[5] Empirically, identification and truncation issues need to be considered.

On the first set of concerns, as α_i will be correlated with R_{ij} (or $E(\alpha_i|R_{ij}=1) \neq 0$), OLS estimation of β will be biased. To deal with this, we follow other studies using plot level data (Jacoby and Mansuri 2009; Shaban 1987) and limit our sample to owner-cum-tenants so that β can be identified from within household variation.[6] A second source of bias is that $E(\varepsilon_{ij}|R_{ij}=1)\neq 0$; in fact sharecropped plots are often assumed to be of lower quality than owned ones. Two factors alleviate concerns that such bias may affect our estimates. First, we control for a wide range of observable plot attributes. Second, many unobserved soil quality attributes such as texture, capillarity, drainage, and salinity, respond to farmers' management decisions over longer periods of time and can thus be considered an investment. As acquisition of new *barga* plots came to a virtual standstill after 1978, differences in these attributes can at least partly be attributed to tenants' actions since receiving the plot as an indicator of tenure-induced under-investment. If there were still unobserved differences in soil quality, they would likely lead us to overestimate the magnitude of the Marshallian inefficiency. Although such bias will be unlikely in our setting, it will be useful to bound the potential magnitude of such bias under rather extreme assumptions. To do so, we use the methodology developed by Altonji, Elder, and Taber (2005) for categorical variables.[7] The lower bounds are estimated based on the assumption of equality of selection on observables and selection on unobservables. Specifically, they are obtained by estimating a bivariate probit model for investment decision and tenancy status of plot *j* by imposing $\rho=Cov(X'\beta, X'\gamma)/Var(X'\gamma)$, where ρ is the correlation between the error components in the investment decision equation $I=1(X'\gamma+\alpha*T+\varepsilon>0)$ and the share tenancy equation $(T=1(X'\beta+u>0))$.

We also note that our data will include a large amount of zeros for investment and some types of inputs. We thus adopt the semi-parametric trimmed LAD approach (Honore 1992) to estimate a fixed-effect tobit to complement the linear probability model to ascertain the probability of any investment being made. If

[5] In the private irrigation regression only public irrigation is included and all irrigation dummies are excluded in the public irrigation regression.
[6] Although an assessment of overall welfare effects would require information on the cost of supervision, landlord monitoring can limit the efficiency loss associated with share tenancy. In a Pakistani sample, the Marshallian inefficiency, estimated to be about 18%, very close to the 17% obtained by Shaban's study, is virtually eliminated for tightly monitored share tenants (Jacoby and Mansuri 2009).
[7] The bounding technique is suitable to estimate bivariate probit model and we have not seen any application to continuous variables in the literature so far, we are limited to estimate the lower bounds on impact of share tenancy on investment decisions (namely, the likelihood to make any land improvement in the past 8 years and the likelihood of using family labor in 2008). For more details see Altonji, Elder and Taber (2005).

investment incentives are systematically lower on sharecropped than on owned land, the total productivity effect of *barga* tenure will be the sum of Marshallian inefficiency and investment effects. For observable investments such as irrigation that enter into the production function, multiplying relevant coefficients is one way to estimate total productivity impacts.

3. Data and descriptive evidence

We use basic information at the household level that is available for all households in the village before focusing specifically on plot-level outcomes for owner-cum cultivators only. For the full sample, our data support the notion that issuance of share contracts virtually came to a halt after 1978 and that, while effectively targeting the poor, land reform did not trigger a massive exodus out of poverty. At the plot level, data for owner-cum tenants are consistent with the hypothesis of tenancy-induced differences in effort supply between owned and sharecropped parcels. Levels of input use, productivity, investment, and exogenous plot characteristics (e.g. salinity) that change slowly over time in response to cultivators' effort are all lower on tenanted as compared to owned parcels, justifying econometric investigation.

3.1 Household-level evidence from listing data

Our data are from a 2008/9 World Bank/FAO survey in 200 randomly selected villages from 10 districts in West Bengal. Villages were selected randomly with probability of selection proportional to the number of beneficiaries from 1978 land reforms, based on official lists obtained from the State Institute of Panchayats & Rural Development (Chakraborti, Mukhodpadhyay, and Roy 2003). The data is thus representative of the universe of West Bengal's land reform beneficiaries. A complete listing of all village residents provided, for the approximately 96,000 households in our 200 sample villages, basic information on current and past household structure, key asset endowments, and the extent and nature to which households were affected by land reform. This was followed by an in-depth follow-up survey of some 1,800 owner-cum-tenants to compare productivity, intensity of input use, and investment between owned plots and those for which inheritable *barga* rights were received during the 1978 reforms.

The village-wide sample highlights that, after the reforms, few if any new sharecropping contracts were concluded. The majority (82%) of share tenants in our sample thus either held their land since 1978 or inherited tenancy rights to a given plot of land (*barga*) from their parents who benefited from land reform. In the remaining 18% of cases, land already encumbered with a tenant had been sold to a third party without interrupting pre-existing tenancy relationships. In line with descriptive studies (Hanstad and Nielsen 2004), the data include 484 cases where residual claims by the other party were bought out by one of the parties, either by the tenant (289 cases) or the landlord (195 cases).

Table 1 reports key 1978 household characteristics, based on recall, for the overall sample and landless, pure owners, owner-cum tenants, and land reform beneficiaries on tenanted (*bargadars*) or ceiling surplus land (*pattadars*). It implies that, as is well documented (Bardhan 1999), land reform targeted the less well off. For example, the share of illiterate heads was 70% overall, but 85% for land reform beneficiaries, 76% for landless, and 67% for owner-cum tenants. This is mirrored by the head's formal education, which ranges from some 4 years for owners to less than 2 years for reform beneficiaries and landless who are also more likely to live in houses with thatch or plastic roof and bamboo or mud walls. Reform beneficiaries also had no or little own land and are more likely to come from scheduled castes or tribes.

