

Credit Programmes for the Poor and Seasonality in Rural Bangladesh

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This article examines the effect of group-based credit used to finance self-employment by landless households in Bangladesh on the seasonal pattern of household consumption and male and female labour supply. This credit can help smooth seasonal consumption by financing new productive activities whose income flows and time demands do not seasonally covary with the income generated by existing agricultural activities. The results, based upon 1991/92 survey data, strongly suggest that an important motivation for credit programme participation is the need to smooth the seasonal pattern of consumption and male labour supply. It is only the extent of lean season consumption poverty that selects household into these programmes. In addition, the largest female and male effects of credit on household consumption are during the lean season.

I. INTRODUCTION

This article examines the effect of group-based credit for the poor in Bangladesh on the seasonal pattern of household consumption and male and female labour supply. Like much of South Asia, Bangladesh has a marked seasonal pattern of agricultural production that results in large differences in the levels of income, consumption and demand for labour across seasons. Household members are typically engaged in agricultural pursuits and the weather induced seasonality of the crop cycle is the greatest source of seasonality in income flows.¹ If seasonal income fluctuations are perfectly predictable, and if credit markets are perfect, then perfectly forecasted income changes arising from seasonal weather variations should not induce changes in consumption across seasons.

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However, it is not likely that credit markets are perfect in rural Bangladesh. The group-based micro-credit programmes examined below provide production credit to rural households lacking significant physical assets. These primarily agricultural households, wishing to reduce seasonal fluctuations in consumption, may try to diversify into non-agricultural activities that are less tied to seasonal weather patterns but may be credit constrained. The majority of borrowers from the micro-credit programmes studied below use their loans to finance non-farm activities. If smoothing seasonal consumption is an important motivation for poor rural households, they are likely to choose self-employment activities that generate income streams that do not highly covary seasonally with income from agricultural pursuits.

There may also be unpredictable shocks to income. Lacking the ability to formally insure against bad income realisations, households seek insurance substitutes. Transfers between households play an important role in smoothing consumption *ex-post*. Rosenzweig [1988] finds that net transfers flow to households that receive bad income realisations, partially taking the place of insurance markets. Diversifying income sources can not only reduce seasonal consumption variation but also reduce the effect of weather shocks on income. Farm households may cultivate different plots that are spatially separated so as to reduce the probability of being affected by common shocks, or plant different crops that are differentially susceptible to weather shocks. Households can also alter the composition of productive and non-productive asset holdings in response to the degree of weather risk. Rosenzweig and Binswanger [1993] find that the asset portfolios of Indian farmers reflect, in part, their aversion to risk. They find there is a significant trade-off between profit variability and average profit returns to wealth and that the loss of efficiency associated with structuring one's portfolio to mitigate risk is considerable for less wealthy farmers. Subsequent work by Rosenzweig and Wolpin [1993] examines the role of productive assets, bullocks in particular, in the risk-coping strategies of low-income farm households. They find that sales of bullocks increase when weather outcomes are poor and purchases rise when weather outcomes are favourable and that consumption smoothing is an important motivation for bullock acquisition.

In addition to its role in smoothing consumption arising from predictable seasonal variations in income, credit can also serve an insurance function much like transfers. By providing access to credit, even monitored production credit, these micro-credit programmes can help households diversify income and free up other sources of financing that can be used to directly smooth consumption. The three group-based credit programmes examined are the major micro-credit programmes in Bangladesh.

Participation in these programmes requires that the area of land owned should not exceed one-half acre and that ownership of other assets be of comparable magnitude. Monitored production credit is unlikely to be a perfect substitute for access to consumption credit for the purpose of smoothing consumption. Peer monitoring in these group-based programmes is sufficiently close that households may have to carry out the funded project using the borrowed funds and the participant's time input as described in the application to borrow, even if both time and funds would be allocated differently in the absence of monitoring.

However, even perfect monitoring does not necessarily mean that production credit is not used for consumption or other purposes. If a household wishes to devote resources obtained from savings, inter-household transfers, or borrowing from moneylenders or other source to a production activity in the absence of group-based credit, it may, in the presence of group-based lending programmes, substitute group-based credit for those resources, thus freeing up those funds for other uses. In this way, simply by relaxing the household's constraints on borrowing and transfers, monitored production credit may help households smooth consumption.

This article estimates the impact of participation, by gender, on the seasonality of household consumption and women's and men's labour supply for three group-based credit programmes: Grameen Bank, Bangladesh Rural Advancement Committee (BRAC), and Bangladesh Rural Development Board's (BRDB) Rural Development RD-12 programme. In recent years, governmental and non-governmental organisations in many low income countries have introduced credit programmes such as these targeted to the poor. Many of these programmes specifically target women based on the view that they are more likely to be credit constrained than men, to have restricted access to the wage labour market, and to have an inequitable share of power in household decision-making.

The Grameen Bank of Bangladesh is perhaps the best-known example of these small-scale production credit programmes for the poor. The Grameen Bank, founded in 1976 by Muhammad Yunus, an economics professor, provides financing for non-agricultural self-employment activities. By the end of 1994, it had served more than two million borrowers, 94 per cent of whom were women [*Khandker et al., 1995a*]. With loan recovery rates of over 90 per cent, the Grameen Bank has been touted as among the most successful credit programmes for the poor and its model for group lending has been used for delivering credit in over 40 countries.

All three of the Bangladesh programmes examined below work exclusively with the rural poor. Although the sequence of delivery and the provision of inputs vary some from programme to programme, all three

programmes essentially offer production credit to the landless rural poor (defined as those who own less than half an acre of land) using peer monitoring as a substitute for collateral.² For example, the Grameen Bank provides credit to members who form self-selected groups of five.³ Loans are given to individual group members, but the whole group becomes ineligible for further loans if any member defaults. The groups meet weekly to make repayments on their loans as well as mandatory contributions to savings and insurance funds. Programmes such as the Grameen Bank, BRAC and BRDB also provide non-credit services in areas such as consciousness-raising, skill development training, literacy, bank rules, investment strategies, health, schooling, civil responsibilities, and altering the attitude of and toward women.⁴

In a previous paper [Pitt and Khandker, 1998], we find that participation in these credit programmes, as measured by quantity of borrowing, is a significant determinant of women's and men's labour supply and household consumption. We also reject the hypothesis that programme credit is exogenous in the determination of household consumption and men's labour supply. That is, unobserved variables that affect credit programme participation (as measured by borrowing) also affect consumption and men's labor supply conditional on credit program participation. However, in that paper, we allowed for seasonality only by including seasonal dummy variables in the conditional demand equations. We did not allow for the effects of programme credit to vary by season. Moreover, if smoothing consumption across seasons is an important motivation for participating in these credit programmes, households with more than average seasonal fluctuations in consumption and labor supply would be more likely to participate.

