Credit and Land Contracting: A Test of the Theory of Sharecropping

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Abstract

Choice of a share vs. fixed rent land rental contract has figured prominently in the theory of industrial organization. This theory tells us that, while a share contract is inefficient in a first-best world, it may be the preferred option under second-best conditions. It has thus predicted the existence of sharecropping as the potentially preferred contract under conditions of liquidity constraint. Rigorous empirical evidence is however still lacking on this basic contribution of theory. We use a randomized experiment in a credit program for landless workers and marginal farmers organized by BRAC in Bangladesh to show that increased access to credit has a large positive effect on the choice of fixed rent over share rent contracts, both in terms of number of contracts and area contracted. As predicted by theory, the magnitude of this shift away from sharecropping is enhanced when the tenant is less exposed to risk. Development programs that facilitate access to credit to potential tenants can thus help them take more efficient land rental contracts.

Keywords: credit, rental, contracts, sharecropping, fixed rent, Bangladesh

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1. Introduction

Share tenancy as a form of land contracting where rent is set as a share of output is widespread across the world. In the 1970s, about 36.2% of the world's total farmlands were under pure or owner-cum tenancy, 61.1% under owner cultivation, and the remaining under other forms of tenure (Otsuka, Chuma, and Hayami 1992). Of tenanted lands, 36.1% were under share tenancy. For Asia, the corresponding proportions were 16% of cultivated land in tenancy and 84.5% of tenanted land under share tenancy. Recent data show that in Bangladesh, the context of this study, 24% of the cultivated land was rented, and 43% of tenanted land was under share contract in 2008 (BBS 2011). A share contract is, however, inferior to a fixed rent contract in eliciting effort under first-best market conditions, a phenomenon famously known as the "Marshallian inefficiency of sharecropping".[1]

A voluminous literature provides theoretical explanations on the resulting puzzle of the widespread existence of sharecropping, examining the potential role of various deviations from the first best (Quibria and Rashid 1984; Hayami and Otsuka 1993). One such deviation is existence of a liquidity constraint. Laffont and Matoussi (1995) show that a liquidity constraint on tenants increases the prevalence of share contracting relative to fixed rent. Shetty (1988) develops a theoretical model where choice of sharecropping is explained by the risk of ex-post liquidity constraints, as a fixed rent could not be fully paid in bad states of nature. Braverman and Stiglitz (1989) show that, in a general equilibrium model of land allocation, when credit is rationed a capital intensive technological change can induce a long-term increase in concentration of land ownership and in sharecropping arrangements as tenants are capital constrained, lowering productivity. Relaxation of a credit constraint can thus be an effective way of reducing the incidence of second-best efficient share contracts. The theoretical literature on sharecropping also emphasizes the role of risk in explaining the prevalence of share contracts when insurance markets are failing and when the tenant is not able or willing to absorb all the production risk. Stiglitz (1974) shows that sharecropping allows risk sharing between landlord and tenant as the rent paid varies with the stochastic level of output achieved. This creates a trade-off between increasing tenant effort by reducing his exposure to risk through a lower output share, and decreasing effort by use of the same instrument. Relaxation of the credit constraint in inducing the choice of a fixed rent over a share rent contract should thus be more intense when risk is less constraining on the tenant.[2]

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[1] The essence of the Marshallian inefficiency is that, under a share contract, the tenant only receives a share of output while assuming the full cost of some of the inputs, labor in particular, which leads to suboptimal provision of the inputs not shared in equal proportion to output. There is substantial empirical evidence on the Marshallian inefficiency of sharecropping (Shaban 1987; Bell 1977; Sadoulet *et al*. 1997; Arcand *et al*. 2007). There is also evidence that moral hazard alone cannot explain the observed inefficiency. Jacoby and Mansuri (2008) suggest that imperfect commitment can also drive inefficiency.

[2] Another argument for sharecropping is missing markets for inputs such as farm management and labor supervision capacity when they are non-contractible and one is more efficiently performed by the landlord and the other by the tenant (Eswaran and Kotwal 1985). We do not explore this mechanism in this paper.

While the theory of sharecropping as a potentially second-best efficient contract when the tenant is liquidity constrained is well established, rigorous empirical evidence on the effect of a liquidity constraint on the choice of land contract is limited. Laffont and Matoussi (1995) investigate this empirically using data collected on 100 households from rural Tunisia in 1986.[3] The analysis was carried out at the plot level, with liquidity measured as the amount of working capital (defined as available monetary liquidity and rental value of equipment owned) available to the farmer. They found that tenants with higher level of working capital are more likely to have fixed rent contracts. Using plot-level data from three Indian villages, Chaudhuri and Maitra (1997) also show that an increase in the tenant's capacity to borrow (measured by his outstanding debt) increases the probability of a fixed rental contract relative to a sharecropping contract. Difficulty with both analyses is the presumed exogeneity of the tenant's working capital or borrowing capacity.

In this paper, we develop a simple model on how liquidity constraint can affect the choice of land rental contract. Guided by the model's theoretical predictions, we estimate the effect of access to credit on the choice of contract. We use for this a randomized experiment built in a program organized by BRAC in Bangladesh that offers credit to landless workers and smallholder farmers. Further, guided by the theoretical prediction that the choice of a sharecropping over a fixed rent contract can also be explained by the tenant's exposure to uninsured risk, we investigate whether the effect of credit on the choice of land contract is heterogeneous with respect to exposure to risk.

We find that the effect of access to credit on taking fixed rent contracts is positive and large in magnitude for both the number of contracts and the area contracted while the effect on taking share contracts is small and statistically insignificant for both outcomes. We also find that the effect of credit on choice of fixed rent contract is heterogeneous, with larger responses for tenants that are in contexts with less risky weather conditions.

This paper contributes to the literature on credit markets and sharecropping following the seminal paper of Laffont and Matoussi (1995). We deviate from this and other studies by using data from a randomized controlled experiment of a unique credit program for landless workers and smallholder farmers. As such, we provide the first rigorous empirical evidence on the role of a financial constraint on contract choice, as well as on the mitigating role of risk in responding to a relaxation of the liquidity constraint. In addition to providing rigorous identification of causality, our study is based on solid empirical evidence based on a large sample compared to previous studies. The study of Laffont and Matoussi (1995) was based on a small sample of 170 plots from Tunisia while that of Chaudhuri and Maitra (1997) was based on data for 266 plots in only three Indian villages. By contrast, our study covers 22 districts (out of 64) in Bangladesh, and more than 4,000 potential tenants. The program we study has been the object of an impact analysis by

[3] They used another similar data set collected in 1988 to test the robustness of their results.

Hossain et al. (2018), but with a different focus. They found that the program induced an increase in farm activities and in crop income among the targeted farmers, although they observe that this may not be sufficient to make a significant difference in overall income. They also briefly look at the impact on land rental, although without distinguishing as we do by contract type and by season, and find like us no aggregate impact on land rental.

The remainder of this paper proceeds as follows. In section 2, we develop a simple model on how a liquidity constraint affects the choice of land rental contract. In section 3, we give information on farming and land rental contracts in Bangladesh. Section 4 presents the BRAC credit program and the evaluation design. Section 5 explains the data used in this study, the program take-up, and gives descriptive statistics on households and contracts. Section 6 presents the results on the impact of access to credit on contract choice. Section 7 concludes.

