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Abstract

This paper studies how land reform and population growth affect land inequality and landlessness, focusing particularly on indirect effects owing to their influence on household divisions and land market transactions. Theoretical predictions of a model of household division and land transactions are successfully tested using household panel data from West Bengal spanning 1967-2004. The tenancy reform lowered inequality through its effects on household divisions and land market transactions, but its effect was quantitatively dominated by inequality-raising effects of population growth. The land distribution program lowered landlessness but this was partly offset by targeting failures and induced increases in immigration.

JEL Classification Nos: J12, O13, O13
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1 Introduction

Land is the pre-eminent asset in rural sectors of developing countries, the primary determinant of livelihoods of the poor. Accordingly, the role of land reform on productivity, inequality, poverty, local governance and social capital in rural areas of LDCs is an important topic of academic research with significant policy relevance (e.g. Berry and Cline, 1979; Binswanger et al., 1993; Besley and Burgess, 2000; Banerjee et al., 2001; Banerjee et al., 2002; Bardhan, 2004; Besley and Ghatak, 2010; DFID, 2004; The World Bank, 2008).

The bulk of the academic literature has focused primarily on the effects of land reform on agricultural productivity. A variety of channels by which productivity might be affected have been studied: relation between farm size and productivity, sharecropping tenancy distortions, access to credit, investment incentives and labor supply resulting from security of property rights. Effects on inequality and poverty have not received comparable attention. The effectiveness of land reforms in changing the distribution of landownership has not been studied seriously. An exception is Assunção [2008] who studies the effects of the Brazilian land reform between 1992-2003 on the household land distribution, and finds it *raised* land inequality among landowning households, without having any significant effect on landlessness (after controlling for household and location characteristics). The reasons for this are not well understood.[1]

There are a number of possible reasons why land redistribution programs may be ineffective in lowering land inequality and landlessness. Apart from imposing political and legal obstacles to implementation of such programs, large landowners frequently attempt to circumvent them by selling land, splitting their households and subdividing properties so as to avoid being targeted for expropriation. On the other hand, small landowning households might be induced to sub-divide so that some resulting fragments own no land and thereby qualify to receive some of the land being distributed by the program. Landless households receiving land titles may subsequently sell them in times of distress. Areas embarking on larger redistributions could attract more landless immigrants, swelling the number of landless households. These induced effects on land market transactions, household division and immigration patterns can indirectly affect the distribution of land in complex ways that could either augment or offset the direct impacts.

Tenancy regulations which are intended to increase empowerment of tenants (by increasing their post-rent shares and/or security of tenure) do not directly affect the distribution of land ownership. But they may have important indirect effects. Those owning and leasing out large amounts of land may see a decline in their returns from leasing, and may subsequently be induced to sell much of their land. Additional effects on household division or sale

[1] De Janvry et al. [1998] provide a general overview of various factors which undermined effectiveness of land reform programs in various Latin American countries. These include lack of skills, infrastructural and marketing support of land reform beneficiaries which led to low profitability and subsequent market sales to larger landowners. Other factors included limited individualization of land rights, and state-led land reform programs with limited devolution to local communities.

incentives would arise if the reforms affect the relative profitability of landholdings of various sizes, owing to induced effects on productivity or local wage rates. For instance, productivity changes could arise owing to greater reliance on family labor in smaller owner-cultivated farms (Eswaran and Kotwal, 1986), changes in sharecropping distortions (Banerjee et al., 2002), access to credit for land reform beneficiaries (de Soto, 2000) or effects on irrigation investments (Bardhan et al., 2012). Wage rates could be altered as a result of changes in demand for hired labor from large landowners, the supply of wage labor by reform beneficiaries (Besley and Burgess, 2000) or increased flow of immigrants hoping to benefit from future reform implementations. These indirect general equilibrium effects could supplement or offset the direct partial equilibrium effects.

The task of evaluating implementation difficulties and obtaining evidence of these indirect effects is complicated by the fact that the process of development simultaneously involves significant demographic and sociological changes that affect household structure, and thereby the land distribution. Traditional family structures in LDCs involving cohabitation and joint ownership of productive land by multiple nuclear units tend to give way to nuclear households as a result of a desire for increasing economic independence and rising intra-household conflicts (Guirkinger and Platteau, 2011, 2012). This may be a response to increases in household size resulting from falling mortality rates. Economic growth and increased financial development reduce the need for members to stay in the same household in order to share risk or avail of household collective goods (Foster and Rosenzweig, 2002). Household divisions can significantly affect the distribution of land measured at the household level in a variety of possible ways. Land inequality would tend to fall (resp. rise) if large landowning households divide at faster (resp. lower) rates compared with small landowning households. Isolating the indirect effect of land reforms on land distributions and quantifying their importance *vis-a-vis* demographic factors in affecting household divisions and land market transactions is therefore an important and challenging research task.

This paper focuses on the experience of the eastern Indian state of West Bengal during the last three decades of the 20th century. West Bengal witnessed large changes in land distribution, high rates of household division and a large land reform program during the 1970s and 1980s compared to other Indian states. Approximately 20% of the rural population directly benefited from this program, which covered 11% of agricultural land. The size of this program was comparable to the land reform carried out in Brazil over the period 1992-2003 (Assunção, 2008; Lambais, 2008).[2]

There were two principal land reform programs implemented in West Bengal: distri-

[2]15% of rural households in West Bengal had received land titles by the late 1990s, and the distributed land area constituted 6% of agricultural area. Another 6% households and agricultural area was covered by the tenancy registration program (Bardhan and Mookherjee, 2011). In a state with a rural population of 12 million households and 8.6 million hectares of agricultural land, this amounted to a program which directly benefited about two and a half million rural households and affected one million hectares of agricultural land. In Brazil less than 1% of farm land had been distributed by 1992. Between 1992-2003, the Brazilian land reforms distributed approximately 10 million hectares of agricultural land (accounting for 5% of agricultural land) to 1 million households (approximately 12% of the rural population).

bution of land titles to the landless, and registration and regulation of tenancy contracts. Earlier research on the West Bengal land reforms have shown evidence of 4% increases in farm productivity for the tenancy registration program (Bardhan and Mookherjee, 2011), and a 20% rise in aggregate rice yields at the district level (Banerjee et al., 2002). On the other hand, Bardhan and Mookherjee [2011] find no significant effects of the land distribution program on farm productivity, or on wage rates for hired workers for either program.

The main purpose of this paper is to assess the role of the two land reform programs in changing the land distribution, separating out their respective direct and indirect effects operating through induced impacts on household division, land market transactions and migration. We also seek to assess the significance of these effects relative to the direct effects of growth of population for natural reasons (i.e., difference between birth and death rates). We use a household and village panel in a sample of 89 villages from the state, spanning the period from the late 1960s until 2004.

During this period, West Bengal witnessed a marked rise in land inequality, owing principally to increased landlessness. Households divided at a rapid rate, resulting in a sharp decline in land per household. A decomposition exercise helps to measure the direct effects of land reforms, household division and land market transactions. It shows high rates of household divisions as the principal driver of increased land inequality.

Household divisions may of course be affected by land reforms. This may represent an important indirect effect of the land reforms which need to be assessed to evaluate their overall impact. Land market transactions may also be influenced by land reforms. One therefore needs to treat household division rates and land market transactions as (potentially) endogenously affected by the land reforms and demographic changes respectively.

Before proceeding to this analysis, we perform a simple reduced form village panel regression to assess the total (sum of direct and indirect) effects of land reform and natural growth of population between 1978 and 1998. The land distribution program significantly reduced landlessness, but by an extent less than the direct impact. Both programs reduced inequality, and the tenancy registration program reduced landlessness, but these effects are less precisely estimated and less robust with respect to the dataset used. In contrast, natural increases in population raised inequality significantly, by an extent that dominated the effects of the land reforms, thereby explaining the overall increase in inequality.

The fact that the net impact of the land distribution program was much smaller than the direct impact, and that the tenancy reform affected landlessness, suggest the presence of important indirect effects of the land reform. The rest of the paper seeks to understand the channels through which these effects may have operated. We treat household divisions and land market transactions as endogenously determined by underlying changes in household demographics and changes in farm profitability induced by the land reforms. To this end, we develop a theoretical model of intra-household joint production among adult members. The model emphasizes free-riding among members when land is jointly owned and cultivated, which becomes more significant when household size is large relative to joint land holdings. Growth in household size relative to land owned gives rise to incentives to subdivide the household, or for some members to out-migrate. Alternatively, it generates incentives for the household to buy land.

The model characterizes stable distributions of household sizes and landownership, given the prevailing wage rate for hired workers, productivity of farms and transaction costs associated with land sales. The model is used to derive comparative static effects on household division and land transactions of exogenous shocks to household size (owing to demographic changes) and farm productivity (owing to the land reform), which generate empirically testable predictions.[3]

With regard to the tenancy registration program, the model predicts (given the observed productivity effects) lower rates of household division and out-migration uniformly across disparate land-size classes. Incorporating additional effects on anticipated future reforms by large landowners, and reduced profitability of leasing out land, it predicts division rates would drop by less for large landowning households. There would also be increased incentives for large landowners to sell land to small landowners. Owing to these reasons, the indirect effects of the tenancy registration program operating through their influence on household divisions and land market transactions should cause land inequality and landlessness to fall. Their net indirect effect would be expected to be negative.[4]

In contrast, the model makes different predictions regarding the net effects of the land distribution program. One reason is the absence of any significant observed effects of this program on farm productivity (owing to poor quality and small size of plots distributed) in the West Bengal context. Hence a key factor generating inequality reducing effects of the tenancy reform through their effect on household division and market transactions were missing in the case of the West Bengal land distribution program. Moreover, the land distribution program could cause land inequality to rise for a number of reasons that do not apply for the tenancy registration program. Since the plots were distributed to those owning no or little land, it would generate incentives among landowning households to sub-divide so that some of them would be entitled to enter the beneficiary queue. Such motives are more likely amongst small landowning households, thereby generating increased landlessness. Moreover, land distribution to the landless in any given village could induce land-poor households in other areas to immigrate, thereby swelling the ranks of the landless. A countervailing effect would arise, however, if large landowning households become motivated to sub-divide or sell land as stepped-up implementation of the program could signal greater redistributive resolve of the government in future.

Concerning the effects of demographic changes, the model predicts that growth in house-

[3]A simplifying assumption made by the model is that the wage rate is given, owing possibly to an aggregate surplus of labor relative to land available. This assumption is not implausible in the West Bengal context which has a high population density and a high proportion of landless households (one third in the late 1960s rising to a half of the overall population by 2000) for whom supplying labor is the main source of livelihood. Moreover, Bardhan and Mookherjee [2011] find that land reforms had no significant impacts on wage rates.

[4]This presumes that the tenancy reform did not affect immigration rates. We subsequently verify this was the case.

hold size would raise the likelihood of household division, controlling for landownership. This would cause land inequality to rise if smaller landowning families were subject to greater demographic growth. The effect through the land market would move inequality in the opposite direction, as households growing faster in size would be more likely to buy land.

We test these predictions on data concerning changes in landholding and household demographics for the West Bengal household panel. To identify the effect of land reforms on land inequality, one needs to observe variation in the amount of reform that is plausibly uncorrelated with other determinants of household division and land transactions. Our main specification exploits differences in the timing and extent of reforms across villages. A difference-in-differences design can then filter out common underlying trends and examine how these variations were associated with changes in division and land market transactions across households located in different villages.

The assumption underlying this identification strategy is that variations in timing and extent of land reform were uncorrelated with other time-varying village-specific factors that may influence household division and land transactions. Banerjee et al. [2002] use this difference-in-differences approach to examine the effect of the tenancy reforms on farm productivity, and argue that the variations in implementation rates of the tenancy registration program arose primarily owing to idiosyncratic administrative compulsions of the state government. Moreover, Bardhan and Mookherjee [2010] show that a determinant of reform was the extent of political competition among the two rival parties at higher (district, state and national) levels, interacted with lagged incumbency at the village level. This reflects greater incentives for elected officials to implement land reforms owing to re-election pressures in more contested elections. This allows us to examine robustness of the OLS double-difference estimates when we use political competition at higher levels as an instrument for tenancy reform, interacted with lagged local incumbency patterns.[5]

Using this approach, we estimate the effects of the two land reform programs on household division and land market transactions. Controlling for household fixed effects, lagged household size and lagged land owned, we find higher implementation rates of the tenancy reform in the past three years in the village significantly reduced rates of division of small landowning households, and raised division rates among large landowning households. It raised the likelihood of land purchases by small landowning households. These findings are robust with respect to estimation methods and dataset used. Consistent with the theoretical predictions, we therefore find that tenancy reforms lowered land inequality owing to their effects on household divisions and land transactions.

On the other hand, the OLS double-difference estimates of the land distribution program fail to yield estimates of their effect on household divisions and market transactions that are comparably precise and robust. The (imprecisely estimated) point estimate of their effect on rates of household division of small landowning households was positive and quantitatively

[5] Bardhan and Mookherjee [2011] use a similar approach to study the productivity effects of tenancy reform.

large, pointing to one reason why they may have indirectly raised inequality. However, we do find stronger evidence of one channel by which the land distribution program would have raised landlessness: it led to higher rates of immigration.

Finally, the results help explain why land inequality rose overall during this period: the negative effects of the tenancy reform were quantitatively overshadowed by the effects of population growth. The effect of expanding household size by 1.3 members (the average effect of population growth observed during this period) on rates of household division turned out to range between four and twenty five times the effect of either land reform program, depending on the specification.

The paper is structured as follows. Section 2 explains the West Bengal land reforms and the household surveys used to construct the data. Section 3 provides descriptive statistics of land distribution during this period, including the decomposition of changes in inequality and the reduced form estimates. Section 4 presents the theoretical model of household division and land market transactions, followed by the corresponding empirical estimates in Section 5. Section 6 describes relation to existing literature, while Section 7 concludes.

2 West Bengal Context and Survey Data

2.1 Land Reform Programs

There were two principal land reform programs in West Bengal since the 1960s. The first represented appropriation of lands (a process known as *vesting*) above the legislated ceilings from large landowners, and subsequent distribution of this land to the landless in the form of titles to small land plots (called *pattas*). For the state as a whole, P.S. Appu (1996, Appendix IV.3) estimates the extent of land distributed until 1992 at 6.72% of its operated area, against a national average for the rest of India of 1.34%. In our sample villages, approximately 15% of all households in 1998 had received land titles (Bardhan and Mookherjee, 2010). However, many of the distributed land titles pertained to very small plots: in our sample, the average plots distributed were approximately half an acre in size. According to most accounts, these plots were of low quality. Recipients were unable to use them as collateral for obtaining loans from banks.

The other land reform program was Operation Barga, involving registration and regulation of tenancy contracts. In order to plug loopholes on prior legislation, a new Land Reform Act was passed in the West Bengal state legislature in 1971. This was subsequently amended in 1977 by the incoming Left Front government to lend further legislative teeth to the program. The 1977 Amendment made sharecropping hereditary, rendered eviction by landlords a punishable offense, and shifted the onus of proof concerning identity of the actual tiller on the landlord. The state government subsequently undertook a massive drive to identify and register tenants with the aid of local governments and farmer unions. Registration was accompanied by a floor on the share accruing to tenants, amounting to 75% (replaced by 50% if the landlord paid for all non-labor inputs). Over a million tenants were registered by 1981, up from 242,000 in 1978 (Lieten (1992, Table 5.1)), increasing to almost one and a half million by 1990. Estimates of the proportion of tenants registered by the mid-90s vary between 80% (Lieten (1992, p. 161)) and 65% (Banerjee et al., 2002). In the villages in our sample approximately 48% tenants had been registered; these amounted to about 6% of all households by the late 1990s (Bardhan and Mookherjee, 2010). The average size of plot registered averaged 1.5 acres, and registered tenants could use the registration document as collateral for a loan from a state financial institution. As with the land title distribution program, most of the implementation of Operation Barga was carried out between the late 1970s and late 1980s.