This suggests that the correlation between the unobserved determinants of programme credit and consumption and labour supply may vary in intensity seasonally. In particular, our earlier work found that there was a significant and negative correlation between programme credit residuals and per capita consumption residuals implying that consumption-poor households (conditional on all the included regressors) were more likely to participate in group-based credit programmes. If seasonal consumption smoothing were a motivation for credit programme participation, we should expect that the correlation between low season consumption and credit would be bigger in absolute value (that is, more negative algebraically) than the correlation between high season consumption and credit. The results reported below find exactly this pattern. We find that the only self-selection into these credit programmes with respect to consumption expenditure arises from heterogeneity in 'hungry season' (*Aus*) consumption expenditure. It is the extent of lean season poverty that selects household

into these programmes.

The estimation method used in this study mirrors that set forth in Pitt and Khandker [1998].⁵ The method applied corrects for the potential bias arising from unobserved individual-, household- and village-level heterogeneity. The study uses a quasi-experimental survey design to provide statistical identification of programme effects in a maximum likelihood framework. The survey design covers one group of households which has the choice to enter a credit programme and which may alter their behaviour in response to the programme, and a 'control' group which is not given the choice of entering the program but whose behavior is still measured. Furthermore, our earlier study found that credit provided to women was more likely to influence consumption and labour supply differently than credit provided to men. Thus, it is important to distinguish credit effects by the gender of the participant.

The identification of these programmes' impact by the gender of the participant is accomplished based on the comparison between groups of each gender with and without the choice to participate. Analysing programme impacts by comparing households in villages with programs and households in village without programmes suffers from the possibility that programme placement is endogenous. These programmes, whose professed goal is to better the lives of the poor, may have chosen villages in a conscious manner based on their wealth, attitudes or other attributes. We use a village-level fixed-effects method to circumvent the problem of village unobservables biasing our estimate of the impacts of these credit programmes.

II. ESTIMATION STRATEGY

Identification from a Quasi-experiment

The econometric methods used in our analysis are essentially the same as that presented in Pitt and Khandker [1998] and hence we present only an abbreviated version here. This article estimates the *conditional* demands for a set of household behaviours, conditioned on the household's programme participation as measured by the quantity of credit borrowed.⁶ Leaving seasonal considerations aside for the moment, consider the reduced form equation (1) for the level of participation in one of the credit programmes (C_{ij}), where level of participation is taken to be the value of programme

$$C_{ij} = X_{ij}\beta_c + Z_{ij}\pi + \mu_j^c + \varepsilon_{ij}^c \quad (1)$$

credit that household i in village j borrows,

where X_{ij} is a vector of household characteristics (for example, age and

education of household head), Z_{ij} is a set of household or village characteristics distinct from the X s in that they affect C_{ij} but not other household behaviours conditional on C_{ij} (see below), β_c , and π are unknown parameters, μ_j^c is an unmeasured determinant of C_{ij} that is fixed within a village, and ε_{ij}^c is a non-systematic error that reflects unmeasured determinants that vary over households such that $E(\varepsilon_{ij}^c | X_{ij}, Z_{ij}, \mu_j^c) = 0$.

The conditional demand for outcome y_{ij} (such as girls' schooling or women's labour supply) conditional on the level of programme

$$y_{ij} = C_{ij} \delta + X_{ij} \beta_y + \mu_j^y + \varepsilon_{ij}^y \quad (2)$$

participation C_{ij} is

where β_y and δ are unknown parameters, μ_j^y is an unmeasured determinant of y_{ij} that is fixed within a village, and ε_{ij}^y is a non-systematic error reflecting, in part, unmeasured determinants of y_{ij} that vary over households such that $E(\varepsilon_{ij}^y | X_{ij}, \mu_j^y) = 0$. The estimation issue arises as a result of the possible correlation of μ_j^c with μ_j^y and of ε_{ij}^c with ε_{ij}^y . Econometric estimation that does not take these correlations into account may yield biased estimates of the parameters of equation (2) due to the endogeneity of credit programme participation C_{ij} .

The standard approach to the problem of estimating equations with endogenous regressors, such as equation (2), is to use instrumental variables. In the model set out above, the exogenous regressors Z_{ij} in equation (1) are the identifying instruments. Unfortunately, it is difficult to find any regressors Z_{ij} that can justifiably be used as identifying instrumental variables. Lacking identifying instruments Z_{ij} , the sample survey was constructed so as to provide identification through a quasi-experimental design.

Our sample of households includes households in villages that do not have access to a group-based credit programme. If credit programme placement across the villages of Bangladesh is attentive to the village effects μ_j , identifying programme effects by comparing households in non-programme villages with households in programme villages will generally result in biased estimates of programme effects if selectivity of programme placement is not controlled. Using a village fixed-effects estimation technique may remove the source of correlation between programme placement and the behaviour of interest, however, without further exogenous variation in programme availability, the credit effect is not identifiable from a sample of self-selecting households as it is captured within the village fixed effects.⁷ The parameter of interest, δ , the effect of participation in a credit programme on the outcome y_{ij} , can be identified if the sample also includes households in villages with treatment choice

(*programme villages*) who are excluded from making a treatment choice by random assignment or some exogenous rule. That exogenous rule in our data is the restriction that households owning more than 0.5 acres of land are precluded from joining any of the three credit programmes.⁸

There are a number of participating households in our sample that had more than 0.5 acres of land at the time of programme entry, raising the possibility of mistargeting and potential bias in econometric results relying on this targeting rule. It appears that some of this excess land is either uncultivable or marginally so. Pitt [1999] demonstrates that the value per acre of land owned by programme participating households who own more than 0.5 acres of cultivable land at the time of joining is a small proportion of that value of programme participants owning less than 0.5 acres of cultivable land at the time of joining. This suggests that programme officers are using some notion of 'effective' units of cultivable land in determining eligibility rather than the type of mistargeting that would result in econometric bias.

Pitt [1999] discusses this issue at length and demonstrates that treating the exogenous targeting rule to be greater than 0.5 acres provides a consistent estimator for certain types of mistargeting. He finds that application of targeting rules greater than 0.5 acres (up to 2.0 acres) actually slightly strengthens the qualitative results on the effect of credit by gender on household consumption. In that paper, the relative insensitivity of the effect of credit on consumption to functional form assumptions is also demonstrated.