2. A model of contract choice

The theory of how a liquidity constraint affects the choice of land rental contract was first developed by Laffont and Matoussi (1995) in a principal-agent model, where the tenant has limited availability of working capital and his effective labor is unobservable to the landlord. The landlord chooses the terms of the contract (a general non-linear contract with a share of the product kept by the tenant, a share of the inputs paid by the tenant, and a fixed cash payment made by the tenant to the landlord) under the tenant's incentive and participation constraints. The main prediction of the model is that conditionally on the level of other inputs, the tenant's output share in the contract is increasing in the tenant's working capital. This model could not be fully solved analytically, and does not accommodate risk. We consequently present a simpler framework that only considers two pre-specified contracts rather than a continuum and a simpler production function, but that can be solved analytically and accommodates risk to illustrate how a liquidity constraint can affect the choice of contract for a particular plot. We use a Cobb-Douglas specification, where output is function of land and labor (labor stands for all variable costs, including seeds, irrigation, and chemicals). Plots of given size A are available for rent under two types of contracts: a sharecropping contract where payment to the landlord is in the form of a share α of output or a fixed rent contract where land is rented at a fixed rental rate r. The tenant faces a financial constraint in covering pre-harvest costs, i.e., labor and if under a fixed rent contract land rental.

A generic expression for the tenant's profit under both contracts is:

$$\Pi = \alpha p \theta L^{\beta} A^{\gamma} - wL - rA$$

where L is labor, p the expected output price, w the price or opportunity cost of labor, and θ a stochastic term of mean 1 and variance σ^2. The sharecropping contract is obtained for $r = 0$ and $0 < \alpha < 1$, and the fixed rent contract for $r > 0$ and $\alpha = 1$.

Consider first risk neutral tenants. The tenant's optimization problem is to choose labor to maximize expected profits under the liquidity constraint:

$$\max_{L} E\Pi = \alpha p\, L^{\beta}\, A^{\gamma} - wL - rA$$
$$\text{s.t. } wL + rA \leq K$$

where *K* is total liquidity available to the tenant.[4]
The solution is:

$$L = \min\left\{\frac{K-rA}{w}, \left(\frac{\alpha p\, \beta A^{\gamma}}{w}\right)^{\frac{1}{1-\beta}}\right\}$$

where the first term corresponds to the cases where the liquidity constraint binds. Correspondingly, expected profit is:

$$E\Pi = \min\left\{\alpha p\left(\frac{K-rA}{w}\right)^{\beta} A^{\gamma} - K, w\left(\frac{\alpha p\, \beta A^{\gamma}}{w}\right)^{\frac{1}{1-\beta}}\left(\frac{1-\beta}{\beta}\right) - rA\right\}. \quad (1)$$

Under both types of contracts, the tenant operates under liquidity constraint and expected profits are monotonically increasing in *K* for:

$$K < \bar{K}(\alpha, r) = w\left(\frac{\alpha p\, \beta A^{\gamma}}{w}\right)^{\frac{1}{1-\beta}} + rA. \quad (2)$$

This expression shows that the liquidity necessary to operate optimally under sharecropping is less than what is necessary under a fixed rent contract for two reasons: under sharecropping, due to the Marshallian disincentive, a lower level of labor is applied to production, implying a lower wage bill, and there is no land rent to be paid before harvest.

Profit as a function of available liquidity *K* is represented in Figure 1. The S curve shows profit under sharecropping, which increases steadily with *K* under liquidity constraint until $K = \bar{K}(\alpha, 0)$, defined in equation (2), where it reaches its unconstrained maximum. Curves F1 and F2 represent profit under fixed rent, for a low and a high value of the fixed rental rate *r*, respectively, assuming fixed rent tenants to be always liquidity constrained. Comparing expected profits (equation (1)) under the two contracts shows that, for low values of $K < \frac{rA}{1-\alpha^{1/\beta}}$ (represented on the figure by *K*1 and *K*2, for low and high rental rate *r* respectively) expected profits are higher with sharecropping than with a fixed rent contract, while for higher values of *K*, expected profits are higher with a fixed rent contract. The two profit curves thus exhibit a single crossing. The intuition is that under sharecropping, payment to the landlord increases with production and hence with liquidity, while it remains constant under a fixed-rent contract.

[4] To keep the model simple, we do not specify separately the amount of liquidity that comes from the tenant's own resources and that which is borrowed, and assume a zero interest rate on all liquidity *K* used for inputs. We also do not consider that in sharecropping contracts, landlords often contribute some of the non-labor costs. This would add to the differential need for liquidity between the sharecropping and the fixed-rent contracts.

Consider now the case of a risk-averse tenant who maximizes:

$$\max_L U = E\Pi - R\mathrm{Var}(\Pi) = \alpha p\, L^{\beta}\, A^{\gamma} - wL - rA - R\sigma^2\left(\alpha p L^{\beta}\, A^{\gamma}\right)^2$$

$$\text{s.t. } wL + rA \leq K$$

where R is the coefficient of risk aversion.

How does risk aversion affect the relative benefits of sharecropping or fixed rent contracts? We show below that when both contracts operate under liquidity constraint (i.e., when liquidity is below $\bar{K}$), the intersection of the two utility curves is also at $K1$, suggesting that an increase in available liquidity induces a shift from sharecropping to fixed rent as it does for risk neutral farmers. When sharecroppers are not liquidity constrained, we show that the intersection of the two utility curves is to the right of $K2$, so it does take a higher increase in liquidity for risk averse tenants to switch from sharecropping to fixed rent.

By definition of $K1$, expected profit at this intersection is the same under the two contracts:

$$E\Pi_S = \alpha p L_S^{\beta} A^{\gamma} - K = E\Pi_F = p L_F^{\beta} A^{\gamma} - K$$

where subscripts S and F represent the sharecropping and the fixed-rent contracts, respectively. At that point both revenue and therefore variance of profit are equal:

$$\mathrm{Var}(\Pi_S) = \sigma^2\left(\alpha p L_S^{\beta} A^{\gamma}\right)^2 = \mathrm{Var}(\Pi_F) = \sigma^2\left(p L_F^{\beta} A^{\gamma}\right)^2$$

Hence $U^S = U^F$. So while both utility curves UF1 and US are lower than the expected profit curves F1 and S, they intersect at the same value $K1$, as represented on Figure 1.

When the intersection of expected profit curves occurs at $K2$, if tenants did not adjust their labor choices to accommodate risk, expected profits would remain equal:

$$E\Pi_S = \alpha p L_S^{\beta} A^{\gamma} - wL_S = E\Pi_F = p L_F^{\beta} A^{\gamma} - K$$

but since $wL_S < K$, the variance would be higher under the fixed rent contract:

$$\mathrm{Var}(\Pi_S) = \sigma^2\left(\alpha p L_S^{\beta} A^{\gamma}\right)^2 < \mathrm{Var}(\Pi_F) = \sigma^2\left(p L_F^{\beta} A^{\gamma}\right)^2.$$

Hence U^F would be lower than U^S at $K2$, and the difference between the curves is an increasing function of $R\sigma^2$. The constrained fixed-rent tenant will not re-optimize since he is applying less labor than optimal, but sharecroppers will re-optimize their labor choice. This induces them to lower their labor and increase their utility. Overall, the utility of the fixed rent tenant is now lower than that of the sharecropper at $K2$, and hence the intersection occurs to the right of $K2$, as represented on Figure 1. The shift to the right is greater for higher $R\sigma^2$. Hence in this simple model, risk aversion R and risk exposure σ^2 affect farmers' decision in similar ways.

This schematic model suggests that an increase in available liquidity will induce some tenants to switch from a share contract to a fixed rent contract in contracting for a given plot of land. This switch is expected to happen less in the context of high risk or with tenants that are more risk averse.