Banerjee et al. [2002] found a significant positive effect of the tenancy registration rate on district rice yields in a double difference OLS regression after controlling for district and year dummies, crop patterns, infrastructure provided by the state government. Their estimates imply that the program raised aggregate rice yields at the district level by 20%. Using a farm cost of cultivation survey for a sample of 89 villages, Bardhan and Mookherjee [2011] also found a significant but smaller positive effect of the cultivation area within a village registered under the program on farm value added per acre, after controlling for farm and year dummies and a range of controls for other farm support programs implemented by local and state governments.[6] No significant effects of the reform on wage rates or employment for hired labor were found, except in farms leasing in land (which constituted less than 5% of all farms by the mid-1980s). The productivity increases accrued to farms of all sizes, except the smallest, with substantial spillover effects on owner cultivated farms. This spillover was explained in Bardhan et al. [2012] by effects of the reform in reducing the cost of groundwater owing to induced investments in minor and medium irrigation. There were no significant effects of the land title program on farm productivity, nor on wage rates.

2.2 Household Survey Details

The survey on which this paper is based covers the same set of 89 villages in West Bengal studied in Bardhan and Mookherjee [2010, 2011] and Bardhan et al. [2012]. This is a sub-sample of an original stratified random sample of villages selected from all major agricultural districts of the state (only Kolkata and Darjeeling are excluded) by the Socio-Economic Evaluation Branch (SEEB) of the Department of Agriculture, Government of West Bengal, for the purpose of calculating cost of cultivation of major crops in the state between 1981 and 1996.[7] Our survey teams visited these villages between 2003 and 2005, carried out a listing of landholdings of every household, then selected a stratified random sample (stratifying by landownership) of approximately 25 households per village (with the precise number

[6]They estimate the program raised farm productivity by 4%. The magnitude and significance of this effect was however diminished in a parallel IV regression where potential endogeneity of the tenancy reform implementation was additionally controlled for.

[7]The village selection procedure used by SEEB was the following: a random sample of blocks was selected in each district. Within each block one village was selected randomly, followed by random selection of another village within a 8 Km radius.

varying with the number of households in each village). 2 additional households were selected randomly from middle and large landowning categories respectively, owning 5-10 acres and more than 10 acres of cultivable land, in order to ensure positive representation of these groups. The stratification of the sample of households was based on a prior census of all households in each village, in which demographic and landownership details were collected from a door-to-door survey.

Representatives (typically the head) of selected households were subsequently administered a survey questionnaire consisting of their demographic and land history since 1967.[8] Response rates were high: only 15 households out of 2400 of those originally selected did not agree to participate, and were replaced by randomly selected substitutes.

We combine the household-level data with data on the extent of land reform carried by the land reform authorities in each of these villages since 1971 (available until the year 1998). Additional village-level information is available from previous surveys concerning various agricultural development programs implemented by local governments, productivity in the farm panel drawn from these villages for specific subperiods. Data concerning total number of households in each village, household size, land areas owned and cultivated by each household in 1978 and 1998 is available from an 'indirect' survey in which village elders compiled household land distributions for each of these two years, based on an enumeration of voters for each village for those years.

The household survey data includes each household's land holding at the time of being surveyed (2004) and as of 1967. Respondents were subsequently asked to list all land transactions the household participated in between these two dates, for each of the following categories: acquisitions (purchases, *patta* (land titles received), gifts and others), disposals (sales, transfers, appropriation by land reform authorities, and natural disaster), and household division (involving both exits of individual members and household splits). We focus on agricultural land, both irrigated and unirrigated (in order to determine the relevant ceiling imposed by the land reform laws, which incorporate irrigation status and household size). Corresponding changes in household demographics on account of births, deaths, and marriages were also recorded.

An effort was made in the questionnaire design to distinguish between exit of individual members and household splitting (where a household sub-unit consisting of at least two members left the original household). But the questionnaire responses indicate that the interviewers and respondents tended to lump the two together. In order to avoid double-counting, we merged the observations that were both in the individual exit and household splitting datasets. We classified the cause of individual exit and household division into four categories: death of the member of the household, exit of the spouse of the head due to death of the head of the household, out-marriage, and exit/division due to other reasons (such as change in household size, change in income/expenditure, disputes, registration of

[8]Other questions in the survey included economic status and activities, benefits received from various development programs administered by local governments (gram panchayats (GPs)), involvement in activities pertaining to GPs, politics and local community organizations.

tenants and threat of land reforms). Table 5 in the online appendix shows that the latter category is by far the most relevant, both in terms of frequency of occurrence and amount of land involved.

Our primary unit of analysis is agricultural land owned by a household for a number of reasons. The focus on land is natural given its pre-eminent role in determining incomes, consumption and occupational patterns, and the fact that its measurement is prone to less error than income or consumption. Table 1 provides evidence of the correlation between land ownership and income, consumption and occupation patterns. In panel A, which shows sources of income by land category, we can observe that total income is highly correlated with land ownership, due to the relevance of farm income in total income. Wage earnings constitute the main source of income for landless households. Panel B shows patterns of consumption, where we observe a similar pattern as in panel A: landed households have more access to durable goods. Finally, in panel C we see that similar to panel A, the main occupation of adults in landless households is non-agricultural work. The proportion of household heads reporting cultivation on owned land as their primary occupation rose from 12% among marginal landowners to between 23-26% for those owning more land.

Choosing the household as the unit of observation is conventional in studies of land inequality, in India and elsewhere, since land is typically cultivated jointly with sharing of resulting incomes by household members. Table 2 shows evidence of joint production. Specifically, it shows that among households with at least one male adult engaged in self-cultivation, the proportion of those with at least one pair of adult male siblings engaged in self-cultivation rose from 6% among marginal landowners to 16% among small landowners, 32% among medium landowners, and over 40% among large and big landowners.[9]

Problems of attrition are low at the level of households, owing to low rates of migration of entire households which co-exist with substantial migration of individuals. In a follow-up survey conducted in 2011 with the same set of households in the 2004 survey, only 15 households out of the original sample of 2,402 households could not be traced owing to all its members having moved out. Over a seven year period this amounts to an attrition of 0.62%. Extrapolating this to the 35 year period covered by the survey, the attrition is estimated at 3.12%.[10] And even if all members of a household were to move out, they could not carry

[9]In this table, 'self-cultivation' is defined to take place if it is reported as either the primary or secondary occupation of the respondent.

[10]This backward extrapolation is likely to over-estimate the attrition rate, since the migration of entire households increased during the 2000s in West Bengal: the Rural Economic and Demographic Survey (REDS) displays a 1.24% yearly attrition for the 1982–1999 period, compared to a 1.38% for the 1999–2006 period (we thank Mark Rosenzweig for providing us these numbers). In addition, overall migration rates also increased in India during the same period: The NSS 38^{th} round for 1983 reports migration rates per 1,000 inhabitants of 209 and 316 for rural and urban, respectively; while the NSS 64^{th} round for 2007–2008 reports corresponding rates of 261 and 354 (National Sample Survey Office, 2010, statement 4.3). Our extrapolated attrition rate compares favorably with 4.7% attrition in the Indonesian Family Life Survey for a seven year period (1993–2000), and an 8.2% attrition in the National Longitudinal Survey of Youth in the US for 1979–1986.

their land with them: they would have to sell or gift it to others remaining in the village. Hence land transactions would not be under-measured owing to attrition.

2.3 Data Recall Problems

The land history constructed for each household over the period 1967-2004 on the basis of a one-time survey in 2004 is potentially prone to serious recall problems, as recalling the details of past changes in landholdings over the past three decades can be a challenging task. Investigators were specially trained to conduct interviews in a manner that would help respondents remember and relate the land histories of their household in a consistent manner. In order to gauge the significance of recall problems, we checked the consistency of reported landholdings in 1967 and 2004 with reports of land changes in the intervening period. Starting with the 2004 land holdings, we added in all transactions for any given year to compute the total land holding in the previous year. Repeating this iteratively, we calculated landholdings for every previous year until 1967.[11] We compare the estimated landholding in 1967 with that actually reported for that year. For households immigrating into the village since 1967, we carry out the match for the initial year that the household arrived in the village.

An additional difficulty arose with the individual exit data: no distinction was made in the questionnaire between agricultural and non-agricultural land lost thereby (i.e., associated with the exit). This complicated our calculation of agricultural landholdings. To deal with this problem we considered three different alternatives. The first assumes that all land reported in individual exits involved non-agricultural land, and is thereafter dropped. The second assumes the opposite, i.e. that all land reported in individual exits corresponds to (unirrigated) agricultural land. Finally, the third alternative assumes that whenever there is "missing" agricultural land (by the iterative procedure described above), it is accounted by land lost because of individual exits.

When all land lost owing to individual exits is assumed to be non-agricultural (alternative 1), around 88% of the households matched their reported landholdings in 1967, up to a 0.2 acre margin of error. This figure increased to 91% when allowing for a 0.5 acre margin of error. The fact that we were able to reconstruct the land history for many households implies that imperfect recall problems were negligible. The match rate fell to 82 and 86% respectively when we assume that land lost from individual exits was entirely agricultural land (alternative 2). Therefore it seems that land lost from individual exits corresponds to other uses of land, such as homestead, ponds or orchards. Finally we consider the implications of assuming that the gap between the reconstructed agricultural land holdings and the self reported in 1967, if any, had to come from agricultural land reported in the individual exit data (alternative 3). For this case 89% of the households matched their reported

[11] For example, consider a household with 2 acres in 2004 that lost 1 acre due to household division in 1995 and bought 3 acres in 1970. Then, we would list the household as owning 2 acres each year from 1995-2004, 3 acres from 1970-1995, and 0 acres from 1967 until 1970.

landholdings in 1967, up to a 0.2 acre margin of error. This 1% improvement in comparison with the first alternative corresponds to only 26 households. Hence we do not believe our lack of knowledge of type of land lost in exits is of any significance. In the rest of the paper, we use the data implied by the third alternative in order to construct the agricultural land time series for each household.

Finally, since there was no distinction between irrigated and unirrigated land in the individual exit dataset, we assumed that all land coming from this dataset was unirrigated. Whenever possible, we apportioned unirrigated to irrigated land to match initial and final holdings of irrigated and unirrigated land. There were a few household-year observations in which households still had negative land holdings, which were set equal to zero.

A similar check for household size and composition indicated consistent reports for 82% of all households. And when we seek consistent reports of both demographics and land histories, we end up with 73% of the sample.

We thereafter proceed on the basis of two samples. One is the restricted sample formed by those households with consistent reports regarding both land and household size. The other is the full sample. The differences between these two samples are presented in Table 3, where we ignore discrepancies of less than 0.2 acres. It shows the restricted sample contains a larger fraction of immigrants and a smaller fraction of medium, large and big landowners. This is consistent with the expectation that recall problems are less likely for immigrants or those owning less land. All subsequent results in the paper are shown for both samples, to gauge the sensitivity of results to possible recall problems.

3 Evolution of Land Inequality in West Bengal (1967-2004)

In this section we exploit our dataset to analyze the trends in demographics and land inequality in West Bengal during our period of study. Panel A of table 4 shows household size fell from 5.9 in 1968 to 5.1 in 2004. At the same time, population grew due to natural causes (i.e, excess of births over deaths) by 50% between 1968 and 1998.[12] The discrepancy between these owes to divisions of households, which we describe further below.

Panel B of table 4 shows land inequality measures for select years between 1967 and 2004. For the restricted sample within-village inequality (averaged across villages) rose by 17% for the Gini and 29% for the coefficient of variation.[13] Panel C of Table 4 shows changes in the proportion of households in different size classes. Landlessness rose from 38% to 57%. The rising landlessness was principally responsible for the rise in land inequality: inequality among the set of landowning households in 2004 did not change much.[14] The proportion

[12]The natural growth of population is estimated using reported births and deaths by households in our sample. For undivided households this is straightforward. For households experiencing divisions, we calculate the natural growth rate between divisions for the fragment in our sample, and extrapolate these growth rates to fragments not in our sample.

[13]The full sample shows a milder increase for both the Gini and the coefficient of variation.

[14]Details of the latter result are not presented here, to conserve space.

of households that were either landless or marginal (owning less than 1 acre) rose from 60% to 81% among the entire population.[15] This was accounted for by a drop mainly of small landowners (owning between 1 and 2.5 acres) and big landowners (owning more than 5 acres).

In the online appendix we provide descriptive statistics for the evolution of land ownership, as well as for other covariates of interest such as household size and migration. Average landownership per household declined 58% between 1967 and 2004, and this decline is not explained away by looking only at natives (i.e. excluding households who immigrated during this period), or because agricultural land was converted to non-agricultural purposes. Households divisions were the main driving force of this decline – they accounted for over 80% of the loss of land per household. The second channel was land transactions (sales and purchases), followed by gifts/transfers and land lost or gained due to land reform.

Figure 1 shows the density of the distribution of land for those households owning between 0 and 3 acres of land (landless households were excluded) for both the full and restricted sample, for three different years (1970, 1985 and 2000). There are two striking results here. First the density at each of these dates peaks at 0.5 acres, with a sharp drop below this level. It suggests a minimum viable landholding size around half an acre. Second, changes in the distribution involve a lowering of the density between one and three acres, and a rise in the density at the half acre peak. Combined with the rising incidence of landlessness, it reveals an increasing tendency for the bottom tail of the land distribution to have two peaks, one at the half acre mark, and the other at zero. It suggests a process whereby land owned by most landed households drifted downwards (following division of the household over time), until it hit the half acre threshold, whereupon the household struggled to preserve its landholding or joined the ranks of the landless.

Table 5 shows that household splits and other exits accounted for the vast majority of changes in household size, dominating births, deaths and marriage. Since the splits and exits for 'other' reasons predominate to such a large degree, we define household division to be any event resulting in a reduction in number of household members. The impact of household divisions on land inequality is not *a priori* obvious. Division of big landowning households would tend to reduce inequality, while division of small landowners would raise landlessness and inequality. Hence the effects of household division on the land distribution depend on the size classes in which they are particularly pronounced. To examine this issue, Table 6 shows division rates and land lost owing to division in the restricted sample, for different size classes over the entire period. Big landowners divided at a slightly higher rate than other households. Big and small landowners lost land at roughly the same rate owing to division, and at a slightly higher rate than marginal, medium or large landowners. The net effect on inequality is thus unclear from this.

Next, we decompose the changes in inequality across the three principal channels (household division, land market transactions, and land reform) using the following accounting

[15] This proportion also increases among natives (i.e. excluding immigrants) to 75% of the households.

exercise. For each of these channels, we calculate the amount of land the household would have owned in any given year had the landholding change associated with the corresponding channel not occurred, and all other changes in landholding would have occurred as observed. We then calculate the average within-village inequality that would have resulted, and subtract this from the observed inequality to estimate the contribution of this channel. Figure 2 shows the results for both full and restricted samples, which indicate clearly that the dominant source of rising inequality was household division, particularly after the mid-1980s. Land market transactions contributed to a slight increase in inequality in the restricted sample, while reducing it in the full sample, particularly for the coefficient of variation.[16] The role of land reforms is comparable to the one of land market transactions: a slight increase in the Gini coefficient and decrease in the coefficient of variation for the full sample, while increasing the Gini coefficient and leaving the coefficient of variation unchanged for the restricted sample. Hence, land reforms exercised a substantially weaker direct effect on both the Gini coefficient and the coefficient of variation compared to the direct effect of household divisions.

Why the land reforms may have directly raised inequality is the following. While the majority of those receiving land titles were landless, there were many that owned land previously. The median, 75th and 90th percentile of land previously owned among those receiving land titles (at the time of receiving the land titles) were 0.5, 3.36 and 5.67 acres respectively. This indicates there were targeting failures in the implementation of the land distribution program, which could partly account for their ineffectiveness in lowering inequality.