To illustrate the identification strategy, consider a sample drawn from two villages – village 1 does not have the programme and village 2 does; and, two types of households, landed ($X_{ij}=1$) and landless ($X_{ij}=0$). Innocuously, we assume that landed status is the only observed household-specific determinant of some behaviour y_{ij} in addition to any treatment effect from the programme. The conditional demand equation is:

$$y_{ij} = C_{ij}\delta + X_{ij}\beta_y + \mu_j^y + \varepsilon_{ij}^y \quad (3)$$

The exogeneity of land ownership is the assumption that $E(X_{ij}, \varepsilon_{ij}^y) = 0$, that is, that land ownership is uncorrelated with the unobserved household-specific effect. The expected value of y_{ij} for each household type in each village is:

$$E(y_{ij} \mid j=1, X_{ij}=0) = \mu_1^y \quad (4a)$$

$$E(y_{ij} \mid j=1, X_{ij}=1) = \beta_y + \mu_1^y \quad (4b)$$

$$E(y_{ij} \mid j=2, X_{ij}=1) = \beta_y + \mu_2^y \quad (4c)$$

$$E(y_{ij} | j=2, X_{ij}=0) = p\delta + \mu_y^2 \quad (4d)$$

where p is the proportion of landless households in village 2 who choose to participate in the programme. It is clear that all the parameters, including the effect of the credit programme δ , is identified from this design. In particular, the estimator of the programme effect δ is a variant of the differences-in-the-differences estimator widely applied in the general programme evaluation literature. To see this, note that an estimate of δ is obtained from the following difference-in-the-difference.⁹

$$\begin{aligned} & [E(y_{ij} | j=2, X_{ij}=0) - E(y_{ij} | j=2, X_{ij}=1)] - [E(y_{ij} | j=1, X_{ij}=0) \\ & \quad - E(y_{ij} | j=1, X_{ij}=1)] \end{aligned} \quad (4e)$$

To illustrate the log-likelihood maximised, consider the case of a binary treatment ($I_c=1$ if treatment chosen, 0 otherwise) and a binary outcome ($I_y=1$ if outcome is true, 0 otherwise). This is the most difficult model to identify in that non-linearity arising from the choice of an error distribution is insufficient to identify the credit effect parameter δ . Distinguishing between households not having choice because they reside in a non-programme village and households residing in a programme village that do not have choice because of the application of an exogenous rule (landowning status), and suppressing the household and village subscripts i and j , the likelihood can be written as:

$$\begin{aligned} \log L(\beta, \delta, \mu, \rho) = & \sum_{\text{choice}} \log \Phi_2((\mu_p^c + X\beta_c)d_c, (\mu_p^y + X\beta_y + \delta I_c)d_y, \rho d_c d_y) \\ & + \sum_{\substack{\text{no choice} \\ \text{programme village}}} \log \Phi((\mu_p^y + X\beta_y)d_y) + \sum_{\text{non-programme village}} \log \Phi((\mu_p^y + X\beta_y)d_y) \end{aligned} \quad (5)$$

where Φ_2 is the bivariate standard normal distribution, Φ is the univariate standard normal distribution, μ_p^c are the village-specific effects influencing participation in the credit programme in programme villages, μ_p^y are village-specific effects influencing the binary outcome I_y in programme villages, μ_n^y are the corresponding village-specific effects in non-programme villages, and $d_c = 2*I_c - 1$ and $d_y = 2*I_y - 1$. The errors ε_{ij}^c and ε_{ij}^y are normalised to have unit variance and correlation coefficient ρ . Village-specific effects (μ_n^c) influencing the demand for programme credit are not identifiable for villages that do not have programmes.

The first part of the likelihood is the joint probability of programme participation and the binary outcome I_y conditional on participation for

those households that are *both* eligible to join the programme (*choice*) and reside in a village with the programme (*programme village*). This part of the likelihood corresponds to the expectation (4d). Without regressors (Z) that influence the probability of programme participation but not the outcome I_y conditional on participation, the parameter δ , the effect of credit on the outcome y , is not separately identified from the parameters μ_p^y and β_y from this part of the likelihood.

The second part of the likelihood is the (univariate) probability of binary outcome I_y for landed households in programme villages and corresponds to expectation (4c). These households are precluded from joining the programme by their landed status. The last part of the likelihood is the probability of the outcome I_y for all households, landed and landless, in villages without a programme and corresponds to expectations (4a and 4b). If one of the regressors in X is a binary indicator of landed status, this part of the likelihood is required for identification. If landed status is a continuous measure of landholding, then the model is identified without the last part of the likelihood. In this case, the parameter β_y in (3) is identified from variation in landholding within the programme villages ($j=2$) and a sample of non-programme villages is not required.

Even if land ownership is exogenous for the purposes of this analysis, it is necessary that the 'landless' and the 'landed' can be pooled in the estimation. In order to enhance the validity of this assumption, we restrict the set of nontarget households used in the estimation to those with less than 5 acres of owned land. In addition, we include the quantity of land owned as one of the regressors in the vector X_{ij} and include a dummy variable indicating the target/non-target status of the household.

The exclusion restrictions that identify the effects of credit on the outcomes y_{ij} are the interactions of a dummy variable indicating if the household has the choice to join the credit programme (which requires meeting the land ownership rule and residing in a village with a credit programme) and all the exogenous variables of the model, X_{ij} and μ_j . Consequently, the model is not non-parametrically identified; that is, if the linear indices $X_c\gamma$ and $(X_y\beta + \delta I_c)$ in (5) were replaced by non-parametric functions of the X s, and I_c the model is not identified.

Identification of the Impact of Gender-Specific Credit using Single-Sex Groups

An important question of this research is whether various behaviours are affected differently by credit if the program participant is a woman or a man. For that reason, the reduced form credit equation is disaggregated by gender

$$C_{iff} = X_{ij} \beta_{cf} + \mu_{if}^c + \varepsilon_{iff}^c \quad (6)$$

$$C_{ijm} = X_{ij} \beta_{cm} + \mu_{jm}^c + \varepsilon_{ijm}^c \quad (7)$$

where the additional subscripts f and m refer to females and males respectively. The conditional household outcome equations allow for seasonal intercept dummy variables as well as separate female and male credit effects by season:

$$y_{ijs} = X_{ijs} \beta_y + \mu_j^y + \sum_s D_{jfs} \alpha_s + \sum_s C_{iff} D_{jfs} \delta_{fs} + \sum_s C_{ijm} D_{jms} \delta_{ms} + \varepsilon_{ijs}^y \quad (8)$$

where D_{jfs} and D_{jms} are village specific indicator variables such that D_{jfs} takes the value of one in village j in season s if there is a female group in village j , and zero otherwise.

