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Discussion Paper 08-02

Giving credit to the microlenders

Formal microlending, credit constraints and adverse selection: a case study of shrimp farmers in Bangladesh

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Abstract

Smallholder farmers in many countries have long been denied access to formal credit. An important reason for this is that formal banks charge high administrative fees for each loan, so that access to the small-scale loans that smallholders need become prohibitively expensive. Information gaps are another important reason: precisely because so little lending takes place to smallholders, formal banks have not developed mechanisms for selecting those smallholders who are most likely to succeed. Due to this lack of traditional formal credit, formal microcredit schemes have become a popular means of improving smallholders' access to credit and making long-term investment possible. However, informal microlending has continued to be important even where formal schemes have become available, suggesting that informal credits still fill a gap in the market.

In this paper, we study efficiency in shrimp farming in a rural region in Bangladesh where formal microlending is well established, but where more expensive informal microlending coexists with the formal schemes. Both farmers who exclusively use formal loans and those who also use informal loans, are credit constrained; both types over-utilise labour in order to reduce the need for inputs that require cash at the beginning of the season, creating inefficiencies in production. However, the credit constraint is actually milder for the informal borrowers; the implicit shadow price of working capital is substantially higher in the group that only takes formal loans than in the group that also uses informal loans.

These results suggest that, even in areas where formal microlending has existed for a long time, access to credit remains a problem for many smallholders. Moreover, informal lenders – with their closer ties to the individual farmers – remain more successful in identifying those smallholder farmers that are most likely to make the best use of the borrowed funds. Thus, although formal microcredit schemes avoid one of the problems of traditional formal lending - the high administrative fees that create barriers to small loans - they do not necessarily solve the problem of how to select successful borrowers. Informal lenders have an information advantage that formal microlenders lack. Formal lenders need to find routes for accessing this information in order for formal microcredits to succeed.

1. Introduction

In this paper, we study measures to improve access to credit for smallholder shrimp farmers in Bangladesh. Specifically, we study whether the increasingly popular small-scale formal credits – microcredits – are successful in reaching those borrowers who are most likely to use the borrowed funds successfully. Our findings suggest that this may not be the case.

It has long been noted that limited access to credit is an important barrier to rural development in many developing countries, and that there are information problems and other inherent problems in the credit allocation process (Hoff and Stiglitz, 1993). The outcome of these information problems, discussed in detail in section 2, is frequently that larger farmers have access to cheap formal credit but that smaller farmers are forced to resort to costly informal loans. Because of these information problems, many attempts at providing cheap credit to smallholder farmers have failed in the past.

A solution to this problem, which has become increasingly popular, is the use of so-called microcredit financing, where various innovative means of securing the loans, such as peer monitoring, are used. The best-known microcredit organisation, the Grameen Bank in Bangladesh, was awarded the Nobel Peace Prize for 2006 jointly with its founder Muhammad Yunus. Grameen Bank has been in operation since the 1970s, starting in Bangladesh and spreading to several other Asian countries and inspiring similar schemes in many developing countries. Microcredits have also had considerable impact on the development debate. Thus, the United Nations declared 2005 the “International Year of Microcredit”, giving some indication of how important this issue is now considered to be for development.

In this report, we examine the effectiveness of formal microcredit schemes as compared to the traditional informal credit sources in a rural shrimp farming district in Bangladesh. We compare the two types of credit by studying the technical and allocative efficiencies of the two groups of borrowers. Our results indicate that formal microlending still has trouble identifying the most suitable loan recipients.

The paper is structured as follows. Section 2 provides theoretical background on the issues surrounding rural microlending and discusses experiences from existing schemes. Section 3 provides the socio-economic context to Bangladesh’s contemporary shrimp industry. Section 4 explains the theoretical framework used in efficiency analysis. Section 5 describes the dataset used and provides some descriptive statistics. Section 6 describes how the analysis of farming efficiency was carried out in practice. Section 7 presents the results from the efficiency calculations, and the final section discusses the policy implications of these results for rural upliftment strategies.

2. Formal and informal credit

Historically, the lack of access to credit has been an important constraint to rural upliftment strategies. Microfinance is not the first attempt to address this problem; many developing countries provided cheap small-scale credit to smallholder farmers in the 1970s. However, these government-run credit schemes were rarely financially viable, and when governments were forced to reduce subsidies in the 1980s many of these rural credit schemes collapsed. In addition to this, other forms of subsidised assistance to smallholder farmers, such as (crucially) agricultural extension services, were also withdrawn in many countries.