It is conceivable, moreover, that the land reforms exerted an important indirect effect on inequality by affecting household divisions and land market transactions. A total assessment of their impact should incorporate these indirect effects. While subsequent sections will treat divisions and land transactions as endogenous, we now present a reduced form estimate of the total impact of the land reform. Table 7 presents cross-village regressions predicting 1998 inequality (measured by the coefficient of variation) by the land reforms implemented since 1968, controlling for the level of inequality in 1968 and the change in the ratio of natural population in the village to cultivable land.[17] The underlying assumption is that birth and death rates were exogenous with respect to inequality and land reforms.[18] Our control is a measure of natural growth of population in the village (relative to cultivable land area) rather than of the actual population, as the latter includes possibly endogenous effects on migration or household division.

Table 7 shows that the land title program (measured either by the proportion of land area distributed, or proportion of households receiving land titles between 1968-98) registers

[16] The results do not change if we include land disposed or acquired as gift in the land market transaction channel.

[17] We obtain similar results if we use the Gini coefficient as a dependent variable.

[18] Results with respect to the effect of the land reforms are similar if we drop the ratio of natural growth of population to land as a regressor. Hence concerns with possible endogeneity of population growth do not affect the reduced form estimate of effects of the land reforms.

a negative coefficient, which is statistically significant in the full sample though not in the restricted sample. The measures of tenancy reform also have a negative coefficient but are statistically insignificant. On the other hand, the growth of natural population has a positive and significant direct effect in all specifications, highlighting the important role of this determinant of land inequality.

Based on the results in column 1, one standard deviation increase in the index of natural population increases the coefficient of variation by 0.24, while a one standard deviation increase in percent land distributed decreases the coefficient of variation by 0.06. From the results in column 2, one standard deviation increase in the index of natural population increases the coefficient of variation by 0.22, while a one standard deviation increase in percent land distributed (resp. registered) decreases the coefficient of variation by 0.11 (resp. 0.04). Hence the effects of population growth overshadowed the effects of the land reforms, resulting in an overall increase in inequality.

Since changes in inequality are closely related to changes in landlessness, we focus next on a comparable reduced form estimates of effects of land reform and demographic factors on this variable. Table 8 presents the results of a regression of landlessness in 1998 on the same measures of land reforms and natural population growth used in the previous Table, controlling for landlessness in 1978. The dependent variable, as well as the regressors in columns 1 and 3, are expressed as a proportion of the number of 1978 households, to avoid the problem arising from possible endogeneity of the number of households with respect to the land reforms.

The regression shows that the land distribution program had a significant negative effect on landlessness, when the former is measured by proportion of households registered (columns 2 and 4). The estimated regression coefficient is -0.125 in the full sample and -0.142 in the restricted sample; both are significant at 1%. Hence titles distributed to 37% of the 1978 population (i.e., a 1 standard deviation increase) resulted in a decline in landlessness by approximately 5% in 1998. The fact that the ultimate impact is about one seventh the size of the original direct impact indicates the importance of offsetting indirect effects operating through induced effects on division or migration patterns, besides targeting failures of the program.[19]

The effect of the tenancy reform on landlessness was negative and statistically significant when measured by the proportion of land registered, but insignificant when measured by the proportion of households registered. Population growth tended to increase landlessness, but this effect was statistically significant only in the restricted sample. A one standard deviation increase in our measure of population to land increased landlessness by 3%. In the case of landlessness, therefore, the land reforms appear to have had a larger overall impact than population growth.

In summary, these reduced form estimates show that the overall effects of the land

[19] Recall that over half the title recipients already owned at least half an acre at the time of receiving the land title, and a quarter of them owned more than three acres.

reforms on land inequality and landlessness were negative. In the case of land inequality, the effects of land reform were overshadowed by the effects of population growth, whereas the opposite was true for landlessness. The observed increase in landlessness cannot therefore be explained by the combination of land reforms and population growth alone: inflows of new immigrants likely played a role also (with 28% of households having immigrated since 1967, roughly the order of magnitude of the observed increase in landlessness).

4 Theory

In this section we develop a theory of household division and land market transactions, focusing on problems of free-riding within the household as different members work together on their jointly owned family farm. We abstract from potential conflicts of interest arising with regard to collective consumption goods. Our focus is also on purely economic incentives for division and market transactions. In subsequent sections we shall explain the impacts of anticipated redistributive policies of local governments.

A household is represented by a vector (n, L), where n denotes the number of adults and L the amount of land owned jointly by these adults. Household members work together as a team on their collective farm. They have identical abilities and preferences. Individual effort cannot be monitored, resulting in a classic moral-hazard-in-teams problem. Collective income is shared equally among household members. If the household engages in cultivation, their collective income from the family farm is given by

$$Y = aL^{1-\alpha}(\sum_{i=1}^{n} l_i + h)^{\alpha} - w(1+s)h - F \tag{1}$$

where $\alpha \in (0, 1)$ and a is a parameter representing crop price and agricultural productivity. l_i denotes the labor effort of member i of the household, while h is the extent of labor hired from the labor market at a wage rate of w. As in Eswaran and Kotwal [1986], hired workers have to be supervised, which raises the cost of hired workers by a fixed proportion $s > 0$. $F > 0$ is a fixed cost of running a farm, representing costs of acquiring information about technology and prices, keeping accounts, obtaining water or electricity connections and engaging in market transactions.

Each household member has a unit endowment of time, and decides to allocate it between working on the household farm (l_i) and working on a labor market at a fixed wage w. An individual member earns income $\frac{Y}{n} + w(1 - l_i)$. Household members may exhibit mutual altruism, assigning a weight of $\lambda \in [0, 1]$ to the income of every other member in the household. Hence member i's objective is to maximize

$$\frac{Y}{n} + w(1 - l_i) + \lambda \sum_{j \neq i} [\frac{Y}{n} + w(1 - l_j)] \equiv [1 + (n-1)\lambda]\frac{Y}{n} + w(1 - l_i) + \lambda \sum_{j \neq i} w(1 - l_j). \tag{2}$$

We assume that the extent of altruism is imperfect so that each member places a lower weight on the welfare of other members relative to his own: $\lambda < 1$. This is the source of free-riding among household members.

The sequence of decision making is as follows. At the first stage, all members will make a collective decision concerning whether to engage in cultivation, and the amount of labor h to be hired on the family farm. At the second stage, each member i will select his own effort l_i on the family farm noncooperatively. This reflects either lack of perfect mutual observability of effort, or inability to enter into enforceable binding agreements concerning their respective efforts. We shall focus on symmetric subgame perfect Nash equilibria of this game, wherein all household members will have the same preferences over h at the first stage.

Let $\gamma \equiv [\frac{1}{n}+(1-\frac{1}{n})\lambda] \in [\frac{1}{n}, 1)$. At the second stage after h has been decided, a symmetric equilibrium will involve individual effort $l^*(h)$ which maximizes

$$\gamma L^{1-\alpha}[h + (n-1)l^*(h) + l]^\alpha + w(1-l) \quad (3)$$

subject to $l \in [0, 1]$. There is a unique symmetric equilibrium

$$l^*(h) = \min\{\frac{L}{n}[\frac{\gamma\alpha a}{w}]^{\frac{1}{1-\alpha}} - \frac{h}{n}, 1] \quad (4)$$

generating payoff per member

$$\Pi(h) = [1 + (n-1)\lambda]\pi(h) \quad (5)$$

where $\pi(h)$ denotes per member income $[\frac{1}{n}\{aL^{1-\alpha}[h+nl^*(h)]^\alpha - w(1+s)h - F\} + w(1-l^*(h))]$. Anticipating this, members will agree at the first stage to choose h to maximize $\pi(h)$, and will decide to engage in cultivation if the resulting per member income is at least w.

In what follows we shall focus on situations where there is enough altruism within households, so that

$$\lambda > \frac{1}{1+s} \quad (6)$$

This assumption is relatively inessential as qualitatively similar results also obtain when it does not hold, though the detailed results differ in that case.[20] When (6) holds, $(1+s)\gamma > 1$ irrespective of the value of n. We can then classify households into three types on the basis of their endowment of land relative to household members:

(a) *land-poor* where

$$\frac{L}{n} < [\frac{w}{\gamma\alpha a}]^{\frac{1}{1-\alpha}} \quad (7)$$

(b) *medium-land* where

$$[\frac{w}{\gamma\alpha a}]^{\frac{1}{1-\alpha}} \leq \frac{L}{n} \leq [\frac{w(1+s)}{\alpha a}]^{\frac{1}{1-\alpha}} \quad (8)$$

[20] The main difference when (6) does not hold is that there may be two types of cultivating households rather than three: the medium-land type of household may not arise.

(c) *land-rich* where

$$\frac{L}{n} > [\frac{w(1+s)}{\alpha a}]^{\frac{1}{1-\alpha}} \tag{9}$$

The following Proposition describes the nature of the unique symmetric equilibrium.

PROPOSITION **1.** *Assume that (6) holds.*

(i) Conditional on deciding to cultivate, a symmetric equilibrium results in the following:

(a) For land-poor households: $l^* = \frac{L}{n}[\frac{\gamma\alpha a}{w}]^{\frac{1}{1-\alpha}} < 1, h^* = 0$ *and per member income of*

$$\pi_p \equiv \frac{1}{n}[La^{\frac{1}{1-\alpha}} w^{\frac{-\alpha}{1-\alpha}} \{(\gamma\alpha)^{\frac{\alpha}{1-\alpha}} - (\gamma\alpha)^{\frac{1}{1-\alpha}}\} - F] + w \tag{10}$$

(b) For medium-land households: $l^* = 1, h^* = 0$ *and each member earns*

$$\pi_m \equiv \frac{1}{n}[aL^{1-\alpha}n^{\alpha} - F] \tag{11}$$

(c) For land-rich households: $l^* = 1, h^* = L[\frac{a\alpha}{w(1+s)}]^{\frac{1}{1-\alpha}} - n$ *and each member earns*

$$\pi_r \equiv \frac{1}{n}[La^{\frac{1}{1-\alpha}} \{w(1+s)\}^{\frac{-\alpha}{1-\alpha}} \{\alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}}\} - F] + w(1+s) \tag{12}$$

(ii) The household decides not to cultivate if the resulting income per member falls below w*, i.e. for land-poor households if:*

$$L < L_p^* \equiv Fa^{\frac{-1}{1-\alpha}} w^{\frac{\alpha}{1-\alpha}} [(\gamma\alpha)^{\frac{\alpha}{1-\alpha}} - (\gamma\alpha)^{\frac{1}{1-\alpha}}]^{-1} \tag{13}$$

for medium-land households if:

$$L < L_m^* \equiv [(F + nw)a^{-1}n^{-\alpha}]^{\frac{1}{1-\alpha}}. \tag{14}$$

and land-rich households if:

$$L < L_r^* \equiv [F - nws]a^{\frac{-1}{1-\alpha}} [w(1+s)]^{\frac{\alpha}{1-\alpha}} [\alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}}]^{-1} \tag{15}$$

(iii) There is free-riding (i.e., member incomes are not maximized) only in land-poor households.

Proof of Proposition 1: Given h, a symmetric equilibrium effort $l^*(h)$ at the second stage must maximize $\gamma a L^{1-\alpha}((n-1)l^* + l + h)^{\alpha} + w(1-l)$ with respect to choice of $l \in [0,1]$. Hence $l^*(h) = \min\{\frac{L}{n}\{\frac{\gamma\alpha a}{w}\}^{\frac{1}{1-\alpha}} - \frac{h}{n}, 1\}$. This implies aggregate labor hours in the household farm $l(h) \equiv nl^*(h) + h = \min\{L(\frac{\gamma\alpha a}{w})^{\frac{1}{1-\alpha}}, n + h\}$.

The first-stage choice of h will then maximize $aL^{1-\alpha}l(h)^{\alpha} - w(1+s)h$ subject to $h \geq 0$. Given the expression for $l(h)$ above, it is evident that the optimal choice $h^* > 0$ only if $L(\frac{\gamma\alpha a}{w})^{\frac{1}{1-\alpha}} \geq n + h$, which implies $l^*(h) = 1$ and $l(h) = n + h$. Then $h^* > 0$ if and only if condition (12) holds, i.e., the household is land-rich. In that case we also have $l^* = 1$.

If condition (12) does not hold, either (10) or (11) holds. We have $h^* = 0$ for these households. Evidently the equilibrium member effort $l^* = l^*(0) < 1$ if (10) holds, while $l^* = l^*(0) = 1$ if (11) holds. The rest of Proposition 1 follows from routine computations. ■

Land-poor households have 'surplus labor': they divide time between working on the family farm and on the outside market. No workers are hired from the market. Owing to imperfect altruism, members spend too little time on the family farm. Income per member would be maximized if each member were to supply labor of $\frac{L}{n}[\frac{\alpha a}{w}]^{\frac{1}{1-\alpha}}$ on their own farm, which is larger than what they actually supply (since $\gamma < 1$). In households that are not land-poor, members work full time on the family farm and there is no free-riding: the equilibrium maximizes income per member. Medium-land households rely entirely on the labor of its members. Land-rich households encounter enough labor scarcity that it is worthwhile for them to hire workers from the market. These land-rich households constitute the employers on the labor market.

For households of any given type, they decide to operate a family farm only if they own a minimum amount of land, given by expressions L_p^*, L_m^* and L_r^* for the three types respectively. A minimum landholding is necessary to ensure that the household earns enough from the farm to cover its fixed costs. Those owning less land would not operate a farm and rely entirely on supplying labor to other farms. The supply side of the labor market is constituted of such land-poor households.

The model could be closed with wage rates determined by the condition that the labor market clears. In what follows we shall abstract from the possibility of equilibrium wages that respond to village level shocks. We assume there is a sufficiently large mass of landless households in the village, that pin wages down to an exogenously fixed reservation wage for the landless. The justification for this is empirical: we do not see significant responses of wage rates to land reforms in West Bengal (Bardhan and Mookherjee (2011, Table 14)). And as we shall see below, there is a large and growing mass of landless households in these villages, supplemented by inflows of immigrants.

4.1 Household Division

We now discuss how the equilibrium described in Proposition 1 would be modified if households could sub-divide. To start with we abstract from the possibility of a land market; the next section will describe the consequences of introducing such a market.

A household is described by its size and landholding (n, L) which enables its members to earn an income of $\Pi(n, L)$ from a household collective farm. This can be viewed as the short-run outcome. Over time, the household can experience change in a variety of ways. Some members may exit, or the household may divide into two smaller households.

Some members could quit while others remain in cultivation: call this *exit* or out-migration. An extreme case of this is when every member of the household decides to quit and go work full time on the labor market. This is essentially the counterpart of deciding to not cultivate a family farm at all. Call this a *shutdown*. Finally, the household could divide into two cultivating households, which we shall refer to as *division*.

More complicated changes may involve a combination of exit and division, or a division of the household into more than two households. We shall ignore this for the time being, as it can be shown it suffices to consider these three kinds of changes to describe stable household structures.

An important assumption we make is that two households cannot merge into a single large household. The incentive for a merger could arise from avoiding the duplication of the fixed costs of farming. This phenomenon is empirically very rare, possibly for the reason that households are formed around close kinship and familial ties. If the village is partitioned into 'familial' subsets of individuals with high altruism within subsets and low altruism across subsets, coalitions comprising individuals from disparate 'families' would encounter too much free-riding and would thereby not be stable. In that case households can only be subsets of families. We have in mind an initial situation where households are of maximal size within each family, and are subject to division pressures owing to growth in household size owing to demographic reasons. We abstract from this complication by simply excluding the possibility of mergers.