Additional identification restrictions are required when there are both male and female credit programmes with possibly different effects on behaviour. Identification of gender-specific credit is also achieved by making use of another quasi-experimental attribute of these programmes and the survey. All programme groups are single-sex and not all villages have both a male and a female group. The sample includes some households from villages with only female credit groups, so that males in landless households are denied the choice of joining a credit programme, and some households from villages with only male credit groups, so that landless females are denied programme choice.¹⁰ In particular, of the 87 villages in the sample, 15 had no credit programme, 40 had credit groups for both females and males, 22 had female-only groups and ten had male-only groups. The necessary assumption is that the availability of a credit group by gender in a village is uncorrelated with the household errors ε_{ij}^y , conditional on X_{ij} and the village fixed effects μ_j . As each village had only one type of credit programme available, and it is assumed that the type of credit programme (BRDB, BRAC or Grameen) is uncorrelated with the household errors ε_{ij}^y , conditional on X_{ij} and the village fixed effects μ_j , there is no need to model which of the programs members of a household join.¹¹

While the likelihood given by (5) illustrates the general principle and method used, the actual likelihoods maximised have been altered to allow for other aspects of our data. Male and female credit and the labour supply of women are limited dependent variables with a mass point at zero. Consequently, the likelihoods contain trivariate normal distribution functions because two credit equations (6) and (7) are being estimated simultaneously with a limited dependent variable outcome equation. In addition, the sample design is choice-based (see section III below). In particular, programme participants are purposely over-sampled.

The Weighted Exogenous Sampling Maximum Likelihood (WESML) methods of Manski and Lerman [1977] were grafted on to the limited information maximum likelihood (LIML) methods described above in the estimation of both parameters and the parameter covariance matrix.¹² WESML estimates are obtained by maximising a weighted log likelihood function with weights for each choice equal to the ratio of the population proportion to the sample proportion for that choice. To remind the reader of these crucial aspects of the maximum likelihood approach taken in this analysis, the method is referred to as WESML-LIML-FE, which stands for Weighted Exogenous Sampling Maximum Likelihood – Limited Information Maximum Likelihood – (Village) Fixed Effects. Pitt and Khandker [1998] provide an explicit characterisation of the likelihood actually maximised as well as the asymptotic covariance matrix.

The specifications of the conditional demand for consumption and conditional labour supply equation presented here differ from those in Pitt and Khandker [1998] in that credit effects are allowed to vary by season, and the correlation between the residuals of these equations and the male and female credit equations are also allowed to vary seasonally. In addition, we do not discriminate among the three credit programmes in the estimates below. Our earlier work found no significant difference in the effects of borrowing from BRDB, BRAC and the Grameen Bank on labour supply and household consumption.

III. DATA, SURVEY DESIGN AND THE NATURE OF SEASONALITY IN BANGLADESH

A multi-purpose quasi-experimental household survey was conducted in 87 villages of 29 *thanas* in rural Bangladesh during 1991–92. The sample consists of 29 *thanas* (sub-districts) randomly drawn from 391 *thanas* in Bangladesh, of which 24 had one (or more) of the three credit programmes under study in operation, while five *thanas* had none of them.

Three villages in each programme *thana* were then randomly selected from a list of villages, supplied by the programme's local office, in which the program had been in operation at least three years. Three villages in each non-program *thana* were randomly drawn from the village census of the Government of Bangladesh. A household census was conducted in each village to classify households as *target* (that is, those who qualify to join a program) or *non-target* households, as well as to identify programme participating and non-participating households among the target households. A stratified random sampling technique was used to over-sample households participating in one of the credit programmes and target non-participating households. Of the 1,798 households sampled, 1,538 were target households

and 260 non-target households. Among the target households, 905 households (59 per cent) were credit programme participants.

There are six partly overlapping seasons delineated in the Bangla calendar and three major rice-based seasons are prominent. The survey of households and communities was designed to reflect this pattern of seasonality. The survey was carried out in three rounds corresponding to the *Aus*, *Aman* and *Boro* cropping seasons. The first round of the survey was conducted during the months of December–January, during the post-harvest of *Aman* rice. The second round of survey was carried out during the months of April–May to cover the post-harvest season of *Boro* rice. The third round of the survey was carried out during the months of July–August to cover the post-harvest of *Aus* rice. In our sample survey data, season one refers to the *Aman* season, season two refers to *Boro* season, and the season three refers to the *Aus* season.

The strong seasonality of crop production in Bangladesh is well known to affect the timing of income flows. The *Aman* rice is the largest crop in Bangladesh agriculture and, hence, its production and harvest has the largest impact on agricultural employment, income and prices. Both *Boro* and *Aus* also provide enhanced opportunities for employment but not in the same scale as *Aman*. As the use of high-yielding varieties and irrigation technologies has spread, *Boro* crop production has increased in recent years. None the less, the period of least food consumption for the rural poor has traditionally taken place in the months just before the *Aman* harvest. The food availability on a per capita basis is the highest during the months just after the *Aman* harvest (November–December), and also during May–June, just after the harvest of *Boro* rice [Chowdhury, 1989].

Agricultural employment also responds to seasonal variations in the demand for labour in various crop-related activities. The *Aman* harvest during the months of November–December is characterised by the greatest demand for agricultural labour. The labour demand is also relatively high in the months of January and March, when the transplantation of *Boro* HYV takes place. Labor demand is lowest during the months of September–October just before the harvest of *Aman* rice. This seasonality in labour demand is mirrored by the seasonal pattern of agricultural employment and wages, and consequently, in the seasonal consumption landless households who depend heavily on wage employment. [Muqtada, 1975; Hossain, 1990].