Current socio-economic characteristics in table 2 imply that land reform helped to somewhat -but by no means drastically- improve beneficiaries' socio-economic position. Some 19% of household heads among pure *bargadars* or 16% among owner-cum-tenants had their main occupation in non-farm jobs (including off-farm wage and off-farm self-employment), compared to 27% of pure owners and 53% among the landless. Among beneficiaries, owner-cum-tenants rely more on agriculture than pure *bargadars*, most likely due to a higher land endowment compared to pure tenants (2.35 *vs* 1.41 ac.). Beneficiaries from tenancy reform had much lower incomes than non-beneficiaries (4,352 Rs./capita for pure tenants and 4,665 for owner-cum-tenants vs. Rs. 5,914 for pure owners and Rs. 5,469 for landless). As one would expect if rental restrictions are binding, the restrictions imposed by land reform legislation impose imbalances on land rental market operation. Compared to almost two thirds (63%) of sample households who want to rent in (78% of pure bargadars and pattadars), only 1% indicate having rented out land and only 3% are interested in leasing out.[8] Beyond potential Marshallian inefficiency, reform-induced restrictions on land rental may thus reduce the scope for rural productivity growth (Deininger *et al*. 2008). The potential inefficiency of tenancy is also supported by listing data. Gross and net crop revenues are higher for land owners (21,628 and 9,112 Rs./ac) than for owner-cum-tenants (18,167 and 8,178.62 Rs./ac), and higher again for these than for pure tenants (13,217 Rs./ac and 5,556 Rs./ac).[9]

Transition matrices for the total sample and for households formed before and after 1978, respectively, from the listing data are reported in table A1. We note a slight decline in the number of landless (54% to 49% of the sample) and the share of owners (from 37.6% to 34.7%), as well as a slight increase in *bargadars* (2.6% to 3.4%) and owners cum tenants (2.3% to 3.4%). For the 15,399 households (16.5% of the sample) that had been in existence since 1978, the numbers of bargadars, pure owners, and owner-cum tenants, and pattadars all increased (by 241, 322,and 502, and 1205, respectively) together with a

[8] Existence of such large imbalances in lease markets suggests that the constraints on new tenancies are binding, strengthening the identification strategy and our argument regarding the exogenous nature of contractual decisions.

[9] In the listing sheet, respondents were asked to provide revenue (value of total crop production) and cost (except for family labor) for each of the three crop seasons (kharif, rabi, and pre-kharif). Gross revenue is calculated by dividing crop revenues for all crops in all seasons by total arable land. The net revenue is obtained by subtracting the cost of purchased inputs and the imputed value of home-produced inputs excluding labor from the gross revenue.

decrease in the share of landless from 49% to 34%, suggesting some 'upward' movement. For dynasties that split since then (84% of the sample or 80,527 households), the number of landless, owner-cum tenants, and bargadars increased slightly (by 2,665, 1,013, and 777), pattadars more than doubled (2,584 to 6,817), and the number of pure owners dropped correspondingly. Compared to other post-reform settings such as Taiwan, China or Korea over a comparable period, movement in the 30 years post-land reform seems limited.

3.2 Plot-level data for the owner-cum tenant sample

Detailed information on plot characteristics is available for the sample of owner-cum tenants as reported in table 3. Plots measure 0.4 ac. on average (0.36 *vs.* 0.46 ac. for owned and *barga*, respectively) with *barga* plots about 170 m more distant from the cultivator's home. Permanent plot characteristics such as soil type, color, or condition are nearly indistinguishable between owned and *barga* plots. Although magnitudes are small, *barga* plots are more likely affected by salinity and drainage problems caused by inadequate management over a long time, possibly a result of investment disincentives: 46.6% (50.6%) of own compared to 45.2% (52%) for barga plots have no (moderate) salinity problems. Similarly, 35.4% (14.1%) of own plots are "easy (difficult) to drain" compared to 34% (15.2%) for *barga* plots.

Productivity per acre on tenanted plots is significantly lower than on owned ones -by some 24% for gross and net revenue excluding family labor (Rs 16,693 *vs.* Rs. 22,062 and Rs 11,051 *vs.* Rs 14,565, respectively). Interestingly, and consistent with predictions, this difference in net revenues is not due to higher levels of input use on *barga* plots; to the contrary, intensity of fertilizer, pesticide, seed, draught power, and family labor use are significantly lower on *barga* plots, as one would expect.

Data on investment suggest that land-attached investment is much lower on *barga* than on owned plots. Although access to irrigation is a coarse measure only, we find a 10 point difference in access to private irrigation, largely borewells, which exist on 54% of owned but 44% of *barga* plots. By contrast, there is no difference between owned and *barga* plots in access to public irrigation.[10] Flows of less observable investments to maintain or improve land quality point in the same direction: Over the last 8 years, such investment was undertaken on 39% of owned vs. 12% of *barga* plots. Amounts of capital and family labor spent on such investment in 2007 are 3 and 4 times larger on the former (Rs. 203 *vs.* 51 and 6.8 *vs.* 1.8 days, respectively). Econometric analysis can help to more clearly assess the magnitude of tenancy-induced effects.

[10] This can be consistent with the finding that tenancy reforms, institutional credit, and public support through distribution of minikits fostered irrigation investment and drops in water prices that benefited all farmers and drove the 1980s and 90s green revolution (Bardhan, Mookherjee, and Kumar 2009).