We make additional simplifying assumptions of transferable utility and symmetric information within each household. So exits and divisions can be accompanied by side-transfers among members — e.g., exiting members can be given a side-transfer by remaining members. Under this assumption, exits and divisions will take place if and only if the total income of members of the original household increases as a result. This motivates the following definition.

DEFINITION **1.** *A cultivating household* (n, L) *is* **stable** *if its members do not collectively benefit from a shutdown, exit or division:*

$$\Pi(n, L) \geq w \tag{NS}$$

$$n\Pi(n, L) \geq mw + (n - m)\Pi(n - m, L) \quad \text{for any } m \in \{1, \ldots, n - 1\} \tag{NE}$$

$$n\Pi(n, L) \geq n_1\Pi(n_1, L_1) + (n - n_1)\Pi(n - n_1, L - L_1) \quad \text{for any } L_1 < L, \text{ and any } n_1 \in \{1, \ldots, n - 1\} \tag{ND}$$

Conversely it is **unstable** *if one or more of these inequalities are violated.*

It may be argued that condition (NE) is incorrect if the household that remains after the exit of m members is induced to shut down (which will happen if $\Pi(n - m, L) < w$), since the payoff of the remaining members would then equal w rather than $\Pi(n - m, L)$.

But in this case the consequences of exit would be the same as shutdown, so this case is covered by (NS). Similarly, in the case of division where $\Pi(n_1, L_1) < w$, but it pays the remaining household to continue to cultivate, the correct condition should be $n\Pi(n, L) \geq n_1 w + (n - n_1)\Pi(n - n_1, L - L_1)$. Since Π is increasing in L, this condition is ensured by (NE).[21]

In the absence of a land market and given the assumption of exogenous wages, the stability of a household is independent of the characteristics of other households in the village. Hence we can define a stable household distribution as follows. We shall refer to any household (n, L) as a *cultivating household* if $\Pi(n, L) \geq w$, and a non-cultivating household otherwise. A non-cultivating household does not utilize its land: such a household might gift its land to other cultivating households, or sell it if there is a land market. So without any loss of generality we can identify non-cultivating households as landless.

Definition **2.** *A distribution over households (i.e. vectors (n, L)) is* **stable** *if there is no positive fraction of cultivating households that are unstable. Otherwise it is said to be an unstable distribution.*

Our main result below provides a near-complete characterization of the set of stable cultivating households.

Proposition **2.** *A cultivating household (n, L) is stable if there is no free-riding and each member earns at least w, i.e., the following conditions hold:*

$$L \geq L_I(n) \equiv n[\lambda + \frac{1}{n}(1-\lambda)]^{\frac{-1}{1-\alpha}}(\frac{w}{a\alpha})^{\frac{1}{1-\alpha}} \qquad (IC)$$

$$L \geq L_R(n) \qquad (IR)$$

where $L_R(n)$ equals L_p^*, L_m^*, L_r^* for land-poor, medium-land and land-rich households respectively (as defined in Proposition 1).

Conversely, the household is unstable if it violates either (IR) or

$$n > \lfloor n_I(L) \rfloor \qquad (IC')$$

where $n_I(L)$ denotes the inverse of $L_I(n)$ and $\lfloor x \rfloor$ denotes the smallest integer exceeding x.

[21] Nevertheless, there may still be the concern that the notion of stability could fail a consistency condition: e.g., one of the fragmented households may itself be unstable and prone to further exits or divisions, which members of the original household ought to anticipate. However, this will not be a problem since further exits or divisions of one of the fragments would only serve to increase further the collective payoff of the members of that fragment. So conditions (NS), (NE) and (ND) are necessary for stability. Are they sufficient? In other words, what about the possibility of division into three or more households, or combinations of exits and division? This is not a problem for the following reason. Owing to the assumption concerning presence of fixed costs and CRS technology, a household dividing into two or more fragments will not be able to attain a higher collective profit. Hence the three conditions are collectively sufficient.

Proof of Proposition 2: We start with sufficiency. Suppose there is no free-riding and each member earns at least w. The latter implies (NS) is satisfied. To show (NE) holds, note that $L_I(n)$ is an increasing function. So for any positive integer m, the equilibrium outcome for a household with $n-m$ members and L land will involve no free-riding, with each member selecting $l = 1$. This implies the marginal contribution of any member in any such household exceeds w, and so the marginal contribution of m members will exceed mw, which implies (NE). (ND) follows from noting that the production function defined by 'output' equal to collective income of a household plus the fixed cost, and inputs consisting of land L and household size n (i.e., $y(L,n)$ which equals $n\pi_m + F$ for a medium-land household and $n\pi_r + F$ for a land-rich household) defines a production set which is a convex cone. Hence the collective income of the household net of the fixed cost is superadditive.

The necessity of (IR) for stability is obvious. To show necessity of (IC'), suppose this condition is violated and we have $n > \lfloor n_I(L) \rfloor$. This implies there is free riding at both n and $n-1$, and per member incomes are defined by (10). Hence $n\pi_p(n,L) = nw - F + H(n)$ and $(n-1)\pi_p(n-1,L) = (n-1)w - F + H(n-1)$ where $H(m) \equiv La^{\frac{1}{1-\alpha}} w^{\frac{-\alpha}{1-\alpha}} \{(\gamma(m)\alpha)^{\frac{\alpha}{1-\alpha}} - (\gamma(m)\alpha)^{\frac{1}{1-\alpha}}\}$ and $\gamma(m) \equiv \lambda + (1-\lambda)\frac{1}{m}$. Clearly $\gamma(m)$ is strictly decreasing in m. Hence $n\pi_p(n,L) - (n-1)\pi_p(n-1,L) = w + H(n) - H(n-1) < w$, and (NE) is violated. ■

Proposition 2 is illustrated in Figure 3. (IC) is an incentive compatibility condition, stating that given the land owned by the household, the number of members is small enough to ensure absence of free-riding: every member supplies maximal effort on the farm. It is a restatement of the condition that the household be either medium-land or land-rich. The corresponding necessary condition (IC') is slightly weaker, owing to the fact that the number of household members is integer-valued. The necessity of this condition flows from the fact that land-poor households are characterized by free-riding, and collective household income is strictly decreasing in the number of members. It then pays one member to exit with a suitable compensation paid by the remaining household members. Condition (IC) reduces to a minimum landholding requirement $L_I(n)$ which is strictly increasing and strictly convex in household size n, provided the extent of altruism is imperfect (i.e., $\lambda < 1$). Conversely it amounts to a maximum household size $n_I(L)$ corresponding to any given ownership of land.

The existence of a limit to household size arises due to the assumption that altruism within the household is not perfect. If instead $\lambda = 1$, there would never be any free-riding within the household, and the collective income of the household would be independent of household size within region (a). The condition for the household to be stable is that $L\{a[\frac{a\alpha}{w}]^{\frac{\alpha}{1-\alpha}} - w[\frac{a\alpha}{w}]^{\frac{1}{1-\alpha}}\} > F$, which does not depend on household size n. As household size increases, its members would spend proportionately less time per capita working on the household farm, and more time on the labor market. The total amount of labor on the family farm, and hence the collective income realized from it would be unchanged. As long as this collective income is greater than the fixed cost, the farm would be operational and the household would face no compulsion to split or for members to leave.

Returning now to the case with imperfect altruism, condition (IR) is an individual rationality constraint that corresponds to condition (NS) wherein every member should earn at least as what they would earn on their own working full time on the labor market. It translates into a minimum landholding requirement $L_R(n)$ given household size. It is evident that for land-rich households this lower bound $L_r(n)$ is linear and decreasing in n. For medium-land households, the bound $L_m(n)$ is U-shaped in n, achieving a minimum at $n^* = \frac{\alpha}{1-\alpha}\frac{F}{w}$. Since stability also requires 'near-absence' of free-riding within the household as expressed by condition (IC'), $L_m(n^*)$ forms an approximate lower bound to the landholding of any stable household, irrespective of how many members it has. Hence a stable land distribution must exhibit a 'hole' in-between 0 and $L_m(n^*)$ quantities of land. Note also that the minimum landholding size needed to satisfy (IR) depends on both F and w. Even if F were zero, a minimum land size would be needed to ensure that per capita earnings are above the wage rate.

The sufficiency of the two conditions arises from the fact that a non-land-poor household realizes maximal agricultural income from its endowment of labor and land, which is increasing in n and L. The absence of free-riding in such households implies that the marginal contribution of each member to household income exceeds the outside wage w. Hence there are no incentives for exit. There are no incentives for division either — at best the fragments would be better off cultivating rather than not cultivating (which would happen if they both continued to satisfy (IR)). And the best-case scenario for division is when neither fragment is characterized by any free-riding. In that case owing to the constant returns feature of the production function (ignoring the fixed cost), collective production would remain the same, and collective income would decline on account of the duplication of fixed cost F.[22] Finally, the (IR) constraint implies that there are no benefits from shutdown.

It is easy to check that the IC and IR curves cross in $n - L$ space at a single point n^{**}. To the right (left) of this, the IC curve lies above (resp. below) the IR curve. In case A of Figure 3 where $\frac{F}{w}$ is high enough (relative to α), they intersect to the right of the bottom of the IR curve (i.e., $n^{**} > n^*$). In the other Case B when $\frac{F}{w}$ is low, they intersect to the left of the bottom ($n^{**} > n^*$). The implications of demographic growth of the number of household members can differ between the two cases, as we discuss next.

4.2 Effects of Changes in Demographics and Profitability on the Land Distribution

Suppose we start with a stable distribution, with support of cultivating households contained in the region bounded below by the intersection of the IR and IC curves, with all remaining households landless. Now take any cultivating household which is initially in the stable region, and suppose that the number of household members increases (owing to either fertility increases or decreases in mortality) while its landholding remains the same.

[22]For the same reason, division into three or more fragments would not be valuable, when it is not worthwhile to fragment into two fragments.

Consider case B of Figure 3, with relatively low fixed costs. Or suppose we are in case A instead, but n exceeds n^*. If the number of members increases sufficiently, the IC constraint will be violated and the household will cease to be stable. As the endowment point moves across the IC curve, the IR constraint continues to be satisfied. Hence either exit or division of the household will be induced, rather than a shutdown. The problem is that the household has too many members relative to its land, inducing some free-riding.

It is also possible that the IR constraint is the first to be violated as the household size grows relative to its landholding. This would happen for instance in Case A where the landholding is close to the lower bound $L_m(n^*)$.

Can we predict whether the outcome of demographic growth will be exit (in which case n will fall while L of the surviving household will remain unchanged) or division (whence landholdings of the surviving fragments will be smaller than of the original household)? Which of these two outcomes will happen will depend on which is associated with a higher collective income of the members of the original household.[23] Note that exit is always feasible, since the extra number of household members that caused IC to fail can exit so as to leave a cultivating household with exactly the same number of members as in the original household. But division may not be feasible, if there was little slack in the IR constraint to start with. For instance, division is infeasible if the original household owned less than twice $L_m(n^*)$, since each of the fragments will have to have at least this amount of land in order to be viable. At the lower end of the land distribution, thus, demographic growth will result in exits, resulting in growing landlessness.

Next suppose agricultural profitability (represented by $\frac{a}{w}$) increases. This causes the IC curve to shift outwards, and the IR curve moves downwards — both constraints are relaxed. This will tend to slow down exits and divisions occurring due to demographic growth.

4.3 Land Market Transactions

Now suppose land can be bought and sold, subject to a unit transaction cost of t. Other problems that may restrict land market transactions include credit constraints that restrict purchases, while status effects or insurance value of land that make households reluctant to sell. Asymmetric information concerning land quality may also create a 'market for lemons' problem. We abstract from these here, and focus on the role of costs of registering land transactions.

Continuing with the assumption of transferable utility and lack of credit constraints or asymmetric information, two cultivating households $(n_i, L_i), i = 1, 2$ will have an incentive

[23] Suppose the IC constraint is the first one that is violated, with n close enough to $n_I(L)$ after the demographic expansion, and fixed costs F smaller than w. Then had the original household remained intact the marginal contribution of any member to collective income will be at least w. Hence exit of any member would result in a reduction in total income by at least w. On the other hand, it is feasible to divide the household into two cultivating households which are stable, in which case their collective income will decline by F, which is smaller than w. In this case division is going to happen rather than exit. On the other hand, if F is large enough then exit will happen rather than division.

to engage in a land transaction of l units if and only if

$$n_1\Pi(n_1, L_1 - l) + n_2\Pi(n_2, L_2 + l) - tl > n_1\Pi(n_1, L_1) + n_2\Pi(n_2, L_2)$$

Since the marginal contribution of land to collective income of any medium-land household (n, L) equals $(1-\alpha)a(\frac{n}{L})^{\alpha}$, it follows that there is an incentive for two medium-land households to enter into a land transaction if and only if their relative endowments differ sufficiently, relative to transaction costs and profitability parameter a:

$$|(\frac{n_1}{L_1})^{\alpha} - (\frac{n_2}{L_2})^{\alpha}| > \frac{t}{a(1-\alpha)} \tag{16}$$

The results in the preceding section imply that in order to identify stable land distributions, we can focus on households that are either land-rich or medium land types. All land-rich households have the same marginal value of land, equal to the value of land for a medium-land household located at the boundary between the medium-land and land-rich regions, i.e., with $\frac{n}{L} = b \equiv \{\frac{\alpha a}{w(1+s)}\}^{\frac{1}{1-\alpha}}$. For purposes of land transactions we can identify land-rich households with such a medium-land household.

The definition of a stable land distribution must now include the condition that no two cultivating households should want to enter into a profitable land transaction.[24] This restricts the range of variation of factor proportions among all cultivating households (after setting the factor proportion of land-rich households to b) to lie within a cone of width which varies with $\frac{t}{a(1-\alpha)}$, as shown in Figure 4. The stable region, i.e., support of a stable land distribution (for cultivating households) must now be contained within the intersection of such a cone with the areas bounded below by the IC and IR curves. If t is small, this cone may be contained entirely within the medium-land region. In that case there is a stable distribution containing only medium-land households. For the same value of t, there could be multiple cones consistent with the stability condition: there could be another which includes the factor proportion b and other medium-land households in the interior of the medium-land region. In this case a stable distribution could include both medium-land and land-rich types of households. Note in particular that for any t there exists a stable distribution containing only land-rich households, as there are no incentives for any pair of land-rich households to trade land.

Demographic growth in some households may now trigger a land transaction rather than an exit or division. This is shown in Figure 4(b), where a household with a relatively high initial ratio of labor to land (represented by vector h) moves to h_1. It then enters into a

[24]We ignore the possibility of purchases of land by landless households from cultivating households. Such transactions are empirically rare. Possible reasons include a large fixed cost F of operating a farm. These necessitate a large amount purchase of land by the landless, which they may be unable to finance owing to credit constraints. Moreover these fixed costs would be duplicated, eroding the potential benefits of the transaction: it would not be profitable if F is sufficiently large relative to w. Additional complications arise when we consider possible combinations of exits or divisions with land market transactions, so we stop short of providing a characterization of stable land distributions and instead focus on necessary conditions.

land purchase from another household h_2 with a relatively low labor-land ratio, with respect to whom condition (16) is now violated. As a result of the transaction, h_1 moves up back to h_3 into the equilibrium cone, while h_2 drops down to h_4 and continues to remain in the stable region. Clearly, the likelihood of buying land is increasing in $\frac{n}{L}$ and in a, while the likelihood of selling land is decreasing in $\frac{n}{L}$ and increasing in a.