Table 1 presents the weighted mean and standard deviations of all the dependent variables used in the regression, by season. Because the samples drawn are not representative of the village population, the means of the variables are adjusted by appropriate weights based on the actual and sample distribution of the households covered in the study villages. The exogenous variables include a set of variables indicating the existence of

TABLE I
WEIGHTED MEANS AND STANDARD DEVIATIONS OF DEPENDENT VARIABLES

Dependent Variables	Households with participants	Obs.	Households without participants	Obs.	All households in programme areas	Obs.	Households in non-programme areas	Obs.	All households	Obs.
Women's labor supply (hours per month, ages 16-59 years)	40,328 (70,478)	3420	37,680 (71,325)	2108	38,905 (70,934)	5528	43,934 (74,681)	1074	39,540 (71,432)	6602
Season 1 (Aman)	44,515 (73,961)	1157	40,559 (72,661)	720	41,855 (73,088)	1877	29,121 (67,761)	365	39,825 (72,401)	2242
Season 2 (Boro)	37,904 (68,590)	1139	28,998 (59,067)	698	31,950 (62,504)	1837	29,728 (52,228)	357	31,587 (60,939)	2194
Season 3 (Aus)	38,492 (68,549)	1124	27,693 (59,213)	690	31,290 (62,664)	1814	35,001 (59,895)	352	31,901 (62,519)	2166
Men's labor supply (hours per month, ages 16-59 years)	202,758 (100,527)	3534	185,858 (104,723)	2254	191,310 (103,678)	5788	180,94 (98,805)	1126	189,477 (102,902)	6914
Season 1 (Aman)	209,389 (107,000)	1201	196,037 (112,121)	769	200,330 (110,640)	1970	184,352 (101,847)	383	197,526 (109,296)	2353
Season 2 (Boro)	201,849 (96,821)	1173	181,772 (100,899)	746	188,267 (100,007)	1919	190,737 (96,384)	372	188,704 (99,530)	2291
Season 3 (Aus)	196,848 (96,942)	1160	179,435 (99,808)	739	185,055 (99,193)	1899	167,651 (95,853)	371	181,961 (98,810)	2270
Weekly per capita HH total expenditure (Taka)	77,014 (41,496)	2696	85,886 (64,820)	1650	82,959 (58,309)	4346	89,661 (66,823)	872	84,072 (59,851)	5218
Season 1 (Aman)	87,673 (50,837)	905	95,162 (63,754)	557	92,706 (59,901)	1462	84,038 (50,555)	295	91,268 (58,530)	1757
Season 2 (Boro)	79,407 (39,808)	897	88,857 (59,411)	548	85,732 (53,883)	1445	111,152 (94,469)	290	89,965 (63,177)	1735
Season 3 (Aus)	63,872 (26,470)	894	73,413 (34,459)	545	70,253 (58,695)	1439	73,707 (34,459)	287	70,826 (55,419)	1726

Note: Standard deviations are in the parentheses.

nonresident relations of various type who are landowners. These types of households are potential sources of transfers which may importantly substitute for credit.

The strong seasonality of labour supply and weekly per capita household consumption is evident in Table 1.¹³ Women's *Aman* season labour supply is about 25 per cent higher than *Boro* and *Aus* season labour supply. Men's labour supply is highest in the *Aman* season, five per cent lower in the *Boro* season, and eight per cent lower than in the *Aus* season. The imperfect ability of household to smooth consumption is also clearly seen in Table 1. Average consumption in our 1991/92 sample is highest in the *Aman* season, is only 2.5 per cent lower in the *Boro* season but is a striking 22.5 per cent lower in the *Aus* season.

IV. ECONOMETRIC RESULTS

TABLE 2
ALTERNATIVE ESTIMATES OF THE IMPACT OF CREDIT ON PER CAPITA
EXPENDITURE AND WOMEN'S AND MEN'S LABOR SUPPLY

Explanatory Variables	Log of Weekly Total Expenditure per Capita	Women's Labor Supply: Hours in past month		Men's Labor Supply: Hours in past month	
		WESML- LIML-FE	WESML- FE	WESML- LIML-FE	WESML- LIML-FE
Amount borrowed by female from BRAC	.0394 (4.237)	0.0721 (1.884)	-.0117 (-.128)	-.1813 (-5.884)	
Amount borrowed by male from BRAC	.0192 (1.593)	-.0126 (-.231)	-.0448 (-.520)	-.1369 (-2.155)	
Amount borrowed by female from BRDB	.0402 (3.813)	.0766 (1.803)	-.0139 (-.139)	-.2308 (-7.066)	
Amount borrowed by male from BRDB	.0233 (1.936)	.0268 (.682)	-.0144 (-.181)	-.1440 (-2.129)	
Amount borrowed by female from GB	.0432 (4.249)	.1037 (3.016)	.0152 (.162)	-.2189 (-6.734)	
Amount borrowed by male from GB	.0179 (1.431)	-.0229 (-.506)	-.0570 (-.677)	-.1592 (-2.524)	
Season 2 (<i>Boro</i>)	-.0178 (-1.276)	-.311 (-2.150)	-.315 (-2.169)	-.0384 (-.823)	
Season 3 (<i>Aus</i>)	-.232 (-17.083)	-.239 (-1.511)	-.242 (-1.534)	-.0908 (-2.174)	
ρ (women)	-.4809 (-4.657)		.1255 (1.062)	.6564 (7.461)	
ρ (men)	-.2060 (-1.432)		.0560 (.592)	.4929 (2.512)	
Log likelihood	-6633.559	-15071.59	-15069.781	-18395.082	
No. of observations	5218	6602	6602	6914	

Note: Figures in parentheses are asymptotic t-ratios.

Source: Pitt and Khandker [1998].

Table 2 excerpts the estimates of the determinants on the natural logarithm of total weekly expenditure per capita, and women's and men's labour supply, conditional on programme credit, that were estimated and presented in Pitt and Khandker [1998]. Over 200 parameters are jointly estimated in each case and we only present the estimated credit effects, correlation coefficients and seasonal dummies. The null hypothesis of credit exogeneity is rejected for both expenditure and men's labour supply, so the WESML-LIML-FE estimates, which treat both village programme placement and household and individual participation as endogenous, are the preferred specifications. Exogeneity of household and individual credit programme participation cannot be rejected in the case of women's labour supply, and so the WESML-FE estimates, which treat only programme placement as endogenous, are the preferred estimates.

The estimates of the impact of credit programme participation on the natural logarithm of total weekly expenditure per capita using all three rounds of survey data, presented in Table 2, reveal that female credit parameters are positive and statistically significant determinants of total expenditure, with no t-statistic less than 3.8, and are jointly significant ($\chi^2(3)=19.03$, $p=0.00$). In contrast, none of the male credit parameters has a t-statistic over 2.0 and the hypothesis that all the male credit parameters are zero cannot be rejected at the 0.05 level of significance ($\chi^2(3)=4.11$, $p=0.25$). The estimated female credit effects are approximately double the male credit parameters for the same credit programme.¹⁴

There are not substantially different effects among the three credit programmes. At the mean, an additional one *taka* of credit provided participating women adds 0.18 *taka* to total annual household expenditure, as compared with 0.11 *taka* if the same amount of additional credit is supplied to participating men. The WESML-LIML-FE ρ s are both negative, more so for women, suggesting that, conditional on their village of residence and observed characteristics, low expenditure households are more likely to participate in a credit programme. That is, poorer households are being successfully targeted. The seasonal dummy variables demonstrate highest consumption in the *Aman* round (season 1) of the survey and significantly lower consumption in the *Aus* season (season 3), as expected.