4. Econometric results

Controlling for unobserved household characteristics allows us to quantify impacts of share tenancy and compare them to the literature. With a 20% difference in net revenue between owned and sharecropped plots, the size of the Marshallian inefficiency estimated here is high relative to what is found by other studies. Input use is also significantly lower on barga plots, though the size of the effect varies depending among others on the ability to observe inputs. We also find evidence of a negative investment effect, the estimated magnitude of which ranges between 26% for soil conservation and 7% for private irrigation. Combining these implies a conservative estimate of tenancy-induced productivity losses of about 25%.

4.1 Cross-sectional evidence from listing data

As descriptive data point towards differences in observables between owner-cum tenants and others, checking for potential differences in unobservable attributes that may set this group aside and possibly compromise the external validity of results from our plot-level analysis is needed. To do so and at the same time obtain a proxy of overall effects of share tenancy on output and investment, we use listing data to run cross-sectional regressions for all 40,000 agricultural cultivators. Two specifications are used, one with a zero-one indicator each for pure tenants and owner-cum tenants and one with the share of tenanted land in a household's total cropped area as independent variables on the right hand side.

Results for output from production in the current period (columns 1-4 of table 5) suggest that, irrespective of whether gross or net revenue is used as a dependent variable, tenancy has a statistically significant and economically meaningful impact on productivity. The point estimate for the magnitude of the 'Marshallian inefficiency' for pure tenants is close to 20% in both cases. At the same time, with estimates of 11% and 14%, the coefficient for owner-cum tenants is significantly smaller (col. 1 and col. 3); in fact we can reject the hypothesis of the two coefficients being equal at the 5% level of significance. This implies that pure tenants are less efficient than owner cum tenants, possibly because owner-cum tenants' owned plots will not be subject to Marshallian inefficiency. Including the share of land tenanted directly on the right hand side supports this; estimates suggest that gross and net revenue for pure tenants will be lower by 20% or 23% than that of full owners, in line with what theory would lead us to expect.

Although the level of investment in the sample is low overall, equivalent regressions on a zero/one indicator of whether any investment was undertaken since the household was established support the notion of significantly lower investment on tenanted as compared to owned plots. The coefficient for pure tenants, though small quantitatively, is marginally significant and negative. There is no evidence of investment being significantly lower for owner-cum tenants; to the contrary, the point estimate is positive, possibly because this group faces little obstacles to invest on owned plots. A similar result emerges if we

use the share of tenanted land. All of this makes it unlikely that unobserved differences lead to systematic differences between owner-cum tenants' and pure tenants' behavior. The sample should thus allow us to reliably estimate the impact of sharecropping as a conservative estimate of the impacts of such an arrangement in environments where contract choice is less constrained by regulations.

4.2 Within-household estimates of tenancy effects on productivity and input use

Table 5 reports results from the household fixed effect regressions for gross or net revenue from crop production on a given plot. Inclusion of household fixed effects limits the set of explanatory variables to plot size and distance, irrigation status, and soil quality indicators, in addition to the *barga* dummy. The coefficient on the latter, which, as the dependent variable is in logs, can be interpreted as an elasticity, is significant throughout, suggesting that net and gross revenue on *barga* plots are 19 and 20 points lower than on owner-cultivated ones in the same household. The coefficient on distance to the homestead is negative as expected suggesting that gross or net revenue for plots owned by the same household that are located 1 km further away is lower by 7% and 9%, respectively. Plot size is estimated to have no appreciable impact on gross revenue but to slightly increase net revenue, possibly due to economies of scope that decrease the cost of cultivating larger plots (Foster and Rosenzweig 2010).

Results are robust to different specifications. Adding plot and soil characteristics (columns 2 and 4) leaves our main result virtually unaffected. Limited within-household variation in sharing rules together with the fact that most households obtain land from one landlord only makes it difficult to assess whether and how much landlord monitoring or provision of inputs might help attenuate Marshallian inefficiency.[11] Overall, the output effect obtained here is comparable to the 16% estimated by Shaban (1987) and the 22% obtained for West Bengal by Bardhan (2009). [12] Although it is much larger than the result by Jacoby and Mansuri (2009) for Pakistan, it is comparable to their estimate of 18% for plots not subject to landlord supervision. As close supervision entails costs which are likely to increase with economic development, our results, which will constitute a lower bound estimate, suggest that disincentive effects from contractual arrangements in land markets may warrant attention by policy makers.

Results from fixed effect tobit estimates for the level of input use in table 6 are consistent with earlier results and, in addition, point towards interesting variation across inputs depending on how much their application can be observed. For all inputs except seeds which are easily observed, amounts applied per acre on tenanted plots are significantly below those on owned ones, as predicted by theory. Comparing

[11] Running regressions separately for households with 50/50 and 75/25 sharing rules fails to substantively alter substantive conclusion although the fact that information on sharing rules is missing for about a third of the sample reduces sample size.

[12] We also included specifications where distance, presence of public irrigation, and 5 land size dummies to represent the quintiles of operational area were interacted with a sharecropping dummy (not reported). The coefficient for the interaction term between irrigation and sharecropping is insignificant throughout while that on the interaction between distance and sharecropping is positive and sometimes significant. The negative and significant coefficient on the interaction between land size and sharecropping supports the notion that share tenancy reduces productivity and investment for all groups of the farm size distribution.

coefficients with mean levels of application points towards differences the magnitude of which ranges from 11% for family labor, to 20% for pesticide and 28% for fertilizer. With the exception of seeds and casual labor, inputs are applied less intensively on larger plots, possibly due to the cost savings associated with their cultivation. Fertilizer and pesticides are also used less intensively on plots further away from the home.