5 Regression Analysis Results for Household Division, Land Transactions and Immigration

We now test the predictions of the preceding model with regard to the determinants of household division and land transactions. Following the discussion of determinants of household division above, we use the following regression specification:

$$\begin{aligned} DIV_{ivt} =& \beta_i + \delta_t + \beta_1 HS_{i,t-1} + \beta_2 L_{i,t-1} + \beta_3 TR_{v,t-k} + \beta_4 TR_{v,t-k} * L_{i,t-1} \\ &+ \beta_4 LD_{v,t-k} + \beta_5 LD_{v,t-k} * L_{i,t-1} + \beta_6 C_{it} + \epsilon_{ivt} \end{aligned} \quad (17)$$

where DIV_{ivt} denotes a dummy for division, or lands lost owing to division, by household i located in village v in year t. The regressors include apart from household fixed effects and year effects, lagged household size HS, landownership L, measures of implementation of the tenancy reform TR and the land distribution program LD in the village lagged by a few (k) years[25], interactions of these with lagged land owned by the household, and a dummy C for whether the household owned land in excess of the legal ceiling. We will report both logit and linear probability versions of this regression. Standard errors of residuals ϵ_{ivt} are clustered at the village level.

We also use a similar specification for dummies for whether a household bought or sold land. The theory indicated that the likelihood of buying or selling would be related to the ratio of (lagged) household size to land owned, so we include a specification where the log of this ratio is used as a single regressor apart from household and time effects. This corresponds to a different functional form, representing differences in endowment compositions that motivate land market transactions.

5.1 Regression Results for Household Division

Table 9 presents a logit regression predicting the event that a household experienced a division in any given year. Columns 1 through 3 show the results for the full sample and 4 through 6 for the restricted sample. Columns 3 and 6 present the specification described above, with the other columns showing a more parsimonious specification which drop some of the land reform variables and some interaction terms.

Focusing on columns 3 and 6, we find growth in household size significantly raised the likelihood of household division. This confirms the notion that demographic growth was a

[25] We take the average of these in three preceding years.

key determinant of division - households with more family members were more likely to split up. In column 1, the effect of land owned itself was positive and significant, in contrast to the theoretical prediction (based on pure economic reasons) of a negative effect. This may in part be due to large landholders being motivated to divide their property in anticipation of potential future land reforms. This interpretation is consistent with the significance of the above-ceiling dummy in column 2 in the full sample (and column 5 in the restricted sample). Households just above the land ceiling were disproportionately more likely to divide relative to those just below the ceiling. Inclusion of the dummy reduces the magnitude of the coefficient of lagged land, and renders it statistically insignificant.

Columns 2, 3, 5 and 6 show that the effects of tenancy program are as anticipated by the theory: an increase in the proportion of cultivable area registered under the program was associated with a significant fall in division rates for small landowning households, and less so for larger landowning households. The intercept and slope effects are significant at the 1% level in the full sample and 5% in the restricted sample. For households owning more than four acres of land, the implied effect is positive. Hence the effect of the tenancy reform on rates of household division provides one channel by which the former induced a fall in land inequality.

Columns 3 and 6 show that the land distribution program had a positive effect on division rates which is statistically insignificant, and an interaction with land size which is negligible and insignificant. Hence the effect of the land title program on division rates is not precisely estimated.

5.2 Regression Results for Land Market Transactions

Columns 1-4 of table 10 present logit regressions for the event that a household engaged in a land sale. There is no evidence of any significant effects of lagged household size, but lagged landownership clearly matters. Consistent with the theory, columns 1 and 3 show a negative effect of the (log of the) ratio of lagged household size to landownership. The corresponding regression using household size and land as separate regressors shows landownership rather than household size to be the important determinant. Columns 2 and 4 pertaining to the likelihood of a land sale show only one significant effect of the land reform: the land distribution program raised the likelihood of sales among large landowning households, consistent with the interpretation of anticipated redistribution in the future.

Next, columns 5-8 of table 10 present the corresponding regressions for likelihood of buying land. We see a converse negative effect of land owned, consistent with the theoretical prediction. The tenancy reform raised probability of land purchases by small landowning households, while reducing it for large landowning households (i.e., those owning more than four acres). The land distribution program has significant effects only in the full sample, where it attenuated the reduction in the probability of purchase by large landowners. However this last result is not robust to the choice of sample. These results, as well as those for land sales, are unaffected by including land disposed or acquired as gift together with land market transactions.

In summary, the evidence shows that the land reforms induced greater activity in the land market. And effects of the tenancy reform on market transactions — raising (resp. lowering) the likelihood of small (resp. large) landowners buying land — also constituted a channel by which they indirectly induced a drop in inequality. As in the case of effects on divisions, we are unable to obtain a precise estimate of the effects of the land title distribution program.

5.3 Regression Results for Immigration

Table 11 considers the determinants of arrival of immigrants into these villages. It regresses the proportion of 1998 households that immigrated into the village since 1967, on the extent of land reforms implemented since 1968, controlling for land per capita in 1968. It is not surprising to see that villages that were more land-abundant attracted more immigrants. Moreover, immigrants were more inclined to arrive in villages those in which more land was distributed through land reforms. The other measures of land reform have statistically insignificant effects.

This shows one important channel by which the land distribution program exerted a negative indirect effect on inequality, and a positive effect on landlessness.

5.4 Robustness: Instrumental Variable Estimates for Household Division

One possible concern with the preceding section is that implementation rates may be correlated with time-varying village-level unobservables that affect division rates, which would lead to an endogeneity problem. We now address this concern with a corresponding instrumental variable estimator of the effect of the tenancy reform on the likelihood of household division.

To instrument for tenancy reform, we exploit the fact that there are political economy determinants of reforms that are plausibly uncorrelated with other factors that would affect division rates. We base our instruments on [Bardhan and Mookherjee [2010]], which are also used as instruments for the tenancy program implementation rate in Bardhan and Mookherjee [2011]. Bardhan and Mookherjee's [2010] analysis of the political economy of the land reforms argued that political competition between the Left Front (LF) and the Indian National Congress (INC), the two principal competing parties in West Bengal politics played an important role in determining local implementation rates. This gives rise to an inverted-U relationship between reform implementation rate and the proportion of local government seats secured by the LF in the previous election, with a peak located around 50%. Moreover, in villages where one of the two parties, say the LF, was already strongly entrenched (as indicated by a share of the LF in the current local government seats that significantly exceeded 50%), a further increase in voter loyalties to the LF at the district or state level (measured by average vote share difference (AVSD) between the LF and INC in the district in question in most recent elections to the state legislature) would lower competitive pressure for re-election, and thus reduce implementation rates. Hence implementation of the tenancy reform in village v in year t can be predicted as follows:

$$\begin{aligned} TR_{vt} &= \gamma_1 LS_{vt} + \gamma_2 LS_{vt}^2 + \gamma_3 AVSD_{vt} \\ &+ \gamma_4 LS_{vt} * AVSD_{vt} + \gamma_5 LS_{vt}^2 * AVSD_{vt} + \gamma_v' + \gamma_t'' + \epsilon_{vt}^1 \end{aligned} \tag{18}$$

where LS_{vt} denotes the LF share of local government seats in village v in year t. The composition of the local government in turn can be predicted on the basis of lagged incumbency and recent swings in popularity of the two parties at the state or national levels:

$$LS_{vt} = \delta_1 LS_{v,t-k} + \delta_2 INC_{t-l} * LS_{v,t-k} + \delta_3 AVSD_{vt} + \delta_v' + \epsilon_{vt}^2 \tag{19}$$

where $LS_{v,t-k}$ is the LF proportion in the previous local government (i.e., prior to the current local government) elected in year $t-k$, INC_{t-l} is the number of seats the INC secured in year $t-l$, the date of the last election to the national Parliament[26], δ_v' is a village fixed effect, and ϵ_{vt}^2 is an i.i.d. village-year shock.

Combining equation (18) with (19), we obtain a prediction for tenancy reform implementation in terms of district and national-level loyalties of voters, interacted with lagged incumbency:

$$\begin{aligned} TR_{vt} &= \nu_1 LS_{v,t-k} + \nu_2 LS_{v,t-k}^2 + \nu_3 INC_{t-l} * LS_{v,t-k} + \nu_4 AVSD_{vt} \\ &+ \nu_5 AVSD_{vt} * LS_{v,t-k} * INC_{t-l} + \nu_6 AVSD_{vt} * LS_{v,t-k} \\ &+ \nu_7 AVSD_{vt} * LS_{v,t-k}^2 + \nu_8 P_{vt} + \nu_v' + \nu_t'' + \epsilon_{vt}^3 \end{aligned} \tag{20}$$

with some higher order interaction terms dropped in order to limit collinearity problems, and P_{vt} denotes some additional village-year varying predictors such as local infrastructure, rainfall and the price of rice. This regression predicts implementation rate of the tenancy program for any given year, which has to be cumulated across past years to predict the total coverage of the program so far. Hence the instruments are the cumulative totals of these predictors across past years.

Table 12 presents instrumental variable as well as OLS estimates of the effects of the tenancy reform in a linear probability regression of division rates for small and large landowning households, controlling for the land distribution program, lagged household size and landownership besides household fixed effects, year dummies and additional village-year controls. These controls reduce the sample significantly, since they are available only for years 1982-1996.[27] Columns 1-4 present results for the full sample, while columns 5-8 show results for the restricted sample. The F-statistics and Kleibergen-Paap tests indicate the

[26]Only the INC had a significant presence in the national Parliament during the period studied, so we focus only on the national popularity of this party.

[27]This is the same time period considered in Bardhan and Mookherjee [2011].

instruments are weak, especially in the full sample, while the Hansen test of overidentifying restrictions is comfortably passed.

Regarding the results for the full sample, OLS results are provided in columns 1 and 3 for the two groups of landowners, with corresponding IV results in columns 2 and 4. Consistent with the results of the logit in the previous Table, tenancy reform reduced division rates among small landowners and raise them among large landowners (though the effects fail to be statistically significant in the IV regressions for small landowners). The gap between the OLS and IV estimates is not large, with the test of endogeneity bias failing to reject the hypothesis of absence of endogeneity at any significance level below 0.2.[28]

The quantitative effect of the land reforms on the division rates implied by these estimates are not large. They are small especially when compared to the effects of demographic growth, which helps explain why division rates rose through the period. We estimate growth in population of native households resulted in an increase in size of undivided households by approximately 1.3 members.[29] The linear probability model IV estimates in Table 12 imply that this would have increased the likelihood of division of small landowning households in any given year by .134, whereas the tenancy program would have lowered this by .008.[30] Hence the effect of demographic growth on rate of division of small landowning households was more than sixteen times the impact of tenancy registration. For large landowning households, the effect of demographic growth was three times that of the tenancy program.[31] The effect of land titles distributed is statistically insignificant in column 2 of this Table. If we nevertheless use the estimated coefficient of -.336, we obtain a predicted impact of -.027 on the likelihood of household division. The total effect of the two land reform programs is -.035, which is still a quarter of the effect of demographic growth. The scale of the land reform program was thus too small compared to the extent of population growth for it to matter quantitatively, resulting in an increase in division rates of both small and large

[28]Unfortunately, we have not succeeded in finding a set of instruments that can help predict land distribution implementation, so we cannot test for endogeneity bias with regard to that program specifically.

[29]Native village population grew 22% between 1978 and 1998, using the number of village households from the indirect survey in Bardhan and Mookherjee (2006, 2010) and the average household sizes in these two years from the direct household survey. Applied to a mean household size of 5.7 in 1978, this implies household size would have expanded by approximately 1.3 members, in the absence of any division.

[30]From column 2, the coefficient with respect to lagged household size is .103, which multiplied by 1.3 yields .134. The coefficient with respect to tenancy registration is -.069, which multiplied by the cumulative proportion of area registered of .11 yields -.008.

[31]Similar results obtain upon using the results of the logit specification. The marginal effects implied by Table 9 in the restricted sample (averaged across all households, with fixed effects set at zero) of household size was .043, of tenancy registration was -.123 and the land title program was .09. While the effect of household size is smaller than in the linear probability specification, the effects of the two land reform programs run in opposite directions and thus neutralize each other. This implies that adding 1.3 members to household size would imply a rise in division rates by approximately .056. In contrast, the cumulative effect of the tenancy reform was to lower division rates by .014, while the land distribution program raised them by .007, with an aggregate effect of -.006. Thus, the effect of demographic growth on the rate of division was more than eight times larger than the effect of the reform.

landowning households.

6 Relation to Existing Literature

A number of West Bengal village case studies (e.g., Lieten, 1992; Sengupta and Gazdar, 1996; Rawal, 2001) have examined changes in land distribution and land market transactions between the 1970s and 1990s. Lieten [1992] argues that the land reforms in West Bengal were instrumental in lowering land inequality between 1970 and 1985, and in explaining why small and marginal landowners in the state own a larger proportion of land compared with neighboring states Bihar and Uttar Pradesh. Our paper is based on a substantially larger sample of villages and covers a longer time period. It finds an insignificant overall impact of the tenancy registration program, and a small but significant effect of the land distribution program. Moreover, our analysis distinguishes between direct and indirect effects of these land reforms.

Papers by Foster and Rosenzweig [2002] and Guirkinger and Platteau [2011,2012] share our focus on the process of household division. Foster and Rosenzweig's theory of household structure is based on a tradeoff between the benefits of grouping within the same household to take advantage of risk-sharing and scale economy benefits of household collective goods, with the costs in terms of resulting lack of diversity in consumption patterns. Their explanation predicts a rise in household division rates as a result of rising agricultural yields that result from technological progress, which increase the preference for consumption variety and reduce the need to stay together in a single household to realize the benefits of scale economies. They test their theory structurally using an all-India household panel. Our explanation of household division focuses instead on problems of land scarcity resulting from demographic growth, owing to rising incidence of free-riding in joint production activities. Moreover, we abstract from considerations of risk-sharing. Our approach predicts that rising agricultural yields owing to technical progress will reduce the rate of household divisions by reducing the tendency for free-riding in joint production activities, in contrast to their prediction that it will raise divisions by heightening intra-household conflict over joint consumption activities. In our field work we found many instances of households which continued to live in the same homestead and carry out production on commonly owned land jointly, while different units within the household cooked and ate in separate kitchens. This could reflect co-existence of both phenomena stressed by our respective approaches.

By focusing on problems of free-riding within household production activities and the role of land scarcity relative to household size, our theory of division is closer to that of Guirkinger and Platteau [2011]. The main difference is that their intra-household model involves an asymmetric relationship involving rent extraction by a patriarch from other members. This is in contrast to the symmetric partnership among household members in our model, which is simpler as a result. Moreover, Guirkinger and Platteau's main interest is in predicting how land scarcity causes the patriarch to allocate a part of the household land as individual plots to other members. The latter divide their time between these individual plots and work on the collective family farm whose returns at the margin accrue to the patriarch. This is an asymmetric division of land and work between household members that we abstract from. Part of the reason is that our data does not identify such asymmetries within households. Guirkinger and Platteau [2012] test the predictions of their theory using a family survey from southern Mali, focusing mainly on allocation of land within the household between individual and communal plots. Our concern instead is to explain circumstances under which households will be induced to split into smaller households, individual members to exit, or the household to undertake land transactions.

A key feature distinguishing our paper from the ones cited above is the attention we devote to the question of the effect of land reforms on household division, land market transactions and land inequality. The effect of tenancy reforms on land inequality is addressed by Besley et al. [2012] in the context of four south Indian states. Their theory emphasizes the reduced returns from tenancy and reduced willingness to lease out lands by landlords, encouraging them to sell land. More skilled farmers belonging to intermediate castes are able to buy more land as a result; hence land inequality declines. At the same time, less skilled farmers from lower castes are unable to lease in land, and are forced to become agricultural workers instead. Nevertheless the wage rate rises as a result of an increase in the demand for hired workers (owing to a rise in skill of cultivators). They confirm these predictions by comparing changes in land inequality, wage rates and occupational patterns across villages located near boundaries between states with differing tenancy regulations. Our paper differs from theirs owing to our focus on the process of household division. On the other hand it shares an interest in question of the indirect effect of tenancy regulations on land inequality, as well as the result that such regulations tend to lower inequality by increasing the likelihood of large landowners selling land. Our empirical work is in the context of a different state in India. Our analysis relies on longitudinal data, while theirs involves a cross-sectional analysis at state boundaries; accordingly the underlying identification assumptions are different. The land reform measures used are also different: we use area-based measures of land reforms implemented at the village level rather than the number of tenancy regulations at the state level.