Considering however the decisions made at the household level rather than at the plot level, increasing working capital can also be used to increase the cultivated land area. The predictions that can be taken to the data are that with greater access to credit, tenants will weakly increase the land area that they cultivate and the probability that it be under fixed rent contract. Concretely we will test in section 6 the effects of access to credit on the number of plots and the area planted under both types of contracts, and the relative importance of the two. We have no measure of individual risk aversion, but will explore heterogeneity by level of risk exposure.

3. The Context: Farming and access to land in Bangladesh

In Bangladesh, the agricultural sector accounts for about 18% of GDP (BBS 2013) and 43% of the country's employed population (BBS 2017). Cropping patterns are determined by the rainfall cycle. The monsoon season extends from mid-June to mid-October, with the rest of the year a continuous dry period where agriculture is practiced with irrigation (available on 60% of the cultivated area). Crops are grown over three seasons: the Aman season extends from July-August to November-December and mostly depends on monsoon rainfall; the Boro season extends from December-January to April-May and depends on tube-well irrigation; and the Aus season bridges the other two between March-April and June-July, also depending on irrigation.[5] Rice is by far the most important crop contributing 61% of total crop value (Ahmed 2004). Of the three seasons, Boro is the most important for rice, contributing 55% of annual output, while Aman contributes 38%, and Aus 7%.

The land rental market is highly developed and increasingly important among rural farm households. Data from agricultural censuses show that the percentage of rural farm households that are pure tenants (i.e. that have no land of their own, but cultivate land rented from others) grew from 1.1% in 1996 to 3.1% in 2008 (BBS 1999; BBS 2010). Mixed-tenant households (i.e., that cultivate both owned and rented land) grew from 37.5% to 39.8% over the same period. In terms of area, the share of land cultivated under tenancy arrangements also increased, with 24% of total cultivated land in 2008, against 22% in 1996 (BBS 1999; BBS 2011). Rental of land is more prevalent in the Boro than the Aman season, as cultivation under irrigation is more labor intensive, and hence landowners sublet more of their lands to tenants.

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[5] https://www.pecad.fas.usda.gov/cropexplorer/pecad_stories.aspx?regionid=bg&ftype=prodbriefs. These three seasons are also called Kharif 2, Rabi, and Kharif 1, respectively.

Contract types have also evolved over time, with a decline of sharecropping arrangements in favor of diverse forms of fixed rent contracts. Yet, in 2008, 43% of rented land was still under share tenancy, 17% in land mortgaging, and the remaining in different forms of seasonal fixed rent contracts (BBS 2011). Under sharecropping contracts, owners and tenants share output and some input costs. The dominant contract is a 50-50 share in crop output, with large variations in non-labor input cost sharing. Under the mortgaging system, the lender takes possession of the land as soon as the mortgage payment (serving as fixed rent) is made, and holds onto it until the debt is repaid; there is no interest paid on the loan as the lender is expected to earn income from using the land (Bode, Haq, and Dev 2013). Seasonal fixed rent contracts used to be mainly an agreement for the payment of a fixed amount of the produce after harvesting. Yet over time, they have evolved to a system of a fixed amount of money rather than produce, and to a payment before tenants could cultivate rather than at harvest time (Raihan, Fatehin, and Haque 2009). We report below in section 5.3 on contracts for the population in our study, distinguishing between these different forms of fixed rent contracts.

Share contracts and fixed rents contracts are typically for one season, although they are often renewed for the following season or for the same season the following year (Jansen 1986, as cited by Reiersen 2004; Jabbar 1978). For land mortgaging contracts, the minimum length is typically two cropping seasons. National level data show that 49% of mortgage contracts are for one year, 24% for two years, and the rest for more than two years (BBS 1999).

Evidence shows that smallholder farmers in Bangladesh have limited access to financial services. Hossain and Bayes (2009), for example, observe that only 1.5% of farmers owning less than 0.20 hectares of land had access to a formal loan in 2008 (and this was mostly from microfinance institutions) while the corresponding proportion for those owning more than two hectares of land was 20%.

4. The credit program and research design

In 2010, BRAC, a Bangladeshi NGO providing microfinance services and social programs to the poor, started a new credit program for landless workers (with some farming experience as tenants) and smallholder farmers known as the *Borgachashi* (Sharecropper) *Unnoyon* (Development) Program (BCUP). The program is operated in the traditional microfinance framework but provides unique advantages: a low interest rate (the effective interest rate is 20% compared to the traditional microfinance interest rate of about 25%), monthly repayments, and lower levels of installment for the first four months. To be eligible for the credit program, a household must meet the following six criteria: (i) have a national ID card; (ii) an age between 18 and 60 years; (iii) an education level not more than grade 10; (iv) permanent residence in the targeted area for at least three years; (iv) at least three years of farming experience; (v) a total holding size including rented land if any between 33 and 200 decimals (a decimal is 1/100 of an acre); and (vi) not be a member of any NGO program. The targeting criterion related to landholding indicates that the program is intended to serve smallholder farmers including landless tenants, small owner farmers, and mixed tenants (who cultivate both own and rented land). Once a farmer has started with the program, access to BCUP loans continues even if his/her cultivating land increases beyond the 200 decimals threshold.[6] Borrowers are required to save BDT 50 per month. Furthermore, 5% of the total amount is deducted as security savings at the time of loan disbursement.

For the purpose of evaluation, BRAC's introduction of the program in 2012 followed an experimental design over 40 branch offices (each covering a geographical area of about 5-6 km radius from the BRAC local office) from 22 districts.[7] BRAC's Research and Evaluation Division (RED) randomly selected 20 branches for intervention with the remaining 20 branches serving as controls, both widely scattered across the country.[8] Starting in September 2012, BRAC offered credit to eligible households in the treatment branch offices. An eligible household can take credit for the following purposes: (i) general credit for working capital (amounting to BDT 5,000-30,000); (ii) credit to purchase machinery (BDT 30,000-120,000); and (iii) credit for land leasing/mortgaging (BDT 30,000-60,000).[9] In this paper, we estimate the effect on land contracts of all three types of credit as money is fungible.[10]

5. Data, program take up, and descriptive statistics

5.1 Data

Each branch covers multiple villages (10 on average), and, while the program was introduced at the level of the branch, for the purpose of the analysis, RED randomly selected 6 villages in each branch. Prior to the start of the program, in April-May 2012, RED carried out a village census in these villages and identified eligible households. It turned out that there were no eligible households in three villages, so the sample consists in 237 villages, 118 in treatment branches and 117 in control branches. The census identified

[6]This credit program is operated through group formation, known as village organizations (VO). Members are grouped in teams of five members, and four to eight teams form a VO (Hossain *et al.* 2014). VOs serve as solidarity groups, but do not have joint liability.

[7]During 2010-2012 (up to October) the program covered 646,000 households (Hossain *et al.* 2014).

[8] The evaluation design is also explained in Hossain *et al.* (2014) and Hossain *et. al.* (2018). The on line Figure A1 maps the location of the treatment and control sites.

[9]In 2014, the exchange rate with the US$ was BDT 77.64.

[10] The program also offered extension services to participants, but only 7% of program participants in the sample received these services. The reason for the low take up of extension services was a supply side constraint. This proportion is however not different from the national average: 8% of farm households cultivating 0.05-0.49 acres received extension services in 2008 (BBS 2011). Because of this, throughout the paper, we use the term "effect of credit" in referring to the impact of the program.