4.3 Investment effects and implications for land values

To explore investment impacts, we use zero one indicators for whether investment in land improvement was undertaken during the last 8 years and if family labor was used for such investment. We also use amounts of money and labor spent on such investment and indicators for whether or not a plot had access to public or private irrigation. Results from a linear probability models (cols. 1 and 2 of table 7) suggest that investment incentives by owner-cum cultivators are significantly lower on tenanted than on owned plots, contrary to the objective of land reform to enhance investment.[13] The average *barga* plot is 26 and 22 percentage points less likely than an owned plot by the same household to have received investment to maintain or improve land quality over the last 8 years and of family labor having been used for such investment, respectively, a rather large effect that points towards considerable levels of tenure insecurity or inability to enforce contracts. As one would expect, estimates of the effect of share tenancy on the likelihood of land investment under the assumption of bias due to the presence of unobserved differences in soil fertility beyond those controlled for in our regression using the method by Altonji, Elder and Taber (2005) are smaller than those in the fixed effect model. Estimated effects on the propensity to have made any land improvement during the past 8 years and to have used family labor in 2008 are 10% and 7%, respectively, in both cases still significant at the 1% level, thus supporting our main result.[14]

Estimates from the fixed-effect tobit model for actual cash and labor days spent on land improvements during the last 8 years or 12 months as reported in the last two columns of table 7 are also negative and significant at 1%. Coefficients suggest that sharecropped plots receive 21 days of family labor and Rs. 959 (or Rs. 120/year) less in terms of investment than plots owned by the same household. Compared to soil fertility improvements, investment in private irrigation is more capital intensive and visible and may generate external effects due to indivisibilities which could also increase landlords' incentives to undertake such investment.[15] Column 5 of table 7 shows that, although the coefficient on access to private

[13] We report results for regressions where availability of public irrigation is not included as one of the right hand side variables. Including this variable on the right hand side does not significantly alter significance or magnitude of other coefficients while suggesting that such irrigation and investment are strong complements, with irrigation increasing incentives for land-improving investment by some 10 points.

[14] Although still negative, the coefficient on access to private irrigation loses significance under the assumption of bias due to omitted variables. While a range of explanations are plausible, we attribute this to mis-measurement resulting from the fact that the variable used is a stock rather than a flow variable that itself affects land quality.

[15] Increased supply of irrigation water by land reform beneficiaries to their neighbors and associated price drops have been identified by one study as a key channel for indirect effects from land reform to materialize (Bardhan, Mookherjee, and Kumar 2009).

irrigation is smaller than that on land investment, it is negative and highly significant, suggesting that *barga* plots are 7% less likely to have private irrigation equipment than owned ones, in addition to private irrigation being less likely on plots further from the homestead. As we do not expect plots' tenure status to affect placement of public irrigation, a similar regression for public irrigation can serve as a placebo. Indeed, doing so yields an insignificant coefficient (col. 6 of table 7), increasing confidence in the data and allaying fears of other unobserved factors may drive our results.

Taken together, these estimates point towards significant investment disincentives on tenanted plots, both in terms of the size of the estimated impact and the nature of investments considered. These are larger than what had been found in other studies exploring commitment problems and their impact on under-provision of non-contractible investment (Jacoby and Mansuri 2008).

Lack of information on productivity impacts of land-attached investment makes it difficult to translate such tenure-induced under-investment into productivity impacts. However, a back of the envelope lower bound estimate can be obtained if we neglect any productivity-impacts of soil improvements. i.e., assume that *barga* tenure will only affect private irrigation investment. In this case, the estimated impact of tenure-induced underinvestment would reduce gross or net revenue by 3.4 to 4.4 percentage points.[16] Adding this to the estimate of Marshallian inefficiency obtained earlier would imply a total efficiency loss from *barga* tenure of close to 25%. This is not only a large effect, it also suggests that, if other factors such as credit access are not binding, ways to allow a buy-out of the other party's residual interest (Majumdar 2003) could help increase productivity without requiring access to large amounts of public finance as predicted productivity increases would be large enough to pay for the associated cost.

As our survey also asked respondents about the amount for which they would be able to sell a given plot, similar within-household regressions allow us to assess the impact of tenure on hypothetical sales prices and thus obtain an upper bound on tenure-induced productivity effects. Results, in table 8, suggest that prices for tenanted plots by the same household are some 42% below those for owned plots.

5. Conclusion

By providing reliable estimates of the static and dynamic productivity effects of share tenancy in West Bengal, our study contributes to the literature on contractual arrangements in rural land markets as well as land reform. Our findings suggest that, in contrast to very favorable short-term impacts (Banerjee, Gertler, and Ghatak 2002), potential long term gains in productivity and investment from land reform may not have been fully realized. Options to reverse this and thus 'complete land reform and increase the likelihood of gains being sustained could include opening up a broader range of contractual options in

[16] The estimate is obtained by multiplying coefficients on irrigation dummy from a separate production function (0.63 and 0.50 depending on whether the other control variables are included or not) with that from the investment equation (0.069). The regression results are not reported.

particular cash rent; allowing current tenants to sub-lease their plots; or providing mechanisms for credit access thus allowing tenants to overcome market imperfections precluding them from borrowing enough to buy out landlords (Mookherjee 1997) so as to replace inheritable usufruct with full ownership (Bandyopadhyay 2008). This may be of relevance to other settings such as Uganda (Deininger and Ali 2008) or the Philippines (Fabella 2003) where overlapping property rights as a result of incomplete land reforms have emerged as an issue.