7 Summary and Concluding Observations

The main question addressed by this paper concerns the effectiveness of land reforms in reducing land inequality, incorporating its indirect effect via induced household division, migration and land market transactions. We developed a theory of joint production within households whose members exhibit some degree of altruism toward one another, yet are not perfectly altruistic. This implies that the household is subject to inefficient free-riding if the number of members exceeds a critical size, relative to the amount of land they own. This gives rise to division of the household, consisting either of a split into two cultivating households, or exit of some members to a labor market while others continue to cultivate, or a land market transaction (where it either purchases some land or the household sells all its land and dissolves altogether). The size threshold for the household where it dissolves depends negatively on farm productivity and positively on the wage rate for hired workers.

The model implies that land reforms can affect household division and land market transactions through their impact on farm productivity and wages. Increases in farm profitability (via higher productivity or lower wages) reduce the likelihood of division, while raising the likelihood of land transactions between households of disparate ratios of land to household size. A tenancy regulation which reduces the profitability of leasing out land would similarly motivate landlords to sell their land. These channels would be supplemented by political signaling effects, if implementation of land reforms signal an increased likelihood of stepped up implementation in the future. Households owning more land than the land ceiling regulation (and not yet affected by the regulations enacted so far owing to delays in enforcement) would be motivated to divide or sell land in order to preempt the application of the regulation to their own context.

While some of these effects are likely to reduce land inequality, others may increase inequality. Medium and small landholders would be motivated to divide so as to become eligible beneficiaries of land distribution programs. If farms are subject to some fixed costs or scale economies over some initial scale of cultivation, a household needs to own a minimum amount of land in order to remain viable cultivators. Increased division of small landholders owing to land reforms or population growth would then induce growing landlessness. Land distribution programs may also induce increased immigration of land-poor households from other regions, thereby raising landlessness and inequality.

These predictions were tested in the context of West Bengal's experience over the last three decades of the 20th century. Reduced form estimates show the land distribution program significant lowered landlessness, but the net impact was smaller than what the direct impact ought to have been. This could be accounted partly by targeting failures of the program (wherein more than half of all recipients already owned at least half an acre of cultivable land). The effects of the tenancy program on inequality and landlessness was negative, but less significant and less precisely estimated. The quantitative effects of the land reforms on inequality were overshadowed by those of population growth resulting from excess of births over deaths, though the reverse was the case for landlessness.

We subsequently estimated indirect effects of the reforms on land distribution through their impact on divisions and market transactions. The effects of the tenancy reform — lowering division rates among small landowning families and raising them among large landowning households – were precisely estimated, and were robust with respect to choice of sample, inequality measure and estimation procedure. Analogously, the reform encouraged land sales by large landowners and purchases by small owners. These results are consistent with theoretical predictions, and imply a negative overall impact of the tenancy reform on land inequality. On the other hand, the effects of the land distribution program on household division and land transactions were neither precise nor robust. However it had a significant positive effect on immigration rates, implying a positive indirect effect on landlessness.

The indirect effects of the land reforms on division rates were quantitatively negligible relative to the effects of population growth. This was mainly because of the corresponding magnitudes of the two phenomena: the proportion of households or cultivable area covered by the land reform was much smaller than the growth of population from natural causes. This helps explain why household divisions and inequality rose during the period, and why the overall impact of the tenancy reform on inequality was quantitatively negligible. The land distribution program on the other hand had a direct effect in reducing landlessness (and thereby land inequality). But this was countered by targeting failures of the program, higher rates of division among small landowning households, and larger inflows of immigrants that the programs helped attract. This explains why the land distribution program reduced landlessness and inequality somewhat, but by an extent that was substantially smaller than would have been expected from the magnitude of that program.

The issues studied in this paper may not be relevant in contexts of large scale land reforms of the kind carried out in early 20th century Mexico, in East Asia in the 1950s, or the more recent post-socialist transition experiences of China or Vietnam. Such reforms were carried out in the aftermath of revolutions or wars in a non-democratic context, where direct beneficiaries constituted the vast majority and there were relatively few large landowning households with the opportunity to circumvent the land reforms by sub-dividing properties or engaging in land market transactions. The West Bengal experience is likely to be more relevant for countries that embark on land reform within a peaceful democratic context (analogous to the reforms in Brazil or South Africa in the last two decades). In these countries, direct beneficiaries constitute a minority, and there is a functioning land market. Hence there is scope for the land reform to generate large indirect effects through market transactions, immigration and household division. As mentioned in the Introduction, analysis of the Brazilian experience by Assunção [2008] showed that the land reforms were surprisingly ineffective in lowering land inequality and landlessness. It would be interesting to understand better the reasons for this, and how they relate to our findings for West Bengal.

Our findings indicate the importance of demographic factors in explaining changes in land distribution, and raises a number of new questions in this regard. For instance, what were the causes of high rates of division among small and marginal landowning households that induced rapid growth of landlessness? What was the role of changing fertility and mortality patterns? Conversely, did the land reforms affect fertility or mortality rates? One hopes that future research will be devoted to these questions, and thereby generate better understanding of inter-connections between household demographics, human development policies and changes in land inequality.

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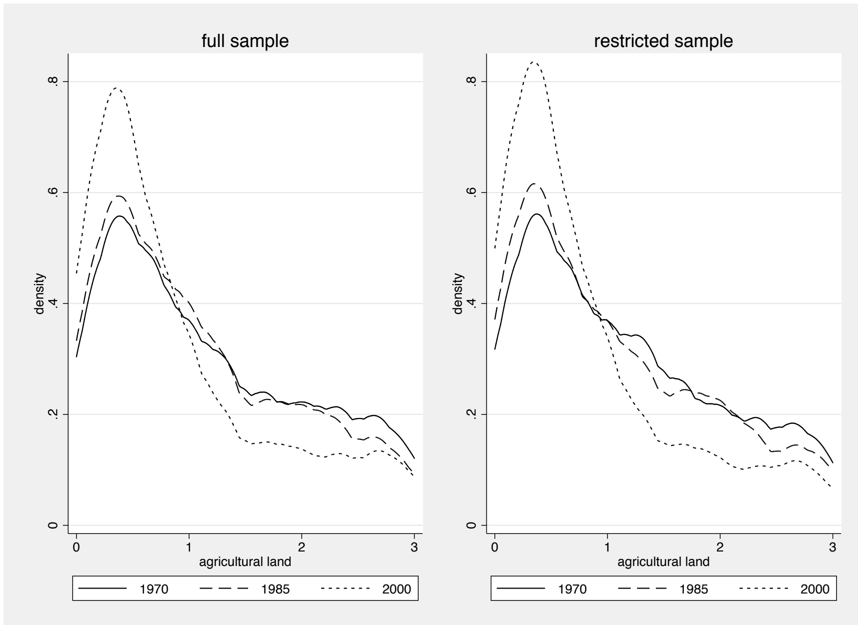
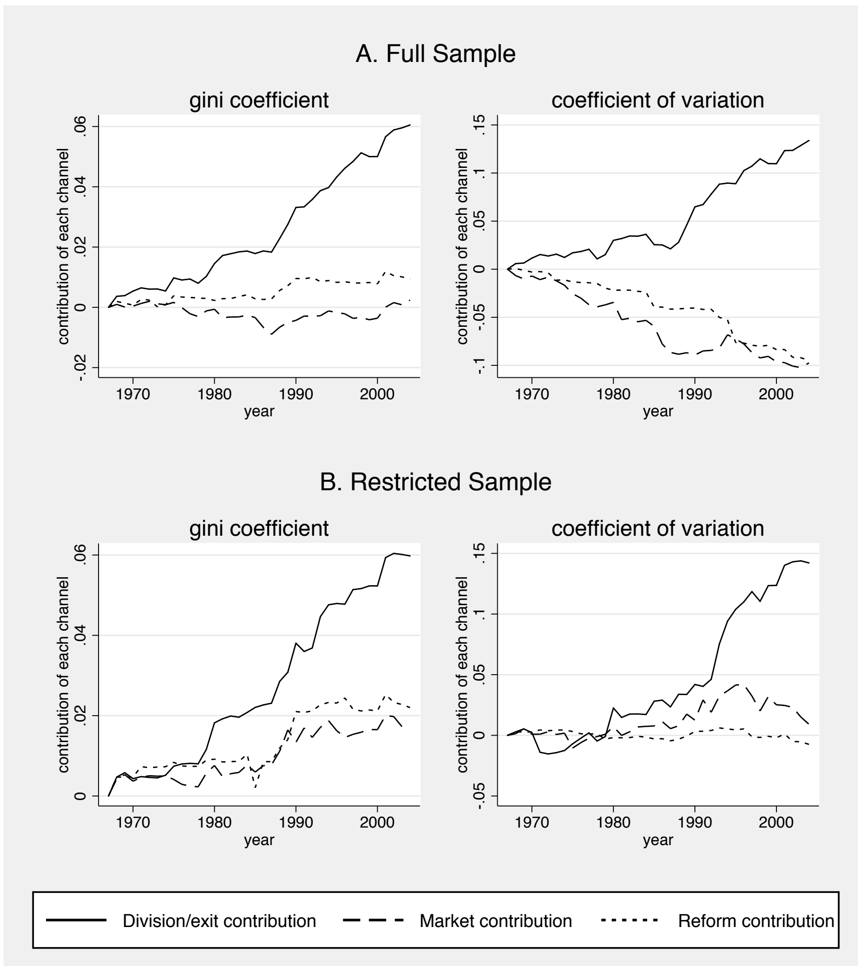
Figure 1: Agricultural land kernel densities, various years



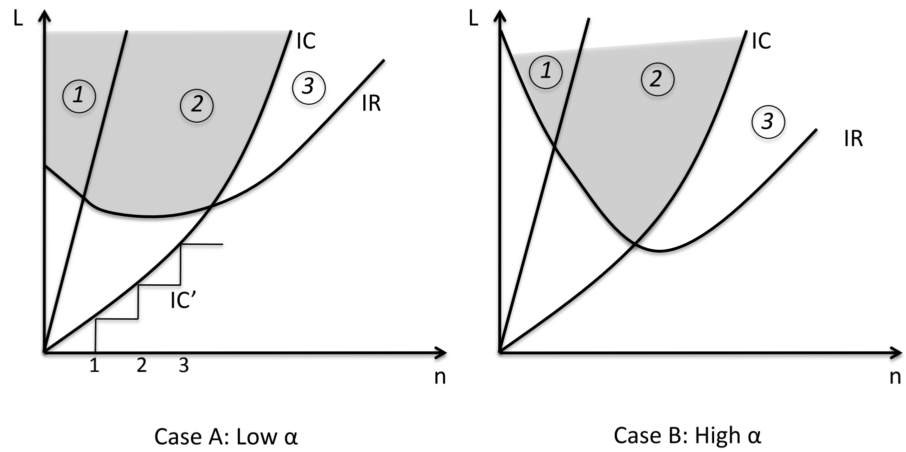
Notes: Landless households are excluded, as well as households owning more than 3 acres of land. All graphs use the Epanechnikov kernel function and a bandwidth of 0.2.

Figure 2: Average within-village land inequality, contribution by channel (1967-2004)



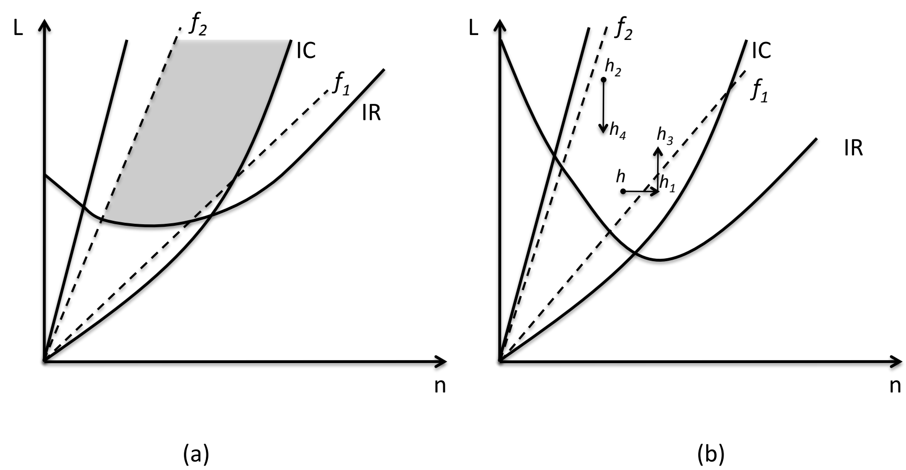
Note: Each line represents the contribution of each channel to the change in the gini coefficient or coefficient of variation.

Figure 3: Characterization of Stable Households without Land Market Transactions



Notes: Stable areas are depicted in light grey. Area 1 is characterized by no free-riding ($l^* = 1$), positive hired labor ($h^* > 0$) and income increases in family size $Y'(n) > 0$. In area 2 there is no free-riding ($l^* = 1$), no hired labor ($h^* = 0$), and income increases in family size ($Y' > 0$). Finally, in area 3 there is free-riding ($l^* < 1$), no hired labor ($h^* = 0$), and income does not increase in family size ($Y' = 0$).

Figure 4: The Effect of Incorporating Land Market Transactions



Notes: (a) Characterization of Stable Households with Land Market Transactions. (b) Land Transactions Induced by Expansion of Household Size.

Table 1: Income, consumption and occupation by land ownership status

land category	Landless	Marginal	Small	Medium	Large	Big
A. Household size						
Average household size	4.64	4.80	5.67	6.76	7.93	9.11
B. Sources of Income (rupees)						
Farm income	676	5,203	17,047	27,924	35,008	57,259
Wage income	1,032	1,466	309	43	0	0
Remittances	270	541	442	492	960	0
Other income	139	52	454	1,022	760	0
Total	2,117	7,262	18,252	29,481	36,728	57,259
C. Consumption (food and durable goods)						
Two meals a day (%)	88.18	91.01	96.92	97.66	98.00	92.59
Own house (%)	81.41	92.16	94.62	97.27	98.00	100.00
At least one cow (%)	55.66	65.85	80.00	87.50	90.67	92.59
TV (%)	26.65	25.16	49.23	53.91	72.00	85.19
Radio (%)	35.37	38.40	45.38	45.70	54.00	70.37
Refrigerator (%)	2.85	1.63	6.15	8.98	15.33	22.22
D. Occupation of adults in the household						
Housework (%)	37.38	37.36	36.07	36.62	37.08	34.31
Student (%)	6.88	8.17	12.72	12.73	12.30	17.05
Employee (%)	5.57	4.55	4.39	4.86	7.03	6.91
Non-agricultural worker (%)	39.09	26.12	17.77	14.48	16.36	17.64
Agricultural worker (%)	10.09	11.91	1.95	1.47	0.56	0.00
Own cultivator (%)	0.56	11.64	26.42	29.03	26.06	23.16
N	1,227	612	130	256	150	27

Notes: Data comes from responses at the time of the survey (2004). Land categories are defined as follows. Landless households do not own agricultural land, marginal households own between 0 and 1.25 acres, small households own between 1.25 and 2.5 acres, medium households own between 2.5 and 5 acres, large households own between 5 and 10 acres, and big households own more than 10 acres. In D figures are constructed considering all household members older than 14, and only their primary occupation.