7,563 eligible households. From the list of eligible households, 4,301 households were randomly selected for the analysis proportionately to the number of eligible households in each village (2,155 households from treatment areas and 2,146 from control areas). The baseline survey was carried out in July-August 2012. A follow-up survey was administered in July-August, 2014, successfully revisiting 4,141 households (2,072 households from treatment and 2,069 from control areas). The overall attrition rate was low (3.72%). Results of an OLS regression of attrition on the treatment indicator and the number of fixed rent and share contracts in the Boro season show that all estimated coefficients are small and statistically insignificant, indicating that there is no significant difference in attrition rates between treatment and control areas, and that baseline outcome variables are not correlated with attrition.[11]

The surveys collected information for the last three cropping seasons on the number of plots households cultivated and, for each plot, on whether owned or rented. For all plots reported as rented, information on the type of contract was recorded. For the largest plot from each sample household, information was also collected on costs and returns (physical amounts as well as market value of outputs), and rental rates in each season. In the follow-up survey, the landlord's share of input costs was also collected.[12] We will use this information to compare contract terms.

5.2 Program take up

Loan disbursement started in September 2012, when the Aman cropping season was already on. Twenty percent of eligible households successfully revisited from treatment areas participated in the credit program offered by BRAC.[13] Forty nine percent of them took one loan from BRAC, 49.6% two loans, and the remaining 1.5% three loans. Of these participant households, 19% took their first loan in 2012, 70% in 2013, and 11% in 2014. Among those who took second and third loans, 76% did so in 2014. Information on the months in which loans were taken is not, however, available. Figure 2 graphs the distribution of BCUP loans, showing significant variation. Most loans are between BDT

[11] Timeline of data collection and OLS regression of attrition are reported in the online Supplemental Material.

[12] The reason for collecting information for the largest plot was pragmatic: cheaper than asking for all the plots, and easier than having to proceed to the selection of a random plot. In addition, we thought that the tenant may pay more attention and recall better the information on the largest plot.

[13] This number seems low compared to the 45% uptake reported in Karlan, Morduch, and Mullainathan (2010), based on a 1991/92 survey done in 87 villages that were served by three microfinance institutions. A different study using population based data shows that about three-quarters of households are eligible for microcredit in Bangladesh, but less than a quarter participate in a program (Evans, 1999). Similar evidence of low uptake is found in other contexts. For example, the uptake rate of microcredit is 13% Morocco (Crépon et al. 2015), 17% in India (Banerjee et al. 2015), and 31% in Ethiopia (Tarozzi, Desai, and Johnson 2015). Recent branch level information for the 20 treated branches shows a sharp increase in uptake from 1,496 borrowers in 2012, to 14,066 in 2014, and 20,423 in 2017, suggesting that it takes some years for a new program to fully develop.

10,000 and 30,000. Average and median loan amounts are BDT 20,327 and 20,000, respectively. At the household level, over the two years, the average loan amount among households that took any loan is BDT 31,000. When asked for the purpose of their BCUP loans, 46% of respondents say it was for crop cultivation, 12% for livestock, poultry, and fishing, 12% for their business, and 30% for other purposes (which include house repairs, land mortgage, consumption, etc.). To get a sense of the size of these loans, a loan of BDT 15,000 could typically cover the non-labor production costs and rental for 0.17 ha, which is a bit more than the average plot size of 0.12 ha in the baseline.[14] Treatment and control households also took loans from other sources; we discuss this in Section 5.3.

The timing of the follow-up survey (in July-August 2014) is such that Aman season data refer to 2013, the first year of the program, while Boro season data are for 2014. We therefore focus the analysis on the Boro season, when the program had more time to have impacts, although we will provide some results for the Aman season as a robustness check on our results for the Boro season.

5.3 Descriptive Statistics

We report in Table 1 baseline characteristics for the surveyed households. Asset endowments are very low, with average 3.1 years of education for the household head and amount of land owned equal to 0.25 ha (of which 0.18 ha are cultivated, with the rest being for homestead, garden, fallows, etc.).[15] The median household in our sample owned 0.16 hectares of land at baseline, indicating that more than half the sample households are considered functionally landless.[16] Land rental contracts are quite frequent, with 56% of all households engaged in contracting during the Boro season (and 35% during the Aman season). Sharecropping is the most prevalent, accounting for 60% of all contracts in the Boro season (and 66% in the Aman season). Similarly, 60% of tenanted lands were under share contract for baseline Boro season (not reported in the table). The prevalence of share contracts among this near landless population is higher than the 43% reported at the national level by BBS (2011). In the Boro season, 32% of households have only share contracts, 19% only fixed rent, and 5% are engaged in both types of contracts. Around 14% of surveyed households had outstanding loans from formal sources (5.9% from a formal bank and 8.1% from an MFI) at baseline. Additionally, 9% of households reported having outstanding loans from informal sources.

Online Appendix Table A2 presents the differences in baseline means for key observable characteristics of the survey households between treatment and control groups. Standard

[14] Based on information collected for the largest plot of tenants in the Boro 2014 season.

[15] Land owned reported in Hossain et al. (2018) only accounts for owner-operated land and is therefore slightly smaller at 0.154 ha (38.11 decimals).

[16] In Bangladesh, households owning less than 50 decimals of lands (0.2 ha) are considered to be functionally landless (Scott and Islam 2008).

errors of the differences are clustered at the BRAC branch office level (the unit of randomization). None of the differences in baseline means of the outcome variables are statistically significant, and most are small, suggesting that randomization is balanced across observables. One exception, however, is the relatively large difference in the number of fixed rent contracts: 0.50 and 0.59 for the treatment and control groups, respectively (with p-value of 0.52). Because this is one of the main outcome variables, we propose in section 6 to use a difference-in-differences method to control for that imbalance.

Contract terms for sharecropping follow the national trends described above. Landlord's output share is most often 50% (for 62% of the Boro and 85% of the Aman contracts), and otherwise 33%. There is some sharing of input costs.[17] Landlords participate to input costs in 36% of the Boro and 18% of the Aman share-contracts. Irrigation costs are important in the Boro season, amounting on average to 30% of all costs and 38% among tenants whose landlord share some costs. Landlords that participate in cost-sharing in the Boro season on average contribute to 28% of all costs (48% of irrigation costs, 22% of fertilizer costs, and 13% of other costs). In the Aman season, there is very little irrigation and even fertilizer costs are lower, so that labor costs dominate, amounting to 40% of input costs. Landlords that participate in costs contribute on average 22% of all costs (58.9% of fertilizer costs and 9.5% of other costs).

Analyzing the data on costs and returns collected for the largest plot shows that gross output is on average larger on plots under fixed-rent than under sharecropping in both years of observation, by 8 to 15% when comparing medians and 3 to 8% when comparing means. Cash costs are also a bit higher, but net revenue remains higher on plots in fixed-rent contract. While these suggest a higher efficiency in fixed rent contracts, as expected from theory, note that these correlations are not causal as the choice of contract is endogenous to the tenant and to the plot.

Our data also show that tenant farmers do switch between share and fixed rent contracts. In the control branch offices, 15% of tenants that had only share contract(s) at baseline had only fixed rent contract(s) at the time of the follow-up survey. Another 46% reported to continue with share contracts only. And the remaining 39% had no land contract at follow-up time. On the other hand, 13% of tenants that had only fixed rent contract(s) at baseline had only share contract(s) at follow-up time. On a season-to-season basis, 19% of sharecropping contracts in the Aman season of the baseline were discontinued and 5% switched to fixed rent contract in the following Boro season. Among contracts that were under fixed rent (cash), 64.9% continued with the same type of contract, 33.9% were discontinued, and the remaining 1.2% switched to other types of contracts. Of the fixed rent contracts under mortgage in the Aman season, 92% continued in the next season.