The WESML-FE women's labour supply estimates demonstrate a statistically significant positive effect of women's participation in the Grameen Bank on women's labour supply, and the marginal significance of the women's BRAC and BRDB parameters. As both labour supply and credit are in natural logarithms, the credit parameters are the elasticities of (latent) hours of market labour supply with respect to credit. The pattern of dummy variables in the women's labour supply equation suggests that *Aman* labour supply is highest and *Boro* season labour supply is the smallest, conditional on the regressors.

The male labour supply estimates suggest that both male credit ($\chi^2(3)=98.66$, $p=0.00$) and female credit ($\chi^2(3)=53.11$, $p=0.00$) reduce the labour time of adult male household members. A ten per cent increase in male group-based credit is associated with about a 1.4 per cent decline in labour supply, and a ten per cent increase in female group-based credit is associated with about a 2.1 per cent decline in labour supply. As it seems unlikely that they are substituting home time for market time, the only conclusion to be drawn is that these negative cross-effects reflect income effects.

If the market value of men's time is unchanged by women's borrowing, their labour supply should fall if male leisure is a normal good. This is consistent with a variety of scenarios. One of these is that men already have ready access to non-program credit markets, so that program credit mostly provides men with rents proportional to the difference between the programme and next-best-alternative rates of interest.¹⁵ These labour supply results suggest that one other reason the effect of programme credit on total household expenditure on goods is higher for women than men is the increased consumption of leisure associated with male borrowing. As with women, the pattern of seasonal intercept suggest the *Aman* season as the season of greatest labour supply, but unlike women, labour supply is least in the *Aus* season.

Table 3 presents alternative estimates of the seasonal effects of credit on per capita expenditure. The first column presents estimates like those in Table 2 except that credit effects are allowed to vary by season but not by credit programme. The effect of both female and male credit on consumption expenditure is greatest in the *Aman* season, the season of greatest expenditure, suggesting that programme credit may not reduce the seasonal fluctuation in consumption. However, these estimates restrict the correlation ($\bar{\eta}$) between credit and consumption residuals to be constant across the seasons, which we have argued is unlikely to be true if one motivation for joining these credit programmes is the need to smooth consumption across the seasons, and there is seasonal heterogeneity in the population.

The estimates of column 2 in Table 3, in which $\bar{\eta}$ is allowed to vary by season, tell a completely different story. The largest effect of female credit on consumption is during the *Aus* season, the season of lowest average consumption, although *Aman* effects are not much lower. For male credit, restricting $\bar{\eta}$ to not vary across seasons results in an underestimate of both *Aman* and *Aus* season credit effects. Underlying this is the large $\bar{\eta}$ associated with the *Aus* season for both women and men, suggesting that households with low consumption (conditional on the observed regressors) during the *Aus* season are more likely to participate and borrow from these credit programme than households with low consumption expenditure in the other seasons.

TABLE 3
ALTERNATIVE ESTIMATES OF THE IMPACT OF CREDIT ON THE SEASONAL
PATTERN OF LOG WEEKLY PER CAPITA EXPENDITURE

Explanatory Variables	Pooled	WESML-LIML-FE estimates			
		Pooled	Season 1	Season 2	Season 3
Amount borrowed by female x season 1 (Aman)	.0453 (4.634)	.0432 (5.156)	.0313 (1.206)		
Amount borrowed by female x season 2 (Boro)	.0387 (3.899)	.0364 (3.370)		.0339 (1.580)	
Amount borrowed by female x season 3 (Aus)	.0396 (4.002)	.0479 (5.827)			.0428 (4.879)
Amount borrowed by male x season 1 (Aman)	.0266 (2.225)	.0290 (2.690)	.00556 (.238)		
Amount borrowed by male x season 2 (Boro)	.0172 (1.433)	.0115 (.935)		.0143 (1.042)	
Amount borrowed by male x season 3 (Aus)	.0171 (1.408)	.0227 (1.828)			.0190 (1.861)
Season 2 (Boro)	.00155 (.087)	.00886 (.387)			
Season 3 (Aus)	-.214 (-12.217)	-.234 (-11.179)			
ρ (women)	-.478 (-4.485)				
ρ (men)	-.206 (-1.393)				
ρ (women, season 1)		-.437 (-4.746)	-.339 (-1.046)		
ρ (women, season 2)		-.429 (-3.314)		-.410 (-1.577)	
ρ (women, season 3)		-.606 (-7.495)			-.568 (5.906)
ρ (men, season 1)		-.237 (-1.797)	.0423 (.137)		
ρ (men, season 2)		-.106 (-.621)		-.144 (-.797)	
ρ (men, season 3)		-.304 (-1.985)		-.272	(2.015)
Log likelihood	-6631.00	-6623.56	-2160.34	-2191.23	-1992.06
No. of observations	5218	5218	1757	1735	1726

Note: Figures in parentheses are asymptotic t-ratios.

The last three columns of Table 3 present estimates of the effects of programme credit on consumption expenditure in which all the parameters, not just credit effects and ρ s, are allowed to vary by season. These estimates are obtained by estimating our model one season at a time. These estimates provides even more striking evidence on the importance of seasonality in evaluating the effect of credit programmes on the poor. The only statistically significant correlation coefficients (ρ) are for the low consumption *Aus* season. Apparently, self-selection into these credit programmes with respect

to consumption expenditure arises only from heterogeneity in *Aus* consumption expenditure. It is the extent of lean season poverty that selects household into these programs. Not surprisingly, the largest female and male effects are during the lean *Aus* season. Given the much larger number of parameters that are estimated in this model, the precision of our estimates falls as compared to the first two columns of the table. Only women's credit during the *Aus* season has a t-ratio greater than 2.0.