Table 2: Multiple-male households engaged in own cultivation

	land category	Landless	Marginal	Small	Medium	Large	Big
(a)	Households engaged in own cultivation	33	372	113	220	127	26
(b)	Households with at least one male engaged in own cultivation	32	357	110	219	125	26
(c)	Households with at least one pair of male siblings engaged in own cultivation	0	21	18	70	53	11
(d)	(b)/(a)	0.970	0.960	0.973	0.995	0.984	1
(e)	(c)/(b)	0	0.059	0.164	0.320	0.424	0.423

Notes: Households are considered as engaged in own cultivation if at least 1 adult reports own cultivation as his/her primary or secondary occupation. Land categories are defined in table 1.

Table 3: Comparing samples

	Full Sample (1)	Restricted Sample (2)	Difference between columns 1 and 2 (3)
Household size	5.159	5.098	0.065
	(2.496)	(2.389)	(0.074)
Fraction of immigrant households	0.303	0.332	-0.046
	(0.460)	(0.471)	(0.013)***
Total agricultural land	1.100	0.950	0.208
	(2.265)	(2.081)	(0.063)***
Irrigated agricultural land	0.732	0.658	0.161
	(1.785)	(1.582)	(0.051)**
Unirrigated agricultural land	0.368	0.346	0.047
	(1.287)	(1.219)	(0.034)
% Landless	53.42	56.60	
% Marginal (between 0 and 1.25 acres)	25.11	24.46	
% Small (between 1.25 and 2.5 acres)	5.13	4.90	
% Medium (between 2.5 and 5 acres)	9.51	8.29	
% Large (between 5 and 10 acres)	5.58	4.74	
% Big (more than 10 acres)	1.26	1.01	
N	2402	1697	

Notes: Columns 1 and 2 report means with standard errors in parentheses. Means are computed using only survey answers for the year 2004. Column 2 includes those households for which both the constructed land holding and family size matched the reported in 2004. Column 3 reports tests for differences of means across columns 1 and 2. Robust standard errors are in parentheses. Tests are based on regressions with village fixed effects. ***, ** and * indicate statistical significance at the 99%, 95% and 90%, respectively.

Table 4: Trends in inequality and land reform, selected years

	1968	1978	1988	1998	2004
A. Population					
Observed average household size	5.903	5.299	4.854	4.971	5.098
Index of natural population	100			150.8	
B. Within-village inequality measures					
Gini coefficient	0.551	0.567	0.617	0.639	0.649
Coefficient of variation	1.360	1.410	1.547	1.677	1.734
C. Share of households by land category					
Landless	37.68	43.31	48.58	53.93	56.60
Marginal	22.61	20.53	22.81	25.10	24.46
Small	11.84	11.12	9.31	5.49	4.90
Medium	13.52	13.22	10.32	8.68	8.29
Large	10.25	8.16	6.75	5.49	4.74
Big	3.98	3.65	2.23	1.30	1.01
D. Land reform					
Cumulative % land registered×100	0.03	5.22	13.57	11.02	
Cumulative % land distributed×100	0.00	1.88	7.52	7.94	
Cumulative % households registered×100	0.19	4.92	7.21	5.92	
Cumulative % households distributed×100	0.00	8.54	19.69	19.15	

Notes: Numbers reported above are simple (i.e. unweighted) averages. In panels A, B and C, data from the restricted sample is used. Average natural population is normalized to 100 in 1968. % land registered and % land distributed are computed as the proportion of land affected by each program over the total cultivable land in each village. % households registered and % households distributed are computed as the proportion of households affected by each program over the total number of households per village.

Table 5: Household division: Summary statistics

	#	Total	Mean	50th p.	75th p.	95th p.
(1) Death of member of the household	1,525	106.71	0.07	0	0	0.04
(2) Exit of spouse of head	49	15.88	0.32	0	0	2
(3) Out-marriage	1,576	203.96	0.13	0	0	0.67
(4) Division due to other reasons	6,551	2648.24	0.40	0	0.16	2.16

Notes: All figures are in acres, except for #, the total number of events. Reasons stated in (4) include change in household size, change in income/expenditure, disputes, registration of tenants and threat of land reforms.

Table 6: Division rates and proportion of land lost, in different size classes 1967-2004 (restricted sample)

Land Class	% of households	% land lost
Landless	4.46	0.21
Marginal	4.43	1.07
Small	4.83	1.52
Medium	4.53	1.19
Large	4.19	1.05
Big	5.03	1.51

Notes: The first column shows the annual proportion of households that divided in a given period of time. The second column indicates the proportion of land that households lost due to division. Division means one or more members left the household. Numbers are percentages.

Table 7: Effect of land reform on inequality reduction: reduced-form village regressions 1968-98

Dependent variable:	Coefficient of variation in 1998			
Sample:	full		restricted	
	(1)	(2)	(3)	(4)
Coefficient of variation in 1968	0.551***	0.530***	0.693***	0.679***
	(0.136)	(0.130)	(0.123)	(0.124)
Cumulative % land registered	-0.004		-0.037	
	(0.023)		(0.031)	
Cumulative % land distributed	-0.255**		-0.805	
	(0.100)		(0.626)	
Cumulative % households registered		-0.453		-0.368
		(0.280)		(0.555)
Cumulative % households receiving titles		-0.436***		-0.266
		(0.125)		(0.195)
Change in $\frac{natural population}{land}$	0.047***	0.042***	0.063***	0.063***
	(0.015)	(0.015)	(0.020)	(0.020)
Constant	0.670***	0.804***	0.645***	0.685***
	(0.151)	(0.152)	(0.151)	(0.158)
Adjusted R-squared	0.534	0.564	0.518	0.516
Observations	88	88	83	83

Notes: Robust standard errors in parentheses. In (1) and (3), % land registered and % land distributed are computed as the proportion of land affected by each program over the total cultivable land in each village in 1998. In (2) and (4), % households registered and % households distributed are computed as the proportion of households affected by each program over the total number of households per village in 1998. Change in $\frac{natural population}{land}$ is defined as the difference between the natural population to land ratio in 1998 and 1968. ***, ** and * indicate statistical significance at the 99%, 95% and 90%, respectively.

Table 8: Effect of land reform on landlessness: reduced form village regressions 1978-98

Dependent variable:	Proportion of households landless in 1998			
Sample:	full		restricted	
	(1)	(2)	(3)	(4)
Proportion households landless in 1978	0.863***	0.836***	0.819***	0.810***
	(0.085)	(0.078)	(0.081)	(0.080)
Cumulative % land registered	-0.021**		-0.028***	
	(0.008)		(0.010)	
Cumulative % land distributed	0.011		-0.611***	
	(0.065)		(0.170)	
Cumulative % households registered		-0.077		-0.065
		(0.095)		(0.115)
Cumulative % households receiving titles		-0.125***		-0.142***
		(0.035)		(0.046)
Change in $\frac{natural population}{land}$	0.004	0.003	0.001***	0.001***
	(0.003)	(0.003)	(0.000)	(0.000)
Constant	0.078***	0.127***	0.133***	0.150***
	(0.028)	(0.030)	(0.040)	(0.042)
Adjusted R-squared	0.649	0.694	0.635	0.645
Observations	88	88	85	85

Notes: Robust standard errors in parentheses. The dependent variable is number of 1998 landless households divided by number of 1978 households in each village. In (1) and (3), % land registered and % land distributed are computed as the proportion of land affected by each program over the total cultivable land in each village in 1998. In (2) and (4), % households registered and % households distributed are computed as the proportion of households affected by each program over the total number of households per village in 1978. Change in $\frac{natural population}{land}$ is defined as the difference between the natural population to land ratio in 1998 and 1978. ***, ** and * indicate statistical significance at the 99%, 95% and 90%, respectively.

Table 9: Determinants of household division, using past reform, average of last three years

Dep. Variable:	Probability of division					
Sample:	full			restricted		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged HH size	0.417***	0.448***	0.448***	0.496***	0.521***	0.521***
	(0.028)	(0.032)	(0.032)	(0.037)	(0.040)	(0.040)
Lagged land	0.125***	0.067	0.067	0.117***	0.067	0.068
	(0.043)	(0.046)	(0.047)	(0.040)	(0.053)	(0.053)
% land registered		-0.294***	-0.295***		-1.840**	-1.841**
		(0.044)	(0.040)		(0.931)	(0.939)
Lagged land*% land registered		0.083***	0.083***		0.427**	0.427**
		(0.020)	(0.018)		(0.188)	(0.190)
Above-ceiling dummy		1.221**	1.222**		0.546	0.545
		(0.497)	(0.497)		(0.690)	(0.687)
% land distributed			0.339			1.193
			(0.699)			(1.370)
Lagged land*% land distributed			-0.022			-0.126
			(0.078)			(0.259)
Observations	40,621	36,870	36,870	28,011	25,442	25,442
Pseudo R^2	0.0868	0.0908	0.0908	0.0938	0.0975	0.0975

Notes: Logit coefficients reported with robust standard errors in parentheses, adjusted for clustering on villages. All regressions include year dummies and household fixed effects. The variables % land registered and % land distributed are computed as the sum over the previous three years of the share of land affected by each program over the total cultivable land in each village, using official land records. ***, ** and * indicate statistical significance at the 99%, 95% and 90%, respectively.

Table 10: Determinants of land sales and purchases, using lagged land reform, average for past 3 years

Dep. Variable:	Pr(land sale)				Pr(land purchase)			
Sample:	full		restricted		full		restricted	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\log\left(\frac{\text{Lagged HH Size}}{\text{Lagged land}}\right)$	-0.908***		-1.086***		0.063**		0.054	
	(0.184)		(0.161)		(0.028)		(0.036)	
Lagged HH Size		0.035		-0.018		0.013		-0.010
		(0.043)		(0.050)		(0.038)		(0.048)
Lagged land		0.133**		0.480***		-0.252***		-0.228***
		(0.056)		(0.077)		(0.052)		(0.057)
% land registered		0.163		-0.002		0.503***		0.510***
		(0.594)		(0.891)		(0.072)		(0.058)
Lagged land*% land registered		-0.153		-0.094		-0.132**		-0.153***
		(0.267)		(0.405)		(0.053)		(0.043)
% land distributed		-1.776		-3.220		-1.904		-0.278
		(1.760)		(3.839)		(1.422)		(3.184)
Lagged land*% land distributed		0.697**		0.833		0.739***		0.082
		(0.309)		(0.711)		(0.260)		(0.916)
Above-ceiling dummy		0.311		0.354		0.924**		-0.004
		(0.351)		(0.450)		(0.471)		(0.538)
Observations	12,612	11,483	8,623	7,837	10,438	9,546	6,952	6,339
Pseudo R^2	0.0639	0.0511	0.0805	0.0824	0.0394	0.0519	0.0459	0.0573

Notes: Logit coefficients reported with robust standard errors in parentheses, adjusted for clustering on villages. Regressions include household fixed effects and year dummies. % land registered and % land distributed are computed as the sum over the previous three years of the share of land affected by each program over the total cultivable land in each village. ***, ** and * indicate statistical significance at the 99%, 95% and 90%, respectively.

Table 11: Determinants of immigration, cross section 1978-98

Dependent variable: Proportion of post-1967 immigrant households in 1998				
Sample	full		restricted	
	(1)	(2)	(3)	(4)
Cumulative % land registered	-0.004		-0.002	
	(0.015)		(0.016)	
Cumulative % land distributed	0.175**		0.581***	
	(0.069)		(0.204)	
Cumulative % households registered		-0.168		-0.138
		(0.146)		(0.209)
Cumulative % households distributed		0.095		0.108
		(0.076)		(0.083)
Land per capita	-0.158**	-0.164**	-0.192**	-0.190**
	(0.066)	(0.071)	(0.079)	(0.082)
Constant	0.238***	0.245***	0.260***	0.281***
	(0.033)	(0.033)	(0.034)	(0.037)
Observations	89	89	88	88
Adjusted R-squared	0.067	0.031	0.095	0.029

Notes: Robust standard errors in parentheses. In (1) and (3), % land registered and % land distributed are computed as the proportion of land affected by each program over the total cultivable land in each village. In (2) and (4), % households registered and % households distributed are computed as the proportion of households affected by each program over the total number of 1978 households per village. Land per capita is the ratio of cultivable land to village population in 1978. All measures of land registration and land distribution are computed on the basis of official land records. ***, ** and * indicate statistical significance at the 99%, 95% and 90%, respectively.

Table 12: IV and OLS estimates of effects of tenancy reform on likelihood of household division (linear probability model, 1982–1996)

Dep. Variable:	Probability of division							
Sample:	full				restricted			
Sample (landowners):	small		large		small		large	
Model:	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cumulative % Land Registered	-0.120***	-0.069	0.213***	0.317**	-0.089***	-0.042	0.230***	0.247***
	(0.019)	(0.042)	(0.023)	(0.128)	(0.020)	(0.057)	(0.024)	(0.066)
Cumulative % Land Distributed	-0.346**	-0.336	0.084	0.221	-1.420***	-1.453***	1.061***	0.952*
	(0.147)	(0.234)	(0.177)	(0.338)	(0.263)	(0.327)	(0.364)	(0.514)
Lagged HH Size	0.103***	0.103***	0.080***	0.075***	0.116***	0.116***	0.074***	0.068***
	(0.009)	(0.009)	(0.011)	(0.010)	(0.012)	(0.012)	(0.017)	(0.018)
Lagged Land	0.048	0.057	0.004	0.006	0.074	0.079	0.006	0.009
	(0.065)	(0.065)	(0.003)	(0.004)	(0.086)	(0.084)	(0.006)	(0.006)
Constant	-0.425***		-0.488***		-0.438***		-0.509***	
	(0.042)		(0.054)		(0.049)		(0.076)	
Observations	5,803	5,685	1,603	1,549	4,347	4,254	889	861
Number of households	1,446	1,328	441	387	1,090	997	246	218
R-squared[a]	0.092	0.093	0.082	0.077	0.099	0.099	0.051	0.054
Kleibergen-Paap under-id test (p-value)		0.984		0.987		0.995		0.996
Hansen's J over-id test (p-value)		0.543		0.670		0.601		0.371
Endogeneity test for Barga (p-value):		0.297		0.196		0.436		0.800
First stage F-test		18.59		8.29		47.79		91.21
First stage F-test (excl. inst.)		15.72		7.89		48.65		91.05

Notes: Robust standard errors in parentheses, adjusted for clustering on villages. All regressions include year dummies and household fixed effects. The variables % land registered and distributed are computed as the cumulative percentage of total land, using official land records. Small landowners are households with less than 2.5 acres of cultivable land. % land registered is instrumented using cumulative lagged share of Left share in local government and its square, cumulative % of INC seats in parliament, cumulative average vote share difference in the district, as well as the number of households, rainfall, GP local irrigation and road expenditures, log price of rice, canals and roads in district, as described in the text. Table A-6 in the online appendix presents the results for the first stage. ***, ** and * indicate statistical significance at the 99%, 95% and 90%, respectively. [a] Adjusted R-squared in (1), (3), (5) and (7), and centered R-squared otherwise.

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ONLINE APPENDIX (NOT FOR PUBLICATION)

Evolution of Land Distribution in West Bengal 1967–2004: Role of Land Reform and Demographic Changes

Pranab Bardhan, Michael Luca, Dilip Mookherjee and Francisco Pino

1. Additional Descriptive Statistics

Average Landownership, Household Size and Immigration

Table A-1 provides average household size, ownership of agricultural land and immigration for select years between 1967 and 2004. Panel A shows statistics for the full sample, while panel B displays the statistics for the restricted sample. We see a sharp drop in the mean land owned from nearly 3 acres per household to a little over 1 acre. The median dropped by less, from 0.7 acre to 0. The drop is equally dramatic when we look at the restricted sample: for instance the 75th percentile landownership dropped from 2.86 to 0.66 acres. With regard to household size, there was some reduction but it was not as dramatic as the drop in land owned: the median fell from 6 to 5, and the mean also fell by 1 unit, resulting in a reduction of the order of 16%. Consequently land per capita fell by nearly three times in the full sample, and more than halved in the restricted sample.