[17] Landlord's participation in these costs was only collected in the follow-up survey.

In on line Appendix Table A3, we provide information on credit market participation of the surveyed households during the two years prior to the follow-up survey. Information indicates that access to BRAC's BCUP loans by participant households did not replace loans from other sources. Specifically, 19% of treatment households took loans from a formal institution other than BRAC's BCUP against 22% in the control group, and the difference is not statistically significant and equal to what was observed at baseline. Similarly, for the loan amounts from these sources, we do not observe a significant difference between the two groups. Access to loans from informal sources was also similar across treatment and control groups. Overall, we do see that the program induces a large increase in access to credit, with 40% of treatment households taking loans from any sources against 27% in the control group.

6. Results and discussion

6.1. Impact of access to credit on contract choice in the Boro season

Descriptive statistics showed that differences in baseline means of the outcome variables between treatment and control groups are all statistically insignificant, but the magnitude of the difference is relatively large for fixed rent contracts. For this reason, we use a difference-in-differences specification controlling for household fixed effects to estimate the causal effect of the intervention:

$$y_{ijt} = \alpha_i + \delta_t + \beta Tassigned_j * Post_t + \epsilon_{ijt} \quad (3)$$

where y_{ijt} is the outcome variable of interest for household i in branch office j and time period t. Time periods refer to 2012 (for baseline) and 2014 (for follow-up). $Tassigned_j$ takes the value of 1 if branch office j is assigned to treatment and zero to control. $Post_t$ is an indicator variable taking the value of 0 if t = 2012 and 1 if t = 2014. α_i are household fixed effects and δ_t time fixed effects. ϵ_{ijt} is an error term clustered at the BRAC branch office level, the unit of randomization. The parameter β identifies the causal intention-to-treat (ITT) effect of the intervention.

We also estimate treatment-on-the-treated (ToT) effects using an instrumental variable (IV) approach. The estimating equation is:

$$y_{ijt} = \alpha_i + \delta_t + \varphi Treated_{ij} * Post_t + \epsilon_{ijt} \quad (4)$$

where $Treated_{ij}$ takes the value of 1 if household i has participated in the program. The parameter φ identifies the causal ToT effect of the intervention. Since not all eligible households from treated areas participated in the program, $Treated_{ij}$ (and hence, $Treated_{ij} * Post_t$) is endogenous. $Treated_{ij} * Post_t$ is instrumented on $Tassigned_j * Post_t$. We estimate the following equation for the first stage:

$$Treated_{ij} * Post_t = \alpha_i + \delta_t + \eta Tassigned_j * Post_t + \epsilon_{ijt} \quad (5)$$

Table 2 reports estimated effects of the intervention on the number of share and fixed rent contracts and on the total number of contracts. Panel A presents the results of estimating equation (3) and panel B equation (4). The coefficients on the *Post* variable show that over these two years there has been a large decline in the number of sharecropping contracts (by 0.157 plot, or 19% of the baseline value of 0.809 in the control group), with no compensating increase in fixed rent contracts. Against this backdrop, the impact of the program has been no differential decline in sharecropping contracts (Panel A, col. 1), but a large increase in fixed rent contracts by 0.190 plots, or 33.8% of the value in the control group at follow up (Panel A, col. 2). These two changes compensate each other for the treated group (Panel A, col. 3), suggesting an overall shift from share-contracts to fixed rent contracts in this group.[18] This aggregate result on land rental is consistent with the results in Hossain et al. (2018).[19]

Focusing on the beneficiary households that took on the credit program (the ToT effect reported in Panel B), we estimate that they have nearly one additional plot (0.947) in fixed rent in response to their access to credit, a very large increase of 168% over the mean value of 0.562 for the control group at follow up. These findings are in line with our testable hypothesis, and are consistent with the results from existing studies on the relationship between credit and contracting (Laffont and Matoussi 1995; Chaudhuri and Maitra 1997). Regression results presented in column 3 of Table 2 show that effect of the intervention on the total number of contracts is positive and large, although not statistically significant. These IV results measure a local average treatment effect, meaning that they apply to the selected 20% of the eligible population that did apply in this case or would have applied in the control group, had they been offered the credit. There is a strong first-stage, with the estimated coefficient on the interaction term highly significant (at the 1% level). Point estimate of this coefficient is consistent with the fact that about 20% of those that are assigned to treatment participated in the credit program (Panel C).

Table 3 reports change in total land area under share and fixed rent contracts due to access to credit, using the same specifications (3) to (5). Results in column 2 indicate that the program increases the land area under fixed rent contracts by 29.5% (ITT effect). For the land area under share contracts, the effect of credit is very small and statistically insignificant (column 1). For those that did take the offer (Panel B results), the program induced an increase in land area by 0.20 ha in total or 0.27 in fixed-rent,[20] which is

[18] We report in on line Appendix Table A4 the results of a simple cross-sectional difference estimation, controlling for baseline outcome. Results are similar to the diff-in-diffs specification, but less precise.

[19] The two analyses however differ on three aspects. Hossain et al. (2018) (i) use an annual aggregate measure of land rented in, while we construct the rental by aggregating plot-by-plot seasonal information; (ii) use a linear specification with district fixed effects and baseline covariates, while we use a log specification for the dependent variable and individual fixed effects; (iii) consider only the aggregate rental, while we focus on the contrast between contract types. We describe in the Supplemental on-line Appendix the construction of the land rental variable.

[20] Using the ToT results in panel B: $(e^{0.806} - 1) * .161 = 0.20$ and $(e^{1.471} - 1) * .08 = 0.27$.

reassuringly in line with the 0.17 ha we had computed in Section 5.3 as what the average loan taken by households could cover if it were used for all non-labor costs and rent.**

We analyze in Table 4 whether relaxation of the liquidity constraint affects differentially the intensive and extensive margins in contracting. The intensive margin is characterized by individuals with baseline contract experience (56% of the sample). These individuals had the interest and ability to contract without the credit provided by the program. The extensive margin, by contrast, is characterized by the 44% individuals with no baseline contract experience. We find that both margins display a positive increase in fixed rent contracting. The effect for individuals with contracting experience at baseline is equal to 0.221 additional plots, larger although not significantly so, than the 0.134 plots for the extensive margin.

We decompose in on line Appendix Table A5 the effect of loan access on the three different types of fixed rent contracts, cash rent (paid in advance), rent in kind (paid at harvest), and mortgage, described above. Results show that the increase in fixed rent contract is mostly for in-kind contracts, and to a lesser extent for cash contracts. This suggests that at least over these first two years of the program, tenants were using the loan for input costs rather than land rents.

Note that these results have to be interpreted as the effects of having had access to credit for the population of eligibles (for the ITT) or having taken a credit for the selected group that did choose to take the credit (for the ToT) over the past two years. When to take a credit and the amount taken are indeed endogenous.