Beyond West Bengal, share tenancy -as a response to market imperfections or to regulatory requirements- remains widespread. While the magnitude of impacts reported in the literature differs widely, partly due to endogeneity of contract choice, our results, from a setting where such endogeneity is unlikely to play a role, suggest that policy-induced constraints on contractual arrangements can have quantitatively large impacts on efficiency of land use in any given period. Moreover, they will also affect the evolution of the agricultural capital stock, with potentially far-reaching implications for overall growth, via land-related investment. Although farmers have ways to attenuate the associated effects, e.g. through close monitoring, the size of the impact of share tenancy obtained here suggests that in many cases policies to improve the functioning of markets and thus reduce the likelihood of share cropping to arise as a second-best contractual option, may be worthwhile.

Table 1. Key Household Characteristics in 1978 and Changes therein by Initial Tenure Status

Variable	Total	Pure owners	Pure bargadars	Owner-cum-tenants	Pattadars	Landless
Household characteristics in 1978						
Household size	6.21	6.74	6.17	6.66	5.86	5.75
Head's age	31.17	32.21	31.01	32.49	31.91	30.04
Head's educ (years)	2.83	3.96	1.57	3.19	1.18	1.90
Illiterate head	0.70	0.62	0.85	0.67	0.84	0.76
SC/ST	0.45	0.39	0.58	0.42	0.70	0.49
Bad roof (thatch/plastic/mud)	0.72	0.71	0.86	0.78	0.84	0.71
Bad wall (mud/bamboo)	0.70	0.70	0.89	0.88	0.74	0.68
Owns livestock	0.46	0.66	0.60	0.73	0.47	0.29
Owns bicycle	0.12	0.18	0.11	0.15	0.10	0.07
Owns motorcycle	0.00	0.00	0.00	0.00	0.00	0.00
Occupation &land ownership 1978						
Wage work main occ.	0.36	0.14	0.33	0.11	0.50	0.54
Farming main occ.	0.40	0.71	0.60	0.83	0.40	0.13
Off-farm wage work main occ.	0.10	0.11	0.03	0.03	0.03	0.10
Off-farm self employment main occ.	0.12	0.12	0.04	0.04	0.04	0.12
Own rainfed land (acres.)	0.81	1.91	0.00	1.58	0.00	0.00
Own irr. land (acres.)	0.32	0.77	0.00	0.40	0.00	0.00
Barga land	0.08	0.00	1.87	1.45	0.11	0.00
Patta land	0.03	0.01	0.00	0.04	0.75	0.00
Change between the two periods						
Household size	-1.45	-1.82	-1.34	-1.63	-1.16	-1.14
Illiterate head	-0.16	-0.21	-0.22	-0.24	-0.18	-0.11
Bad roof (thatch/plastic/mud)	-0.40	-0.46	-0.36	-0.44	-0.34	-0.35
Bad wall (mud/bamboo)	-0.15	-0.21	-0.11	-0.15	-0.07	-0.12
Owns livestock	0.01	-0.06	-0.04	-0.08	0.07	0.07
Owns bicycle	0.51	0.56	0.47	0.57	0.52	0.47
Ag. wage work main occ.	-0.07	0.03	0.00	0.07	-0.05	-0.15
Farming main occ.	-0.11	-0.22	-0.20	-0.26	-0.09	-0.02
Off-farm wage work main occ.	0.06	0.05	0.05	0.07	0.04	0.06
Off-farm self employment main occ.	0.10	0.10	0.09	0.11	0.08	0.10
Own rainfed land	-0.50	-1.33	0.09	-0.91	0.15	0.10
Own irr. Land	-0.07	-0.26	0.06	-0.06	0.04	0.08
Barga land	0.05	0.05	-1.28	-0.90	0.12	0.14
Patta land	0.04	0.04	0.04	0.02	-0.39	0.05
No. of observation	95,666	38,682	2,236	2,161	2,687	49,900

Source: Own computation from 2008/9 West Bengal listing survey.

Table 2. Household Characteristics in 2008, overall and by Tenure Type

Variable	Total	Pure owners	Pure bargadars	Owner-cum-tenants	Pattadars	Landless
Household characteristics						
Household size	4.75	5.08	4.99	5.57	4.75	4.41
Members <14 years old	1.50	1.43	1.55	1.52	1.42	1.56
Members 14 to 60 years old	2.99	3.32	3.21	3.63	3.03	2.66
Members>60 years old	0.26	0.32	0.24	0.42	0.30	0.19
Head's age	44.57	47.60	46.46	49.51	46.94	41.15
Head's educ (years)	3.11	4.48	1.82	3.65	1.45	2.27
Share of heads illiterate	0.54	0.42	0.70	0.47	0.74	0.62
Area of own land (ac.)	0.57	1.37	0.00	1.10	0.00	0.00
Area of Barga land	0.13	0.00	1.41	1.07	0.66	0.00
Area of Patta land	0.06	0.08	0.00	0.18	0.41	0.00
Barga under 25/75 sharing rule	-	-	0.48	0.44	-	-
Barga under 50/50 sharing rule	-	-	0.52	0.56	-	-
Head's occupation and income sources						
Wage work main occupation	0.31	0.14	0.33	0.14	0.47	0.44
Farming main occ.	0.30	0.58	0.48	0.70	0.30	0.03
Off-farm wage work main occ.	0.27	0.18	0.14	0.11	0.17	0.38
Off-farm self employment main occ.	0.12	0.09	0.05	0.05	0.06	0.15
Income per capita (Rs.)	5504.66	5913.92	4351.95	4665.49	4192.01	5469.39
.. share from wage & salaried work	0.65	0.43	0.58	0.38	0.72	0.77
.. share from crop prod	0.15	0.38	0.32	0.47	0.15	0.01
..share from self-employment	0.13	0.12	0.07	0.09	0.07	0.15
.. share from livestock prod	0.02	0.03	0.01	0.03	0.02	0.01
.. share from other sources	0.05	0.05	0.03	0.03	0.04	0.06
Productivity						
Annual gross revenue (Rs./ac)	20408.59	21628.00	13216.82	18167.36	17611.82	-
Annual net revenue (Rs./ac)	8652.84	9112.45	5554.71	8178.62	7606.50	-
Agricultural market participation						
Ever rented out land	0.01	0.03	0.00	0.01	0.01	0.00
Would like to rent in land	0.64	0.64	0.78	0.70	0.78	0.62
Would like to rent out land	0.03	0.04	0.04	0.03	0.04	0.01
No. of observation	95926	36053	2740	3094	6457	46609

Source: 2008/9 West Bengal listing survey.