Table 4 presents our new estimates of the seasonal effect of credit on women's labour supply. Programme credit was found to be exogenous in the determination of women's labour supply in our earlier work, and that finding persists in the seasonal specifications. It is harder to unambiguously relate the pattern of parameter estimates presented in Table 4 to a need to smooth the seasonal pattern of market labour supply. Women's market labour supply is only one-sixth that of men, and so we are not looking at the

TABLE 4
ALTERNATIVE ESTIMATES OF THE IMPACT OF CREDIT ON THE SEASONAL
PATTERN OF WOMEN'S LABOR SUPPLY (HOURS IN LAST MONTH)

Explanatory Variables	Pooled	WESML-LIML estimates		
		Season 1	Season 2	Season 3
Amount borrowed by female x season 1 (Aman)	.0919 (3.095)	.0954 (3.215)		
Amount borrowed by female x season 2 (Boro)	.0842 (2.867)		.0951 (3.252)	
Amount borrowed by female x season 3 (Aus)	.0876 (2.995)			.0741 (2.482)
Amount borrowed by male x season 1 (Aman)	.00489 (.131)	-.00747 (-.197)		
Amount borrowed by male x season 2 (Boro)	-.00587 (-.172)		.0209 (.586)	
Amount borrowed by male x season 3 (Aus)	-.00156 (-.065)			-.00504 (-.138)
Season 2 (Boro)	-.295 (-1.650)			
Season 3 (Aus)	-.222 (-1.120)			
Log likelihood	-15072.74	-5054.24	-4848.25	-4923.42
No. of observations	6602	2242	2194	2166

Note: Figures in parentheses are asymptotic t-ratios.

most important use of their time when we examine market time. Nor do we have a clear understanding of whether the productivity of women's nonmarket time varies by season and the extent to which there are inter-seasonal substitution possibilities in the production of nonmarket goods. It seems unlikely that there is much inter-seasonal substitution for important goods such as child care and food preparation.

TABLE 5
ALTERNATIVE ESTIMATES OF THE IMPACT OF CREDIT ON THE SEASONAL
PATTERN OF MEN'S LABOR SUPPLY (HOURS IN LAST MONTH)

Explanatory Variables	Pooled	WESML-LIML-FE estimates			
		Pooled	Season 1	Season 2	Season 3
Amount borrowed by female x season 1 (Aman)	-.212 (-6.832)	-.206 (-6.687)	-.196 (-4.047)		
Amount borrowed by female x season 2 (Boro)	-.193 (-6.051)	-.213 (-7.391)		-.232 (-10.552)	
Amount borrowed by female x season 3 (Aus)	-.204 (-6.252)	-.195 (-5.077)			-.0232 (-.280)
Amount borrowed by male x season 1 (Aman)	.00207 (.184)	-.0271 (-.646)	-.171 (-3.953)		
Amount borrowed by male x season 2 (Boro)	.00148 (.155)	-.0131 (-.367)		.0232 (.885)	
Amount borrowed by male x season 3 (Aus)	-.103 (-2.032)	-.0871 (-1.101)			.0378 (1.096)
Season 2 (Boro)	-.0770 (-1.230)	-.0627 (-.758)			
Season 3 (Aus)	-.109 (-1.951)	-.127 (-1.672)			
ρ (women)	.652 (7.196)				
ρ (men)	.487 (2.237)				
ρ (women, season 1)		.629 (6.233)	.597 (4.458)		
ρ (women, season 2)		.727 (8.356)		.786 (16.595)	
ρ (women, season 3)		.615 (5.162)			.117 (.430)
ρ (men, season 1)		.521 (2.085)	.575 (4.224)		
ρ (men, season 2)		.410 (1.093)		-.050 (-.723)	
ρ (men, season 3)		.462 (1.046)			-.116 (-1.026)
Log likelihood	-18406.20	-18399.95	-6145.33	-6051.23	-6047.89
No. of observations	6914	6914	2353	2291	2270

Note: Figures in parentheses are asymptotic t-ratios.

It is interesting to note that in the non-programme villages of our sample, *Aus* season labour supply is about 20 per cent greater than in the *Aman* and *Boro* seasons, but in the programme villages, *Aman* season women's labour supply is substantially higher than in both the *Boro* and *Aus* seasons. This different pattern may to some extent reflect the effects of the credit programmes on the seasonal distribution of market time allocation in the village as a whole, as well as non-random programme placement across villages and sample variation. The estimates in column 1 of Table 4 do not

suggest important differences in the effect of credit on women's labour supply by season, consistent with the view that there is likely to be less seasonality in the time allocation of women given the small share of market time in total time. Breaking the sample by round does not qualitatively alter this finding, although the point estimate of the *Aus* season credit effect is about 22 per cent lower than in the *Aman* or *Boro* seasons.

In the sampled households, men devote considerable time to the market; more than 43 hours per week in the full sample and 46 hours per week among participating households, with *Aman* being the peak season. The first column of Table 5, which allows credit effects to vary by season but does not allow for differential self-selection by season, does not find any seasonal variation in the effect of women's credit, but does suggest that men's credit reduces slack season (*Boro*) men's labour supply ($t=-2.03$) and has no effect on labour supply in other seasons. Allowing for differential self-selection (endogeneity) by season in column 2 suggests that there is no difference in the effects of both men's and women's credit by season on men's labour supply. Breaking the sample by season (columns 3 to 5), the most flexible specification of seasonal effects, suggests that there are indeed strong seasonal differences in the effect of both women's and men credit, and in the pattern of self-selection.

Women's credit has no statistically significant effect on men's *Boro* season labour supply, but large (in absolute value), negative and statistically significant effects on men's *Aman* and *Boro* season market labour supply. Women's *Aman* and *Boro* credit effects are approximately ten times the *Aus* credit effect. Women's credit reduces men's labour supply except in the slack season. In addition, the correlation coefficients ($\bar{\rho}$) between the women's credit error and the men's labour supply error are only large and statistically significant during the *Aman* and *Boro* seasons, so, as with household consumption, the endogeneity of women's programme credit is only seasonal – that is, self-selection of women into the credit programme is only seasonal with respect to men's labour supply.

The negative effects of men's credit on their labour supply reported in our earlier work and in Table 2 obscures important seasonal differences. In the *Boro* and *Aus* season, men's credit has small positive but statistically insignificant effects on their labour supply. In addition, the pattern of correlation coefficients (ρ) reflects this seasonal pattern. There is a large positive correlation coefficient between men's credit residuals and labour supply residuals for the *Aman* season, but small negative ρ 's for the other seasons. Men with higher than average demands on their time during the *Aman* season (conditional on the regressors), the time of peak labour demand, are more like to self-select themselves into these credit programmes and borrow from them, with the consequence of reduced market labour supply during that peak season.