6.2. Heterogeneity of effects with respect to risk exposure

Throughout the year in Bangladesh the main sources of risk for rice cultivation are drought, flood, extreme temperatures, and pests (Shelley et al. 2016). During the dry Boro season on which we focus, all rice cultivation is under irrigation, and extreme temperatures are the main risk. Rice grows normally within the temperature range of 20°C to 35°C, and is particularly sensitive to low temperature in its initial stage (March) and high temperature in its final stage (April). To characterize weather at the branch level, we matched each of the 40 branches in the experiment with the closest of 16 weather stations.[21] We verify in Table A6 that, in our 2012-2014 panel data for the control villages, yield is indeed negatively affected by temperature dropping below 20°C in March and by temperature exceeding 35°C in April (although when jointly estimated, the high temperature in April dominates). These events are cross-sectionally important. In 2012, 47.6% of the observations had March temperatures below 20°C and 14.2% April temperatures above 35°C. The corresponding figures for 2014 are 77.2% and 79.6%, respectively, a year with

[21] Temperature data were collected from the Bangladesh Bureau of Statistics (various issues of the Statistical Pocketbook and Monthly Statistical Bulletin).

exceptionally high temperatures. The low temperature event reduces yield by 0.57 kg/decimal (23 kg/ha) and the high temperature event by 1.8 kg/decimal (73 kg/ha), which correspond to 2.8 and 8.8% of the mean yield, respectively. We therefore characterize the risk associated with low and high temperatures by the probability of facing a temperature below 20°C in March and above 35°C in April, respectively, measured by the proportion of years that experienced this temperature in the 10-year period 2003-2012. We should note that while temperatures are the main weather risk for this season, farmers face other idiosyncratic risks such as pests.

We extend equation (3) to estimate heterogeneity of effects with respect to risk:

$$y_{ijt} = \alpha_i + \delta_t + \theta_1 Tassigned_j * Post_t + \theta_2 Tassigned_j * Post_t * risk_j + \theta_3 Post_t * risk_j + \epsilon_{ijt} \quad (6)$$

where $risk_j$ is a measure of baseline exposure to risk for branch office j (corresponding to the term σ^2 in the model). The parameters of interest are θ_1 and θ_2. This equation estimates the ITT effect of the intervention. We expect θ_2 to be negative for fixed rent contracts and positive for share contracts.

Table 5 shows how exposure to low and high temperature risk affects the impact of access to credit on land contract during the Boro season. We find that risk associated with exposure to low temperature has a large negative effect on the impact of credit on fixed rent contracting. Risk associated with high temperature does not have a significant effect on the role of credit on contracting. When considered together, the low temperature risk is the one that dominates on the role of credit in contacting, with a large and highly significant coefficient. A potential reason for this asymmetric result is that in our data, there is little variation in high-temperature risk: 38% of the observations have a 0 high temperature risk, and 78% have a risk less or equal to 20%. In contrast, the distribution of risk of cold temperature is almost bimodal with probabilities of either 0.2-0.3 or 0.6-0.7, and mean value 0.424. This makes it easier to identify its effect. To see the order of magnitude of this effect, consider the two modal values of 30% and 70% probability of a cold spell. The regression results suggest that in an area with a 30% probability of low temperature (low risk) the credit program induces an increase of fixed rent rental by (0.495-0.3*0.696) = 0.286 plots, significant at 1%, while there is no effect at all in a high-risk area with a 70% chance of cold weather. The result thus confirms the model prediction that access to liquidity has a greater effect on increasing fixed rent contracts when there is less need for sharecropping as a risk-reducing instrument.[22]

[22] We also verified that contract choice responds to temperature shocks in a panel regression among control households. Experience of a high temperature event in April of the previous year induces an increase in sharecropping contracts and a (non-significant) decrease in fixed rent contracts, and a low temperature event in March of the previous year a significant decrease in fixed-rent contracts and a non-significant decrease in sharecropping contracts. These responses to shocks are consistent with a simple liquidity effect, but also subject to other possible confounding channels of influence from temperature shocks to contract choice. On

Like with any cross-sectional variation, it remains possible that there are some confounding factors that we cannot completely eliminate. Those would be factors correlated with temperature risk at the station level that would also induce a differential response in contracts to the availability of credit. Because we do not have any reliable measure of risk aversion at the individual level, this parameter measures the impact of temperature risk at the average level of risk aversion in the population, implicitly assuming that the distribution of risk aversion is not correlated with temperature risk. We should thus consider these results as suggestive rather than a definite test.

6.3 Results for the 2013 Aman season

The main focus of this paper has been on the 2014 Boro season, which took place two years after the onset of the program. Because of the timing of the endline survey, the Aman season is that of 2013, just one year into the program, and hence with a lower uptake than in the next Boro season. On the other hand, Aman crops cultivated mostly under rainfed conditions have much lower production costs, meaning they can be undertaken with less credit. Estimation of the ITT effects of having had access to credit for one year on the number of land contracts in the Aman season show that the program increases the number of fixed rent contracts by 0.182, a result that is significant at the 10% level (on line Appendix Table A7). This result is less precisely estimated but similar to the effect measured for the Boro season reported in Table 2. Relative to the control group mean, however, this effect is twice as large as the effect for the Boro season.

7. Conclusion

A voluminous literature provides theoretical explanations on the Marshallian puzzle of sharecropping (Hayami and Otsuka 1993). Because a share contract is inferior to a fixed rent contract in eliciting effort under first-best conditions, sharecropping should not prevail under those conditions, posing the puzzle of its widespread existence. The literature has consequently explored conditions of market failure under which a share contract may be preferred to a fixed rent contract. In addition to risk with insurance market failure (Stiglitz 1974), the role of a financial constraint was proposed by Laffont and Matoussi (1995). Liquidity constrained tenants need contract land as sharecroppers until the liquidity constraint no longer binds at which time they can switch to fixed rent. Rigorous empirical evidence on the importance of liquidity on the choice of contract was however still missing. This paper advances our quantitative knowledge on the puzzle of sharecropping

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the other hand, we are unable to find a cross-sectional relationship between contract structure and temperature risk in the baseline data. This is likely due to the small number of weather stations and the impossibility of controlling for the many factors that determine contract choice in this cross-sectional regression.

by using a randomized experiment of the effect of access to credit on the choice of land contract in the context of Bangladesh where almost half of land tenure arrangements are share contracts. The testable hypothesis is derived from a model of contract choice for a given land plot under credit constraint, and on how this relation is modified by exposure to uninsured risk.

The program we analyze focuses on landless and near landless households with farming experience, and the impact is measured two years after the onset of the program, when approximately 20% of eligible households had taken at least one credit. As predicted by theory, we find evidence that the effect of access to credit for potential tenants on the number of, and area under, fixed rent relative to share contracts is positive, significant, and large in magnitude, a result consistent with the evidence provided by Laffont and Matoussi (1995). The effect is found to be heterogeneous, being larger for farmers who are less exposed to production risk as measured by the incidence of extreme temperatures, a result consistent with Stiglitz's (1974) theoretical prediction.

A large empirical literature documents the inefficiency of sharecropping relative to fixed rent contracts in terms of input use (Shaban 1987; Bell 1977). The findings of our study suggest that improved access to credit for landless tenants and smallholder farmers can raise the efficiency of land contracting by increasing fixed rent relative to share rent contracts. Microfinance programs that help relax liquidity constraints on land rental for potential tenants can thus be sources of efficiency gains for the rural poor through the choice of better contracts.

References

Ahmed, R. 2004. "Rice Economy of Bangladesh: Progress and Prospects." *Economic and Political Weekly* 39(36): 4043-52.

Arcand, J-L., C. Ai, and F. Ethier. 2007. "Moral Hazard and Marshallian Inefficiency: Evidence from Tunisia." *Journal of Development Economics* 83(2): 411-45.

Banerjee, A., E. Duflo, R. Glennerster, and C. Kinnan. 2015. "The Miracle of Microfinance? Evidence from a Randomized Evaluation." *American Economic Journal: Applied Economics* 7(1): 22-53.

BBS. 1999. "Census of Agriculture-1996 and Agriculture Sample Survey 1997." Bangladesh Bureau of Statistics (BBS), Ministry of Planning. Dhaka, Bangladesh.