Table 3. Plot-level Data on Output and Input Use as well as Investment for Owner-cum Tenants

	All	Own land	Barga land	Difference
Plot characteristics				
Land area (acre)	0.40	0.36	0.46	*
Distance to homestead (meter)	878.8	810.9	979.1	***
Gray color soil	0.853	0.854	0.853	
Sandy soil	0.145	0.148	0.142	*
Loam soil	0.111	0.111	0.110	
Light clay soil	0.457	0.458	0.455	
Heavy clay soil	0.259	0.257	0.261	
No salinity	0.460	0.466	0.452	***
Moderate salinity	0.512	0.506	0.520	***
Easy to drain	0.350	0.354	0.340	**
Moderately easy to drain	0.504	0.505	0.503	***
Difficult to drain	0.146	0.141	0.152	
Input use & productivity				
Used any fertilizer	0.970	0.969	0.972	
Used any manure	0.596	0.632	0.544	***
Used any pesticides	0.866	0.885	0.837	***
Used any seeds	0.984	0.978	0.992	***
Used any draught power/transport	0.311	0.328	0.300	***
Used any casual labor	0.672	0.660	0.681	
Used any family labor	0.928	0.920	0.941	***
Fertilizer & manure (Rs/acre)	1,942.06	2,195.05	1,569.15	***
Pesticides (Rs/acre)	605.61	666.13	516.40	***
Seeds (Rs/acre)	1,256.45	1,428.47	1,002.88	***
Draught power/transport (Rs/acre)	1010.87	1087.02	898.62	***
Casual labor cost (Rs/acre)	886.98	942.67	804.90	***
Family labor use (Days/acre)	70.07	74.74	63.17	***
Gross production value (Rs/acre)	19,892.1	22,062.2	16,693.3	***
Net production value (Rs/acre)	13,145.3	14,565.9	11,051.3	***
Land-related investment				
Invested in soil & water conservation (y/n)	0.28	0.39	0.12	***
… if yes, cost (Rs)	141.48	203.08	50.67	***
No. of family days invested in 2007	4.78	6.78	1.83	***
Access to private irrigation (y/n)	0.50	0.54	0.44	***
Access to public irrigation (y/n)	0.17	0.17	0.18	
Number of plots	9,285	5,532	3,753	

Source: Household questionnaire from the 2008/9 West Bengal survey.

* significant at 10%; ** significant at 5%; *** significant at 1% (based on simple t-test for the mean difference between own land and barga land). Private irrigation includes ponds, wells, and bore wells.

Table 4. Household-level Cross-sectional Estimates for Impact of Tenure Status on Revenue and Investment

	Gross revenue Rs/ac		Net revenue Rs/ac		Investment Rs/ac	
Pure Tenancy (α)	-0.182***		-0.172***		-0.011*	
	(7.83)		(6.98)		(1.86)	
Owner-cum-tenant (β)	-0.116***		-0.142***		0.005	
	(6.34)		(5.95)		(0.80)	
Share of barga land in total land		-0.202***		-0.198***		-0.008**
		(9.35)		(8.22)		(2.03)
Head's educ (years)	0.007***	0.007***	0.008***	0.008***	0.002***	0.002***
	(4.70)	(4.63)	(4.99)	(4.93)	(4.47)	(6.36)
ST/SC caste	-0.098***	-0.096***	-0.078***	-0.076***	-0.007*	-0.007***
	(4.65)	(4.53)	(3.29)	(3.22)	(1.70)	(2.71)
Head's age	0.000	0.000	0.001	0.001	0.001***	0.001***
	(1.10)	(1.01)	(1.32)	(1.25)	(3.34)	(5.01)
Total area cultivated (log)	0.709***	0.707***	0.610***	0.608***	0.026***	0.026***
	(47.71)	(48.07)	(37.33)	(37.58)	(8.49)	(19.67)
Household size (log)	0.095***	0.095***	0.077***	0.077***	-0.006	-0.005*
	(9.33)	(9.28)	(6.86)	(6.79)	(1.07)	(1.77)
Own livestock	0.131***	0.131***	-0.013	-0.014	0.021***	0.021***
	(11.40)	(11.26)	(0.56)	(0.61)	(4.02)	(8.42)
No. of households	41,031	41,031	41,031	41,031	34,046	34,046
R-squared	0.69	0.69	0.93	0.93	0.13	0.13

Note: Dependent variable is log of gross or net value of revenue as explained in the text. Robust t statistics in parentheses.
*, **, and *** denote significance at 10%, 5%, and 1%, respectively.
For the investment regression, livestock ownership is for 1978 and the share of irrigated land in 1978 and the year dummies for household formation are included but not reported.