To what extent was the reduction in average landownership the result of immigration? Table A-1 shows that approximately one third of all households in 2004 had immigrated into the village since 1967. Approximately one third to one fourth of these immigrants came from Bangladesh. Hence immigrant inflows were sizeable. Immigrating households typically arrive with no land, and lag behind natives with respect to landownership. Nevertheless, trends in average landholdings for native households were similar to those for the full sample, as shown in table A-1. This suggests that the declining patterns of landownership cannot be attributed to rising immigration.[32]

Could the decline in landholdings per household have resulted from conversion of agricultural land to non-agricultural purposes? Table A-2 shows changes in cultivable land and number of households over two decades of the 1980s and 1990s, using the indirect household survey used in Bardhan and Mookherjee (2006, 2010). The number of households rose

[32]This is what one would expect if most of these immigrant flows were from other West Bengal villages, the effects of which would tend to wash out on average. However, our questionnaire did not ask immigrants where they had been living originally, except whether they had arrived from Bangladesh. So we do not know the extent to which the non-Bangladeshi immigrants came from within West Bengal rather than other parts of India.

sharply, while the amount of cultivable land per village remained approximately the same. Hence conversion of agricultural land into forests or other non-agricultural purposes was not the cause of the decline in land availability per household. This table also shows that village population increased sharply, as the number of households per village rose approximately 70%, significantly outweighing the 16% drop in average household size. Our theory suggests that the increase in the number of households resulted from the growth in population which spurred increased rates of household divisions.

Returning to the direct household survey, immigration accounted for a 15% drop in land per household, while for natives it dropped by about 40%. Table A-3 decomposes the latter change between different channels. For the full (restricted) sample, 81% (85%) of the decline in land for native households was accounted for by land lost owing to household division, 6.6% (11%) to land market transactions, 6.3% (7%) to gifts and transfers, 4.6% (-1.1%) for land reforms, and 3.6% (1.3%) for other miscellaneous reasons. Hence land lost owing to household splits and migration of household members was the dominant source, followed by immigration, land market transactions and transfers. The direct effect of land reforms was negligible, measured by the proportion of land redistributed.

Household Divisions, Land Transactions and Land Reforms

Figure A-1 in the online appendix shows the size and frequency of land market transactions. These are not necessarily balanced because we are working with a sample of households rather than the entire village population. Besides we exclude non-residents who may own some land, as well as those who may have left the village between 1967 and 2004. Nevertheless it is apparent that the sales and purchases approximately balance each other in the data, except the last 5 years or so when the sales outstrip the purchases (which may reflect an increasing tendency for non-residents to purchase land). However the extent of excess sales towards the end is of the order of 0.2–0.25 acres, not large enough to explain the mean reduction in land per resident household in excess of 1 acre for the period as a whole.

Note also that the land transactions are considerable in frequency, and occur throughout the period. Hence the land market has been quite active. Table A-4 in the online appendix shows 26% of all households engaged in land sales, while 23% engaged in land purchases. In the full sample there is a tendency for rising extent of transactions in the first half, with some noticeable spikes between 1980–85, the period of heightened land reform activity. In the restricted sample these spikes are muted, with no evident tendency to be bunched in the earlier period.

Since there may be recall problems with regard to land reforms, we rely instead on the official land records. Figure A-2 in the online appendix uses data from the local land records offices for both tenancy registration (*barga*) and land title distribution (*patta*) for the village as a whole, until the year 1998 (the year when the official village level data on land reform was collected). The figure on the left expresses the extent of land reform as percent of cultivable land, and the latter as a percent of households. These data series are taken from

Bardhan and Mookherjee (2006, 2010), with the land area and household numbers calculated on the basis of interpolation of estimates from the indirect household survey for years 1978 and 1998. Both sets of land reforms were pronounced between the late 1970s and mid-80s, with the tenancy reform more significant in terms of cultivable land area and the land titling program more significant in terms of the number of households directly benefitting.

2. Additional Figures

Figure A-1: Land market: Sales and purchases per household (1967-2004)

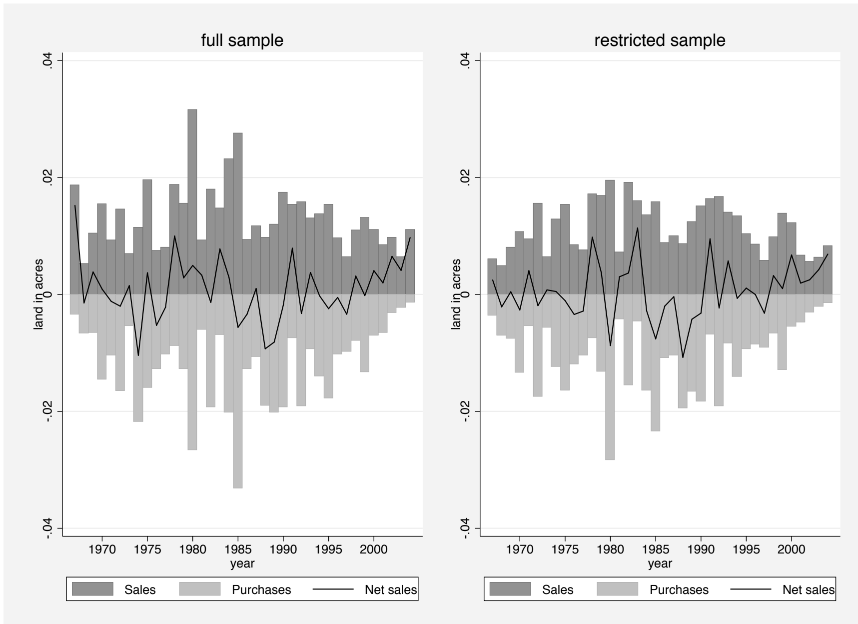
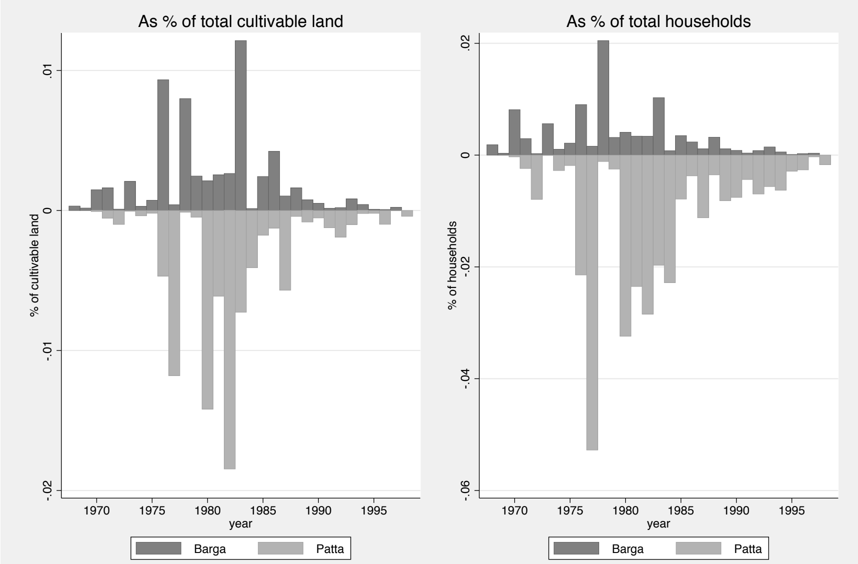


Figure A-2: Average land reform implemented, official land records (1968-1998)



Source: West Bengal Block Land Reform Office (BLRO) for relevant villages.

3. Additional Tables

Table A-1: Landownership, household size and immigration

Variable	statistic	1967	1976	1985	1994	2004
A. Full Sample						
Land per household	(mean)	2.908	2.418	1.973	1.557	1.228
	(50th perc.)	0.720	0.620	0.330	0.160	0.000
	(75th perc.)	3.662	3.320	2.660	1.840	1.060
Share of landless	-	0.344	0.376	0.416	0.461	0.505
Household size	(mean)	6.332	5.763	5.158	5.074	5.216
	(50th perc.)	6.000	6.000	5.000	5.000	5.000
	(75th perc.)	8.000	7.000	7.000	6.000	6.000
Land per capita	(mean)	0.621	0.509	0.407	0.306	0.230
	(50th perc.)	0.129	0.109	0.080	0.033	0.000
	(75th perc.)	0.611	0.556	0.500	0.370	0.238
Land per capita (only natives)	(mean)	0.622	0.531	0.446	0.355	0.270
	(50th perc.)	0.132	0.125	0.113	0.075	0.047
	(75th perc.)	0.611	0.600	0.563	0.472	0.364
Share of immigrants	-	0.002	0.073	0.143	0.233	0.278
Share of immigrants from Bangladesh	-	0.001	0.018	0.033	0.062	0.065
B. Restricted Sample						
Land per household	(mean)	2.170	1.869	1.523	1.204	0.950
	(50th perc.)	0.500	0.330	0.100	0.000	0.000
	(75th perc.)	2.865	2.640	1.980	1.000	0.660
Share of landless	-	0.378	0.426	0.475	0.527	0.566
Household size	(mean)	5.937	5.433	4.785	4.843	5.098
	(50th perc.)	6.000	5.000	5.000	5.000	5.000
	(75th perc.)	7.000	7.000	6.000	6.000	6.000
Land per capita	(mean)	0.407	0.366	0.303	0.234	0.184
	(50th perc.)	0.096	0.060	0.026	0.000	0.000
	(75th perc.)	0.500	0.447	0.383	0.244	0.143
Land per capita (only natives)	(mean)	0.408	0.385	0.340	0.285	0.222
	(50th perc.)	0.096	0.083	0.080	0.043	0.027
	(75th perc.)	0.500	0.500	0.473	0.350	0.250
Share of immigrants	-	0.002	0.089	0.169	0.278	0.332
Share of immigrants from Bangladesh	-	0.001	0.021	0.041	0.075	0.077

Notes: Land includes only agricultural land. Household size includes all members (adults and children).

Table A-2: Changes in cultivable land and number of households, indirect survey

	Obs.	Mean	Std. Dev.	Min	Max
	Initial report prior to 1980				
Cultivable land in initial year	63	358.5	303.6	18.0	1265.5
Cultivable land in 1998	63	360.2	283.3	26.2	1304.0
No. households in initial year	63	231.0	219.5	24.0	1083.0
No. households in 1998	63	419.5	380.3	47.0	1692.0
	Initial report on or after 1980				
Cultivable land in initial year	26	230.6	170.1	4.6	642.7
Cultivable land in 1998	26	217.6	149.2	9.6	495.3
No. households in initial year	26	236.7	156.0	18.0	759.0
No. households in 1998	26	346.7	186.9	60.0	770.0

Notes: Cultivable land is measured in acres. Date of initial report varies by village. Among those with reports prior to 1980, 46 villages report cultivable land in 1977, 14 in 1978 and 3 in 1979. Among those with reports on or after 1980, 1 village reports cultivable land in 1980, 1 in 1981, 23 in 1983, and 1 in 1984.

Table A-3: Determinants of decrease in land holdings: cumulative changes at the household level, only natives (1967-2004)

Sample:	full	restricted
Land in 1967	2.862	2.143
Land change	-1.370	-0.926
Lost due to land division	-1.108	-0.785
Lost through sales	-0.557	-0.475
Gained through purchases	0.467	0.373
Lost due to reform	-0.097	-0.018
Gained due to reform	0.034	0.028
Lost as a gift	-0.116	-0.097
Gained as a gift	0.030	0.032
Lost for other reasons	-0.060	-0.024
Gained for other reasons	0.011	0.012

Notes: All numbers indicate average acres gained or lost per household. The category *Lost for other reasons* includes forced transfer, mortgaged, and lost due to natural disasters. All data comes from the household survey.

Table A-4: Proportion of households experiencing transactions, land reform and divisions (1967-2004)

Sample:	full	restricted
Sales	0.257	0.238
Purchases	0.229	0.211
Lost due to reform	0.007	0.004
Gained due to reform	0.036	0.036
Exits and division	0.685	0.638

Notes: All numbers indicate the proportion of households with at least one event (sale, purchase, etc) between 1967 and 2004.

Table A-5: Determinants of land lost by households due to division

Dep. Variable:	Land lost due to division in acres					
Sample:	full			restricted		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged HH size	0.016***	0.019***	0.019***	0.009**	0.013***	0.013***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)
Lagged land	0.051***	0.040**	0.040**	0.069***	0.038***	0.038***
	(0.010)	(0.016)	(0.016)	(0.019)	(0.007)	(0.007)
% land registered		-0.011	-0.010		-0.020	-0.020
		(0.014)	(0.014)		(0.021)	(0.021)
Lagged land*% land registered		0.000	-0.000		0.006	0.006
		(0.009)	(0.009)		(0.012)	(0.012)
Above-ceiling dummy		0.175	0.173		0.091	0.093
		(0.122)	(0.121)		(0.110)	(0.110)
% land distributed			-0.208			0.181
			(0.231)			(0.134)
Lagged land*% land distributed			0.062			-0.069
			(0.077)			(0.086)
Constant	-0.148***	-0.190***	-0.189***	-0.120***	-0.134***	-0.135***
	(0.032)	(0.036)	(0.036)	(0.027)	(0.022)	(0.022)
Observations	58,765	54,175	54,175	41,536	38,190	38,190
R-squared	0.030	0.027	0.028	0.035	0.019	0.019
Number of households	2,304	2,268	2,268	1,681	1,649	1,649

Notes: OLS coefficients reported with robust standard errors in parentheses, adjusted for clustering on villages. The regressions include observations where there was no land lost (coded as a zero). All regressions include year dummies and household fixed effects. The variables % land registered and % land distributed are computed as the sum over the previous three years of the share of land affected by each program over the total cultivable land in each village, using official records. ***, ** and * indicate statistical significance at the 99%, 95% and 90%, respectively.

Table A-6: First stage of IV regressions

Dep. Variable:	Cum. % Land Registered			
Sample:	full		restricted	
Sample (landowners):	small	large	small	large
	(1)	(2)	(3)	(4)
$LS_{v,t-1}$	51.834***	43.065***	53.596***	48.190***
	(13.454)	(11.990)	(12.194)	(11.123)
$LS^2_{v,t-1}$	-33.096***	-19.500*	-33.754***	-25.944**
	(10.406)	(11.151)	(10.259)	(12.224)
$INC_t * LS_{v,t-1}$	-44.357***	-49.269***	-46.550***	-50.998***
	(11.484)	(10.139)	(9.937)	(6.813)
$AVSD_{vt}$	-46.757**	-38.319**	-41.561**	-37.539**
	(18.481)	(16.876)	(18.664)	(16.198)
$AVSD_{vt} * LS_{v,t-1} * INC_t$	26.258*	45.887**	28.799*	34.921
	(15.466)	(21.032)	(15.739)	(21.728)
$AVSD_{vt} * LS_{v,t-1}$	-142.562	-113.064	-170.430	-141.744
	(102.542)	(85.646)	(110.623)	(111.487)
$AVSD_{vt} * LS^2_{v,t-1}$	173.238*	114.981	193.336*	152.922
	(95.678)	(92.658)	(102.201)	(113.288)
Observations	5,685	1,549	4,254	861
F-test	18.59	8.29	47.79	91.21
Number of households	1,328	387	997	218
Adjusted R-squared	0.570	0.619	0.620	0.726

Notes: Robust standard errors in parentheses, adjusted for clustering on villages. All regressions include year dummies and household fixed effects, as well as the number of households, rainfall, GP local irrigation and road expenditures, log price of rice, canals and roads in district. Political variables (LS, INC, AVSD and interactions) are cumulated and scaled by the amount of cultivable land in the village. Small landowners are households with less than 2.5 acres of cultivable land. ***, ** and * indicate statistical significance at the 99%, 95% and 90%, respectively.