BBS. 2010. "Census of Agriculture-2008." Bangladesh Bureau of Statistics (BBS), Ministry of Planning. Dhaka, Bangladesh.

BBS. 2011. "Agriculture Sample Survey 2008." Bangladesh Bureau of Statistics (BBS), Ministry of Planning. Dhaka, Bangladesh.

BBS. 2013. "The monthly statistical bulletin." Bangladesh Bureau of Statistics (BBS), Ministry of Planning. Dhaka, Bangladesh.

BBS. 2017. "Report on quarterly labor force survey (QLFS) 2015-16." Bangladesh Bureau of Statistics (BBS), Ministry of Planning. Dhaka, Bangladesh.

Bell, C. 1977. "Alternative Theories of Sharecropping: Some Tests Using Evidence from Northeast India." *Journal of Development Studies* 13(4): 317-46.

Bode, B., A. Haq, and B. C. Dev. 2013. "Forms of Land Tenure in the Northwest of Bangladesh", CARE Bangladesh, available at http://www.carebangladesh.org/publication/Publication_9087812.pdf

Braverman, A., and J. Stiglitz. 1989. "Credit Rationing, Tenancy, Productivity, and the Dynamics of Inequality." Working Paper 176, The World Bank.

Chaudhuri, A., and P. Maitra. 1997. "Determinants of Land Tenure Contracts: Theory and Evidence from Rural India." Working Paper No. 1997-10, Department of Economics, Rutgers, The State University of New Jersey.

Crépon, B., F. Devoto, E. Duflo, and W. Pariente. 2015. "Estimating the Impact of Microcredit on Those Who Take It Up: Evidence from a Randomized Experiment in Morocco." *American Economic Journal: Applied Economics* 7(1): 123-50.

Eswaran, M., and A. Kotwal. 1985. "A Theory of Contractual Structure in Agriculture." *American Economic Review* 88(3-4): 867-94.

Evans, T. G., A. M. Adams, R. Mohammed. 1999. "Demystifying Nonparticipation in Microcredit: A Population-Based Analysis." *World Development* 27(2): 419-430.

Hayami, Y., and K. Otsuka. 1993. *The Economics of Contract Choice: An Agrarian Perspective*. Oxford, U.K.: Oxford University Press.

Hossain, M., and 14 others. 2014. "Impact Assessment of Credit Program for Tenant Farmers: Baseline Report 2012." Research and Evaluation Division, BRAC, Dhaka, Bangladesh.

Hossain, M., and A. Bayes. 2009. *Rural Economy and Livelihoods Insights from Bangladesh*. Dhaka: AH Development Publishing House.

Hossain, M., M.A. Malek, A.M. Hossain, M. Reza, and M. Ahmed. 2018. "Agricultural Microcredit for Tenant Farmers: Evidence from a Field Experiment in Bangladesh." Forthcoming *American Journal of Agricultural Economics*.

Jabbar, M. A. 1978. "Conceptual Issues related to Classification of Land Tenure Systems in Bangladesh". *Bangladesh Journal of Agricultural Economics* 10(1): 17-29.

Jacoby, H. G., and G. Mansuri. 2008. "Land Tenancy and Non-Contractible Investment in Rural Pakistan." *The Review of Economic Studies* 75(3): 763–788.

Jansen, E. 1986. *Rural Bangladesh: Competition for Scarce Resources*. Oslo: Norwegian University Press.

Karlan, D., J. Morduch, and S. Mullainathan. 2010. "Take-up: Why Microfinance Take-up Rates are Low and Why it Matters". Financial access initiative research framing note. Available at http://www.arabic.microfinancegateway.org/sites/default/files/mfg-en-paper-take-up-why-microfinance-take-up-rates-are-low-why-it-matters-jun-2010.pdf.

Laffont, J.J., and M. Matoussi. 1995. "Moral Hazard, Financial Constraints, and Sharecropping in El Oulja." *Review of Economic Studies* 62(3): 381-99.

Otsuka, K., H. Chuma, and Y. Hayami. 1992. "Land and Labor Contracts in Agrarian Economies: Theories and Facts." *Journal of Economic Literature* 30(4): 1965-2018.

Quibria, M.H., and S. Rashid. 1984. "The puzzle of sharecropping: A survey of theories." *World Development* 12(2): 103-14.

Raihan, S., S. Fatehin, and I. Haque. 2009. "Access to Land and Other Natural Resources by the Rural Poor: The Case of Bangladesh." Munich Personal RePEc Archive paper 38621.

Reiersen, J. 2004. “Status and Incentives.” *Nordic Journal of Political Economy* 29(2): 87-104.

Sadoulet, E., S. Fukui, and A. de Janvry. 1997 “The Meaning of Kinship in Sharecropping Contracts.” *American Journal of Agricultural Economics* 79(2): 394-407.

Scott, L., and R. Islam. 2008. “Socio-Demographic Characteristics of Households Entering the Experimental First Phase of the CLP’s Asset Transfer Program.” Government of Bangladesh and DFID. Available at: http://clp-bangladesh.org/wp-content/uploads/2015/05/ATP-Phase-1-Registration.pdf.

Shaban, R. 1987. “Testing Between Competing Models of Sharecropping.” *Journal of Political Economy* 95(5): 893-920.

Shelley, I. J., M. Takahashi-Nosaka, M. Kano-Nakata, M. S. Haque and Y. Inukai. 2016. “Rice Cultivation in Bangladesh: Present Scenario, Problems, and Prospects.” *Journal of International Cooperation for Agricultural Development* 14: 20–29

Shetty, S. 1988. “Limited Liability, Wealth Differences, and Tenancy Contracts in Agrarian Economies.” *Journal of Development Economics* 29(1): 1-22.

Stiglitz, J. 1974. “Incentives and Risk Sharing in Sharecropping.” *Review of Economic Studies* 41(2): 219-255.

Tarozzi, A., J. Desai, and K. Johnson. 2015. “The Impacts of Microcredit: Evidence from Ethiopia.” *American Economic Journal: Applied Economics* 7(1): 54-89.

Table 1. Baseline characteristics of households and contracts

	Mean value	Standard deviation
Household head is male*	0.933	(0.251)
Age of household head (years)	44.8	(11.7)
Years of household head education	3.1	(3.4)
Primary occupation of household head is agriculture*	0.654	(0.475)
Household is food secure*	0.791	(0.406)
House has electricity connection*	0.594	(0.491)
Area of land owned (ha)	0.25	(0.28)
of which cultivated land (ha)	0.18	(0.24)
Household has outstanding loan from banks*	0.059	(0.24)
Amount of outstanding loans from banks (conditional, BDT)	27029	(42292)
Household has outstanding loan from MFIs*	0.081	(0.27)
Amount of outstanding loans from MFIs (conditional, BDT)	15709	(32117)
Household has outstanding loan from informal sources*	0.089	(0.28)
Amount of outstanding loans from informal sources (conditional, BDT)	61502	(98485)
Land contracts in the Boro season		
Household has land contract*	0.56	(0.50)
Household has only sharecropping contracts*	0.32	(0.47)
Household has only fixed rent contracts*	0.19	(0.40)
Household has both contracts*	0.05	(0.22)
Total number of land contracts	1.35	(1.73)
Number of share contracts	0.81	(1.42)
Number of fixed rent contracts	0.54	(1.20)
Land contracts in the Aman season		
Total number of land contracts	0.85	(1.52)
Number of share contracts	0.56	(1.26)
Number of fixed rent contracts	0.29	(0.90)
N	4141	