Table 5. Impact of Land Tenure on Productivity (Fixed Effect Estimation)

	Gross revenue Rs/ac		Net revenue Rs/ac	
Barga land	-0.193***	-0.194***	-0.202***	-0.203***
	(7.42)	(7.36)	(7.08)	(7.05)
Plot size (acre)	0.007	0.009	0.090***	0.092***
	(0.44)	(0.60)	(4.42)	(4.50)
Distance to homestead (km)	-0.112***	-0.106***	-0.135***	-0.131***
	(4.48)	(4.34)	(4.65)	(4.64)
Soil/plot characteristics incl.	No	Yes	No	Yes
No. of households	1,772	1,772	1,761	1,761
No. of observations (plots)	9,053	9,010	8,818	8,777
R-squared	0.62	0.63	0.59	0.59

Notes: All regressions are household level fixed effects estimates. Standard errors corrected for village level clustering. Robust t statistics in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table 6. Estimates for Impact of Land Tenure on Input Use Intensity (Fixed Effect Tobit Model)

	Fertilizer (Rs./acre)	Pesticide (Rs./acre)	Seeds (Rs./acre)	Bullocks (Rs./acre)	Casual labor (Rs./acre)	Family labor (Days/acre)
Barga land	-609.208***	-136.611***	-311.888	-530.121***	-85.825**	-8.745***
	(7.62)	(5.39)	(1.57)	(3.85)	(2.11)	(4.76)
Plot size (acre)	-746.583***	-256.760***	-155.203	-281.390**	56.848	-58.176***
	(4.18)	(5.04)	(0.76)	(2.30)	(0.29)	(8.80)
Distance to	-0.112*	-0.029**	-0.053	-0.141	0.007	-0.005
homestead (km)	(1.80)	(2.53)	(1.34)	(1.53)	(0.30)	(1.26)
No. of households	1,777	1,777	1,777	1,777	1,777	1,777
No. of obs. (plots)	9,207	9,207	9,207	9,207	9,207	9,207

Notes: All regressions are household level fixed effect tobit estimates as explained in the text. Plot and soil characteristics are included throughout. Absolute values of *z*- statistics in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%.

Table 7. Within-household Fixed effect Estimates of Land Tenure Impact on Land Investment

	Land improvement				Access to Irrigation	
	Improvement past 8 years	Family labor used in 2008	Spending in past 8 years.	Days spent in 2008.	Private	Public
Barga land	-0.264***	-0.217***	-965.517***	-21.127***	-0.068***	-0.004
	(10.08)	(9.52)	(5.01)	(11.49)	(4.36)	(0.46)
lower bound	[-0.098]***	[-0.068]***				
Plot size (acre)	0.002	0.003	523.588	17.180***	0.003	0.001
	(0.48)	(0.72)	(0.96)	(3.68)	(1.53)	(0.99)
Distance to	-0.005	-0.004	-70.953	0.490	-0.068***	0.011*
homestead (km)	(0.48)	(0.52)	(0.83)	(0.45)	(5.30)	(1.73)
No. of households	1,777	1,777	1,777	1,777	1,777	1,777
No. of obs. (plots)	9166	9166	9166	9101	9166	9166
R-squared	0.16	0.14			0.05	0.01

Notes: All regressions include household level fixed effects. Col. 1, 2,5, 6 use a fixed effect linear probability model while col. 3 and 4 report results from fixed-effect tobit models. Plot and soil characteristics are included throughout. Robust t statistics in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%.
Figures in square brackets are lower bound estimates following Altonji, Elder and Taber (2005)

Table 8. Household Level Fixed Effect Estimates for Hypothetical Sales Prices at Plot Level

	Dependent variable: Log of sale price (Rs/Acre)			
Tenancy land dummy	-0.429***	-0.430***	-0.428***	-0.433***
	(16.94)	(16.97)	(16.45)	(15.05)
75/25 sharing rule				0.020
				(0.39)
Area (log)	0.031	0.035	0.035	0.036
	(0.59)	(0.63)	(0.63)	(0.64)
Log area squared	0.001	0.002	0.002	0.002
	(0.29)	(0.32)	(0.33)	(0.33)
Dist. to homestead in	-0.032***	-0.031***	-0.029***	-0.029***
km (log)	(3.87)	(3.66)	(3.61)	(3.60)
Irrigated land			0.017	0.017
			(0.81)	(0.79)
Soil quality measures	No	Yes	Yes	Yes
Number of households	1,774	1,774	1,774	1,774
No. of obs. (plots)	8,727	8,677	8,677	8,677
R-squared	0.29	0.29	0.29	0.29

Robust t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.
Standard errors adjusted for clustering at village level.

Table A1. Transition Matrices between Tenure Types, overall and for Households Formed before and after 1978

	In 1978	Pure Owner	Bargadar	Owner cum tenant	Pattadar	Landless	No of obs
In 2008			**Entire sample**				
	Pure Owner	72.99	8.33	19.34	7.12	11.69	33,261
	Bargadar	0.00	51.88	5.32	2.43	3.48	3,295
	Owner cum tenant	0.00	9.01	55.34	2.03	4.21	3,675
	Pattadar	5.01	5.64	3.79	64.88	8.77	8,695
	Landless	22.00	25.14	16.20	23.55	71.86	47,000
	No of obs.	36,075	2,498	2,161	3,257	51,935	95,926
In 2008			**Households established before 1978 only**				
	Pure Owner	86.32	8.08	15.23	2.67	14.07	6,603
	Bargadar	0.00	67.88	3.81	3.27	4.80	736
	Owner cum tenant	0.00	11.92	76.14	3.57	6.79	896
	Pattadar	5.94	4.85	3.30	85.74	11.79	1,878
	Landless	7.74	7.27	1.52	4.75	62.55	5,286
	No of obs.	6,281	495	394	673	7,556	15,399
In 2008			**Households established after 1978 only**				
	Pure Owner	70.18	8.39	20.26	8.28	11.28	26,657
	Bargadar	0.00	47.93	5.66	2.21	3.25	2,559
	Owner cum tenant	0.00	8.29	50.71	1.63	3.78	2,780
	Pattadar	4.81	5.84	3.90	59.44	8.25	6,817
	Landless	25.01	29.56	19.47	28.44	73.44	41,714
	No of obs.	29,794	2,003	1,767	2,584	44,379	80,527

Source: Own computation from 2008/9 West Bengal listing survey.