To some extent, the problems that these government credit schemes encountered were not surprising. There are a number of reasons why credit markets tend to be more problematic than many other markets, especially in developing countries, and policy interventions that do not take this into account are likely to fail. The main reason why credit markets are more problematic than others is that lenders and borrowers have different information about the quality of the borrower's project, both with respect to the expected outcome and with respect to the variance of the outcome.

Lenders face an adverse selection problem. They can discourage borrowers who have projects with low expected returns by charging high interest rates. However, the borrowers most likely to accept loans with high interest rates are the ones whose projects have high risk but potentially also high return–for the borrower. This means that a higher interest rate will increase the share of risky projects in the lender's loan portfolio and will, at sufficiently high interest rates, reduce the overall return on the loan portfolio (Stiglitz and Weiss, 1981). Therefore, lenders will normally try to ration credit through other means as well, especially in settings – such as those in many developing countries – where the scope for collecting debt from defaulters is limited due to weak institutions.

As an alternative way of rationing credit, lenders can impose high collateral requirements in order to ensure that the borrowers will be able to repay even if the projects fail, but high collateral requirements will of course tend to make it difficult for smallholders to borrow. Alternatively, lenders can rely on screening procedures in order to identify those borrowers who are likely to succeed. However, screening is costly for a bank and the cost will have to be recouped through increasing the cost of the loan. Since the screening cost is likely to be high even for the small loans that smallholder farmers might be interested in, the costs of such loans become prohibitively high for smaller farmers.

On the other hand, informal lenders who are based within communities can observe individual farmers' production activities and can more easily identify those farmers who are likely to succeed in their projects. Such informal lenders therefore have a natural advantage over formal banks, and since they have a far smaller adverse selection problem than the formal banks do they can charge high interest rates on the loans that they provide.

Attempts to provide cheap credit to farmers through government credit schemes might, in theory, avoid some of the problems facing other formal lenders – since the government can more easily, for example, confiscate land from farmers who do not repay their loans. In practice, however, these advantages have rarely been used. Governments have been reluctant to enforce loan repayments from defaulting farmers; this has meant that government credit schemes have needed subsidies in order to function. Since default rates have frequently increased over time – when other farmers observe that defaulters have not been penalised – most such government credit schemes have collapsed at some point.

Formal microcredit schemes are an attempt to utilise social pressure in order to encourage borrowers to repay their loans. A common set-up is that a group of borrowers in the same village or region are made jointly responsible for each other's projects. This moves part of the cost of defaults from the bank to the borrowers. It also reduces the need for screening loan applicants, because neighbours will monitor each other's loan performance and there will be considerable social pressure on individual borrowers to repay loans. By reducing the costs related to small-scale loans, such arrangements make it possible for the formal lenders to make cheap loans available to smallholder farmers. The intent is that this will enable smallholder farmers to make investments and production decisions that would not be profitable at the interest rates charged by informal lenders, but that are profitable when interest rates are lower.

The formal microcredit initiatives are intended to promote rural development and help the poorer small-scale farmers by making long-term investment easier. Making cheap credit available to a randomly selected group of poor farmers could in principle, do this. However, given the adverse selection issues, which have troubled small scale formal credit schemes in the past, there should also be some attempt to target those farmers who are most likely to use the invested funds successfully.

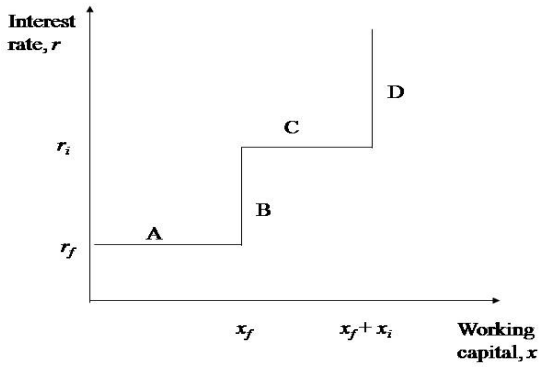

FIGURE 1. THE SUPPLY OF WORKING CAPITAL TO AN INDIVIDUAL FARMER.