* indicates binary variable (Yes=1, No=0)

Table 2. Effects of access to credit on the number of share and fixed rent contracts

	Number of share contracts	Number of fixed rent contracts	Total number of contracts
Panel A: ITT			
Assigned*Post	0.004	0.190**	0.194
	(0.075)	(0.090)	(0.125)
Post	-0.157***	-0.0251	-0.182**
	(0.057)	(0.041)	(0.069)
Individual fixed effects	Yes	Yes	Yes
R-sq	0.011	0.008	0.005
Panel B: TOT (IV regression)			
Treated*Post (instrumented)	0.0204	0.947*	0.968
	(0.366)	(0.501)	(0.665)
Post	-0.157***	-0.0251	-0.182***
	(0.056)	(0.041)	(0.068)
First stage: Treated*Post			
Assigned*Post	0.201***	0.201***	0.201***
	(0.027)	(0.027)	(0.027)
Individual fixed effects	Yes	Yes	Yes
N	8282	8282	8282
Mean outcome in control group at follow up	0.662	0.562	1.223

Standard errors in parentheses, clustered at the branch office level
* p<0.10, ** p<0.05, *** p<0.01

Table 3. Effects of credit on the land area under share and fixed rent contracts

	Log of land area under share contracts	Log of land area under fixed rent contracts	Log of total land area under all contracts
Panel A: ITT			
Assigned*Post	-0.0236	0.295**	0.162
	(0.097)	(0.121)	(0.137)
Post	-0.230***	0.0382	-0.188***
	(0.064)	(0.057)	(0.054)
Individual fixed effects	Yes	Yes	Yes
R-sq	0.014	0.015	0.004
Panel B: TOT (IV regression)			
Treated*Post (instrumented)	-0.118	1.471**	0.806
	(0.482)	(0.685)	(0.694)
Post	-0.230***	0.0382	-0.188***
	(0.063)	(0.056)	(0.053)
Individual fixed effects	Yes	Yes	Yes
N	8282	8282	8282
Mean area in control at follow up (ha)	0.081	0.080	0.161

Because some observations have 0 land area, we added 1 decimal (0.0040 ha) to each observation
Standard errors in parentheses, clustered at the branch office level
* p<0.10, ** p<0.05, *** p<0.01

Table 4. Effects of credit on the number of land contracts: Extensive and intensive margins

	Number of share contracts	Number of fixed rent contracts	Total number of contracts
Assigned*Post	0.0155	0.221*	0.237
	(0.131)	(0.123)	(0.171)
Aassigned*Post*No baseline contract	-0.0568	-0.0869	-0.144
	(0.145)	(0.122)	(0.168)
Post	-0.490***	-0.202***	-0.692***
	(0.0952)	(0.0664)	(0.0953)
Post*No baseline contract	0.781***	0.415***	1.196***
	(0.111)	(0.0751)	(0.0996)
Individual fixed effects	Yes	Yes	Yes
N	8282	8282	8282
R-sq	0.074	0.028	0.108
Assgn*Post+Assgn*Post*No baseline contract	-0.041	0.134*	0.093
	(0.0501)	(0.069)	(0.080)

Standard errors in parentheses, clustered at the branch office level
* p<0.10, ** p<0.05, *** p<0.01

Table 5. Effects of credit on the number of land contracts: Heterogeneity by temperature risk exposure

	Low temperature risk			High temperature risk			Low/High temperature risk		
Number of contracts:	Share	Fixed	Total	Share	Fixed	Total	Share	Fixed	Total
Assigned*Post	0.0441	0.495***	0.539***	0.0714	0.162	0.234	-0.00147	0.550***	0.549**
	(0.130)	(0.150)	(0.184)	(0.0886)	(0.108)	(0.161)	(0.130)	(0.159)	(0.223)
Assigned*Post*Low temp. risk	-0.0951	-0.696**	-0.791*				0.178	-0.811***	-0.633
	(0.274)	(0.306)	(0.412)				(0.265)	(0.283)	(0.422)
Assigned*Post*High temp. risk				-0.0184	0.139	0.120	-0.00468	-0.183	-0.188
				(0.264)	(0.317)	(0.468)	(0.283)	(0.305)	(0.527)
Individual fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	8282	8282	8282	8282	8282	8282	8282	8282	8282
R-sq	0.011	0.014	0.009	0.015	0.008	0.008	0.015	0.015	0.011

Standard errors in parentheses, clustered at the branch office level; * p<0.10, ** p<0.05, *** p<0.01
Low temperature risk is the proportion of years in 2003-2012 in which the lowest temperature in March was below 20 degree Celsius. High temperature risk is the proportion of years in which the highest temperature in April was above 35 degree Celsius.
Variables Post, Post*Low temp. risk, and Post*High temp. risk included.

Figure 1. Expected profit and utility under sharecropping and fixed rent contracts

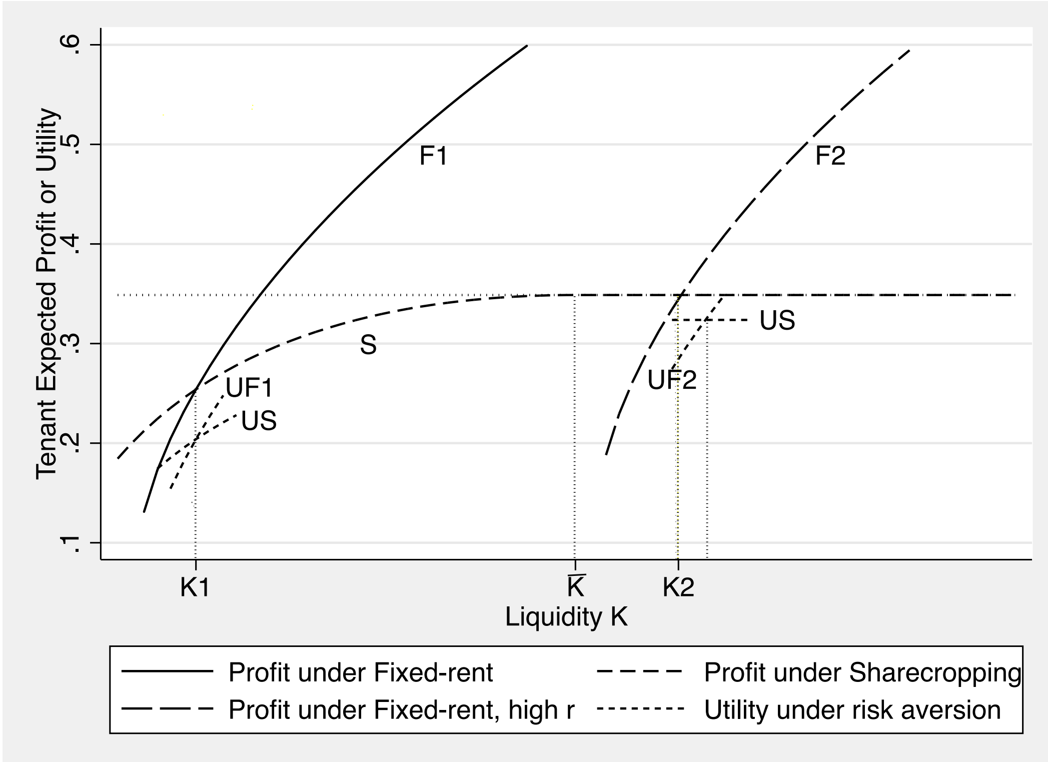

Figure 2. Distribution of BCUP loans taken by program participants