Table A2. Impact of Land Tenure on Productivity (Fixed Effect Estimation)

	Gross revenue		Net revenue	
		Subsample with 50/50 sharing rule		
Barga land	-0.168***	-0.162***	-0.173***	-0.170***
	(3.67)	(3.59)	(2.99)	(2.98)
Land size (acre)	-0.042	-0.039	0.038	0.045
	(1.40)	(1.48)	(0.80)	(0.97)
Distance to homestead (km)	-0.109***	-0.099***	-0.098***	-0.094***
	(3.80)	(3.62)	(2.80)	(2.87)
Observations (plots)	2521	2507	2441	2427
R-squared	0.65	0.66	0.60	0.61
		Subsample with 75/25 sharing rule		
Barga land	-0.173***	-0.178***	-0.173***	-0.178***
	(4.05)	(4.15)	(3.63)	(3.66)
Land size (acre)	-0.008	-0.009	0.065**	0.061*
	(0.29)	(0.34)	(2.10)	(1.91)
Distance to homestead (km)	-0.049	-0.039	-0.075*	-0.072*
	(1.51)	(1.41)	(1.71)	(1.87)
Soil/plot characteristics included	No	Yes	No	Yes
Observations	2284	2268	2216	2202
R-squared	0.63	0.65	0.58	0.59

Notes: Standard errors corrected for village level clustering. Robust t statistics in parentheses.
*, **, and *** denote significance at 10%, 5%, and 1%, respectively.

Table A3. Household Level Fixed Effect Estimates for Impact of Land Tenure on Input Use Intensity (Tobit Model)

	Fertilizer	Pesticide	Seeds	Bullocks	Casual labor	Family labor
			Subsample with 50/50 sharing rule			
Barga land	-782.389***	-120.547*	-1,149.474	-1,181.520*	-88.708	-4.078
	(3.54)	(1.80)	(0.49)	(1.68)	(1.15)	(1.13)
Land size (acre)	-1,496.249***	-685.589***	-632.715	-626.246	-41.385	-78.094***
	(3.25)	(3.22)	(0.45)	(1.59)	(0.27)	(6.59)
Distance to	-0.284**	-0.061**	-0.053	-0.320	-0.057	-0.021*
homestead (km)	(2.28)	(2.16)	(0.48)	(1.32)	(0.87)	(1.95)
No. of obs. (plots)	2565	2565	2565	2565	2565	2565
			Subsample with 75/25 sharing rule			
Barga land	-262.068***	-79.704**	-14.240	-124.090	-75.653	-5.675***
	(4.16)	(2.34)	(0.18)	(1.51)	(1.13)	(2.84)
Land size (acre)	-350.555***	-137.839***	-284.088	-368.831**	-22.751	-30.949***
	(3.31)	(2.94)	(1.59)	(2.12)	(1.30)	(2.89)
Distance to	0.010	0.003	-0.017	-0.013	0.049	0.000
homestead (km)	(0.47)	(0.38)	(1.30)	(0.53)	(1.19)	(0.22)
No. of obs. (plots)	2300	2300	2303	2300	2300	2300

Notes: All regressions are household level fixed effect tobit estimates as explained in the text. Absolute values of *z*- statistics in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%.

Table A4. Within-household Fixed Effect Estimates of Land Tenure Impact on Land Investment

	Land improvement				Access to Irrigation	
	Improvement past 8 years	Family labor used in 2008	Spending in past 8 years.	Days spent in 2008.	Private	Public
Subsample with 50/50 sharing rule						
Barga land	-0.212***	-0.174***	-1,711.630**	-19.883***	-0.056*	0.006
	(7.07)	(5.94)	(2.29)	(6.25)	(1.94)	(0.46)
Plot size (acre)	0.011	0.002	2,071.171**	8.429	-0.015	0.010
	(0.38)	(0.15)	(2.18)	(1.21)	(0.56)	(0.81)
Distance to	0.002	-0.004	12.630	-0.907	-0.061**	0.003
homestead (km)	(0.11)	(0.30)	(0.07)	(0.72)	(2.49)	(0.47)
Observations	2555	2555	2555	2542	2555	2555
No. of households	512	512			512	512
R-squared	0.12	0.11			0.05	0.02
Subsample with 75/25 sharing rule						
Barga land	-0.213***	-0.185***	-1,025.248***	-15.191***	-0.055**	-0.002
	(5.33)	(5.54)	(3.30)	(5.54)	(2.11)	(0.10)
Plot size (acre)	0.002	0.008	313.166	28.356***	0.002	0.000
	(0.55)	(0.98)	(0.24)	(5.53)	(0.78)	(0.07)
Distance to	0.014	0.001	191.388	0.134	-0.007	0.019
homestead (km)	(1.11)	(0.05)	(0.89)	(0.08)	(0.46)	(1.04)
Observations	2292	2292	2292	2283	2292	2292
No. of households	451	451			451	451
R-squared	0.16	0.15			0.03	0.02

Notes: All regressions include household level fixed effects. Col. 1, 2,5, 6 use a fixed effect linear probability model while col. 3 and 4 report results from fixed-effect tobit models. Plot and soil characteristics are included throughout. Robust t statistics in parentheses. *, **, and *** denote significance at 10%, 5%, and 1%.

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