Figure 1 helps to illustrate the potential outcomes of making cheap credit available to a farmer. We assume that the farmer has a demand for working capital, determined by the profitability of the marginal unit of working capital, and that the farmer can borrow the amount x_i at an informal rate r_i to finance part (or all) of his/her working capital requirements. The size of this informal credit, and the interest rate at which it is lent, will vary between different farmers, depending on the informal lenders' perception of the individual borrower. If a formal credit scheme makes an amount x_f of cheap credit available to the farmer at the lower interest rate r_f, we see that this can have a range of different outcomes. The outcome will depend on the supply of formal and informal credit (illustrated in the figure) relative to the farmer's demand for working capital.

If the formal credit is sufficiently large compared to the farmer's demand for working capital, the farmer will make all the investments that are profitable at the interest rate r_f, will not wish to borrow the full amount of formal credit made available, and will not borrow informally. This outcome corresponds to the farmer choosing some level of credit along the part of the credit supply curve denoted by A. The farmer's shadow price of working capital will be equal to the formal interest rate.

If the formal credit is not sufficiently large to achieve this outcome, the farmer will perceive a credit constraint, in that he/she would prefer to borrow more at the formal rate, and will perceive a shadow price of working capital that is higher than the formal interest rate. However, if this shadow price is lower than the informal interest rate made available to that specific farmer, he/she will still not borrow informally. This outcome corresponds to a level of credit along the part of the credit supply curve denoted by B. The shadow price of working capital will be higher than the formal interest rate, but lower than the informal interest rate available to that farmer.

If the demand for working capital is sufficiently high, the farmer will also borrow informally. If the amount of informal credit made available is sufficiently large to cover his/her working capital needs at the informal interest rate r_i, the farmer will perceive a shadow price of working capital that is equal to the informal interest rate. This outcome corresponds to a level of credit along the part of the credit supply curve denoted by C in Figure 1. The farmer borrows x_f formally and combines this with additional informal funds.

When the informal credit constraint is also binding, the farmer borrows the total working capital $x_f + x_i$. However, even at the higher informal interest rate r_i, the farmer would prefer to borrow more than this amount. He/she therefore perceives a shadow price of working capital, which is higher than the informal interest rate. This corresponds to section D of the credit supply curve.

In all four cases, the cheap formal credit generates a welfare improvement for the farmer, because his/her borrowing costs are reduced. However, it is only in case A that the farmer's investment decision will be directly determined at the margin by the formal interest rate. In all the other cases, the farmer's marginal investment decision will be determined by the relationship between his/her shadow price of working capital and the informal interest rate that informal lenders offer. Since this informal rate will vary from farmer to farmer, this means that the farmer's shadow price of capital and, hence, marginal investment decision will be determined by how the farmer is perceived as a credit risk by the informal lenders.

If a farmer faces a constraint on formal credits but nonetheless chooses not to borrow informally, this is because his/her shadow price of working capital is lower than the informal rate that he/she is offered. If the farmer's shadow price is higher than the average informal interest rate, this indicates that the farmer is perceived as a poor credit risk by informal lenders – he/she would be prepared to borrow at the informal interest rates offered to other farmers, but is not offered this interest rate. In this case, the farmer does not borrow informally because informal lenders are reluctant to lend to him/her, and the formal lender has made a poor choice when lending to this borrower rather than to others.

On the other hand, if the farmer's shadow price of working capital is lower than the informal rates offered to other farmers, the farmer's main reason for not borrowing informally is that the formal credit takes care of most of his/her working capital needs. In this case, the farmer could (presumably) borrow informally at rates comparable to those offered to other farmers, but chooses not to because this would not be profitable. Thus, we can study the adverse selection

issue in formal lending by looking at whether farmers who only borrow formally have higher or lower shadow prices of working capital (and, hence, are perceived as worse or better credit risks) than the farmers who also take informal loans.

In order to analyse these issues, we make an analysis of technical and allocative efficiency for shrimp farmers in a rural region in Bangladesh where formal and informal small-scale credit schemes coexist. Some farmers only use small-scale formal loans, a few use only informal loans, and some use both types of loans. Studying whether there are systematic differences in efficiency between the borrowers who use only formal loans, and those who also (or exclusively) use informal loans, indicates how successful the formal schemes have been in identifying the farmers who are most likely to use the borrowed funds successfully.