V. SUMMARY

This study has examined the effect of group-based credit for the poor in Bangladesh on the seasonal pattern of household consumption and male and female labour supply. Like much of South Asia, Bangladesh has a marked seasonal pattern of agricultural production that results in large differences in the levels of income, consumption and demand for labour across seasons. In the absence of complete markets for contingent claims and credit, household consumption may vary over the seasons both as a result of an inability to smooth the predictable component of seasonal income and of seasonal income shocks. Group-based production credit can help smooth seasonal consumption by financing a new productive activity whose income flows and time demands do not seasonally covary with the income generated by existing activities of households. In rural Bangladesh, male household members are typically engaged in agricultural pursuits. The weather-induced seasonality of the crop cycle is therefore the greatest source of seasonality in income flows. Agricultural households wishing to reduce seasonal fluctuations in income will try to diversify into non-agricultural activities that are less tied to seasonal weather patterns. Indeed, the majority of borrowers from these use their loans to finance nonfarm activities. As a consequence, the self-employment activities that are financed are unlikely to generate income streams that highly covary with income from agricultural pursuits.

Even with perfect monitoring, the fungibility of credit and other sources of financing suggests that access to group-based credit may permit households to devote resources obtained from savings, interhousehold transfers, or borrowing from moneylenders or other sources to other uses when they might have been allocated to the production activity in the absence of the group-based credit programme. In this way, simply by relaxing the household's constraints on borrowing and transfers, monitored production credit may help households smooth consumption.

The econometric results are striking. They strongly suggest that an important motivation for credit programme participation is the need to smooth the seasonal pattern of consumption and male labour supply. It is *only* the extent of lean season (*Aus*) consumption poverty that selects household into these programmes. In addition, the largest female and male effects of credit on household consumption are during the lean *Aus* season. For male labour supply, as with household consumption, it seems that these group-based credit programmes (i) have a pattern of seasonal effects that act to smooth flows over the seasons, and (ii) have a pattern of self-selection in which those households with the experiencing great than average seasonal variation in flows are most likely to join the programmes and borrow. The

results for women's labour supply do not suggest important differences in the effect of credit on women's labour supply by season, consistent with the view that there is likely to be less seasonality in the time allocation of women given the small share of market time in total time.

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NOTES

1. There are other sources of income seasonality in addition to the weather induced seasonality of the crop cycle. Livestock seasonality may follow a different pattern as a consequence of the time of breeding and the availability of fodder. None the less, as Clay [1981] points out, it is the cropping calendar that is the dominant feature of income and time-use seasonality in rural Bangladesh. See the volume edited by Chambers, Longhurst and Pacey [1981] for a thorough synthesis of issues of seasonality in low-income societies including Bangladesh.
2. Theoretical aspects of targeted group-based lending to the poor are well summarized in Rashid and Townsend [1993]. Some non-production lending does take place. In the Grameen Bank, for example, a group fund, financed by the weekly contributions of group members, is used to make consumption loans to group members. More recently, Grameen has offered housing loans to group members as well.
3. A brief description of the participation process in Grameen Bank described by Hossain [1988] will help further illuminate what it means to participate in one of the group based micro-credit programs:

Interested persons are asked to form groups of five like-minded people of similar economic standing. Only one person from a household can be a member, and relatives must not be in the same group. Male and female members form separate groups. Loans are given to individuals (for a maximum of 5,000 taka) without any collateral. A borrower may use the credit in any productive activity, but the loan has to be used immediately and the principal repaid in 50 weekly instalments. Disbursement of loans is not a simple matter. When a group is formed, it is kept under close observation for a month by the bank worker to see if members are conforming to the discipline of the Grameen Bank. The prospective borrowers are obliged to participate in a group training programme for a minimum of seven days of continuous instruction by the bank worker. The training is intended to make the members thoroughly conversant with the rules and regulations of the bank. This includes understanding the purpose of the various bank procedures; health, children's education, and other social development programmes. The group is accorded formal recognition when all members are found to be well versed in the rules and procedures. Two members of the group then receive loans and their loan-repayment behaviour is observed for a month or two. If they pay the weekly installments on a regular basis, the next two members become eligible for loans. A repeat loan is not approved for any member until the accounts of all members of the group are settled [1988: 25-6].

4. As part of Grameen Bank's social development program, all members are required to memorise, chant, and follow the 'Sixteen Decisions'. These decisions include 'We shall keep our families small', 'We shall not take any dowry in our sons' wedding, neither shall we give any dowry in our daughters' wedding', 'We shall not practice child marriage', and 'We shall educate our children'. For more information on: Grameen Bank see Fuglesang and Chandler [1993], Hossain [1988], and Khandker *et al.* [1995a]; BRAC and BRDB see Khandker *et al.* [1995b, 1996].
5. Other studies using these data include McKernan [2002], Pitt, Khandker, McKernan and Latif [1999], Pitt, Khandker, Chowdhury and Millimet [2003], Morduch [1998] and Pitt

- [1999, 2000]. Menon [2001] is the only other paper to fully exploit the seasonal variation in these data. That paper uses an Euler equation approach to study the long run benefits of credit programme participation, finding a positive relationship between duration of membership in these programmes and the ability to smooth consumption across seasons.
6. The quantity of credit is, of course, only one measure of the flow of services associated with participation in any one of the group-based lending programmes. These programmes are more than just lending institutions. Nevertheless, the quantity of credit is the most obvious and well measured of the services provided.
 7. In addition, the effect of any observed village characteristics that are thought to influence y_{ijt} , such as prices and community infrastructure, are not identifiable.
 8. The validity of the assumption that landownership is exogenous is defended at length in Pitt and Khandker [1998].
 9. However, as Pitt [1999] points out, since this is a quasi-experiment, not an actual experiment, the direct application of (4e) would most likely result in a downward biased estimate of α . The regression approach applied here is quite necessary to control for differences in other observed and unobserved variables across the four groups identified in equations (4a) to (4d).
 10. Although rules prohibit more than one adult member of each household to belong to a credit group, in our data there were a number of households in which both a male and female adult belonged. As a consequence, we do not restrict the probability of having both a male and female group member to be zero in the estimation.
 11. There are a very small number of individuals who belonged to credit programmes that met in other villages. For example, there are some women in the sample who belonged to Grameen Bank groups even though there was not a Grameen Bank group in their village. These participation decisions were treated as exogenous in the analysis. There are also a few households in which both an adult male and adult female belonged to a credit group although this is nominally prohibited.
 12. Our method is a substantial generalisation of the LIML likelihoods presented in Smith and Blundell [1986] and Rivers and Vuong [1988] for limited dependent variables.
 13. Expenditure includes all goods consumed in the reference week, including home produced food and other products.
 14. Although the magnitude of these differences is large, the set of female credit parameters is not significantly different from the male credit parameters ($\chi^2(3)=3.39$).
 15. When this result was presented to those who manage and work in these credit programmes in Bangladesh, they stated that it is consistent with their casual observation that the provision of credit from their programmes tended to reduce men's labour supply.

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