3. Bangladesh's shrimp industry in context

Box 1: A history of informal credit in Bangladesh

The people of ancient Bengal had experience in informal credit before 400 BC and reference is found in Koutilya's *Artha Shastra* and the *Mangalkavya*. By 1150 AD, borrowing and lending was given formal shape with credit activities centred at temples and other religious places. Credit systems in the Indian sub-continent gathered pace during the Mughal period, when different types of gold coins were in circulation, promoting monetary transactions and profit-motivated credit activity. In 1700, credit became "formalised" through the establishment of the Hindustan Bank in Calcutta, the first modern bank in the sub-continent. Yet, informal credit remained dominant and during the eighteenth century credit transactions were managed by s*eths*, *sarrafs*, *mahajans* and *potdars* who constituted private non-institutional credit.

Trade credit became important. In the early eighteenth century, *mahajans* advanced money to cultivators before the season for grains, accepting repayment in-kind and storing the grain anticipating a profitable market. The interest rate charged on credit by different informal providers was very high, between 2 and 4 per cent per month. The English and Dutch East India Companies and Asian merchants engaged in exporting goods from Bengal to various other markets in Europe and Asia provided local traders with short-term advances to increase production of exportable goods. These advances increased the flow of funds into the Bengal economy and benefited traders, who re-lent these advances to farmers and artisans to finance their production. After the occupation of Bengal, Bihar and Orissa by the East India Company, moneylenders, mercantile communities, and other traders in money and credit suffered heavy losses and caused serious instability throughout the economy. With a view to stimulating trade and commerce, the British established several English Agency Houses in Bengal bringing new types of credit that were popular in Britain at the time. While local traditional moneylenders advanced loans to peasants in cash or kind at a high rate of interest, they did not seek any control on the production process. The British agencies were connected with trade and commerce, and advanced money to farmers in order to secure a portion of their produce. By the middle of the nineteenth century, small farmers' grain production for market was largely financed by loans from grain merchants and the landlords. But interest rates remained high and debtor farmers often sold part or all of their produce at low rates to creditors to repay debts.

Laws were passed to regulate perceived problems with credit systems. The Bengal Moneylenders Act 1940 was adopted to regulate the activities of the moneylenders, stipulating that interest in excess of 15 per cent on secured loans and in excess of 20 per cent on unsecured loans was illegal.

When Bangladesh became independent in 1971, it inherited a very weak credit and banking system. The formal segment of the credit system had only 1,130 branches of 12 commercial banks. The non-formal segment comprised local moneylenders and merchants, shopkeepers, and other types of lenders, who were almost non-functional during the early years of independence due to scarcity of loanable funds. Despite the rapid increases in institutional components of the rural credit market in Bangladesh, non-institutional sources continued to remain as the major sources of rural credit. Today, the rural credit delivery system in Bangladesh is dominated by traditional or informal moneylenders who account for about two-thirds of credit delivered in rural areas.

Source: Banglapedia

Bangladesh is one of the world's poorest countries, with over two-thirds of its inhabitants living in rural areas. It has a large and growing informal economy, currently estimated at 37.7 per cent as a proportion of GDP (Schneider, 2006).

At a national level, shrimp are the third largest source of income from export, earning over USD 400 million or eight per cent of GDP from 60,000 tonnes of production. The main importers of shrimp from Bangladesh are the EU (52 per cent), USA (38 per cent) and Japan (5 per cent). The shrimp industry has strong poverty alleviation implications since it employs an estimated one million mainly rural and poor people along its domestic supply chain. The shrimp industry supply chain involves many sectors and agents or middlemen - a shrimp can pass through more than ten different hands before export. Many of these are classified as poor. Like most of Asia,

Bangladesh is characterised by small-scale production on farms less than three hectares and often less than one hectare (Hambrey et al., 2003). Diversification of production is low; research in 2004 indicates that for half of the shrimp farmers, sale of shrimp is the primary activity and provides two-thirds of the household income (Holmgren, 2005).

A major non-farm industry is wild fry collection, which is a very important activity for many poor and unskilled Bangladeshis. The fry collectors are often landless, poor, illiterate people, and many women and children are involved in the collection. The industry plays a positive gender-balancing role with women involved with fry collection, shrimp production, large shrimp depots, and shrimp processing.

In a survey of the business economics of the shrimp industry, carried out by Bangladesh Centre for Advanced Studies (BCAS), it was reported that the formal banking sector only contributed a small fraction of the loans given to shrimp farming. The shrimp farmers instead borrow money from farias (petty traders), commission agents, local moneylenders or other informal credit institutions, resulting in a bonded relationship with few shrimp farmers being able to pay off the loans within the season.

The structure of opportunities facing shrimp farmers is constrained by market forces, credit availability, land rights issues, governance and external inputs - including diminishing stocks of wild fry and labour availability.

4. Efficiency measurement

Standard economic theory assumes that firms adopt a profit maximising or a cost minimising strategy. These are reasonable assumptions. But even though optimisation is the main objective of the producers, for various reasons it might not always be achieved. Efficiency theory extends standard economic theory and assumes that firms can be technically or allocatively inefficient, or both, in their production decisions. Technical inefficiency is measured in mechanical terms, and means that the firm may not choose the best possible technology. Firms might be allocatively inefficient by not choosing the combination of inputs and outputs that generates the maximum profit, or the input combination that generates the least cost.

Efficiency theory goes back at least to Koopmans (1951), who provided a definition of technical efficiency, Debreu (1951) and Shephard (1953) who provided a measure of the distance between the production point and the optimal frontier, and Farrell (1957) who provided a computational framework for both allocative and technical efficiency.

Today, economic efficiency is evaluated using either a deterministic or a stochastic approach. The deterministic approach has the advantage of allowing for flexible functional forms but the drawback that no inference can be made about the efficiency measurement. The stochastic approach can be divided into at least two different categories: the stochastic frontier analysis and the shadow price approach. In the stochastic frontier analysis, efficiency is basically modelled by adding two stochastic error terms to the objective function: one symmetrical error term that allows for random noise across firms, and one skewed error term that captures the effect of inefficiency relative to the frontier. The skewed error term is negative in production and profit function setting and positive in the cost function setting. The stochastic frontier analysis is straightforward in a single equation framework, but is very difficult to estimate in a simultaneous equation framework (Kumbhakar and Lovell, 2000). Using only a single equation model, on the other hand, has the drawback that it does not allow for a distinction between allocative and technical efficiency and it does not utilise data on input quantities. In this paper, we therefore use the shadow price approach.

The basic assumption behind the shadow price approach is that firms optimise with respect to shadow prices, rather than the observed market prices. Efficiency parameters are included in the objective function and in the first order conditions. This approach, originally due to Lau and Yotopoulos (1971), will be used in this paper. The motivation behind using this approach is that it is stochastic so it will allow us to make inference about the efficiency parameters and it also allows for simultaneous equations which will make better use of our limited data. This method also permits us to estimate the farmers' perceived shadow prices of working capital directly.

We assume that the environment for the shrimp farmers in rural Bangladesh can be characterised by competitive markets, where output is demand driven so that input prices and output can be considered as exogenous. This makes the cost function an appropriate behavioural function. Cost efficiency can be modelled using either an input or an output-oriented measure. As the input-oriented efficiency is easier to estimate (Kumbhakar and Lovell, 2000) it will be used here. In this framework, technical efficiency can be seen as the ability to minimise the input use for producing a given output. The underlying production function can then be specified as

$$y_i = f(\phi_i x_i; \beta) \exp\{v_i\} \qquad (1)$$

where y_i is the scalar output of farmer *i*, x_i is the input vector, $f(x_i;\beta)$ is the deterministic part of the production function, β is a vector of parameters in the production function, v_i is a symmetrically distributed stochastic error term with mean zero and constant variance, and $0 \le \phi_i \le 1$ is a farm specific measure of technical efficiency. The technical efficiency parameter causes the cost function to shift.

Allocative inefficiency is introduced into the model by allowing the farmers to fail in minimising the cost with respect to the observed prices, i.e., the marginal rate of transformation is allowed to diverge from the input price ratio. Instead, the farmers are assumed to minimise cost with respect to shadow prices that are parametrically related to the observed factor prices. The first order condition for the optimisation problem can then be written as:

$$\frac{\dfrac{\partial f(\phi x,\beta)}{\partial \phi x_2}}{\dfrac{\partial f(\phi x,\beta)}{\partial \phi x_1}} = \theta_{21}\frac{w_2}{w_1} \qquad (2)$$

where θ_{21} is a measure of the relative allocative efficiency. If θ_{21} = 1, the farm is allocatively efficient. If θ_{21} < 1, it means that the farmer is optimising with respect to a relative shadow price of factor two that is lower than the actual relative price of that factor, leading to over usage of factor two. The opposite is true if θ_{21} > 1. In the following, the first input is set as a numeraire and the shadow price vector is written as:

$$w^* = \left[w_1, \theta_{21}w_2, ..., \theta_{N1}w_N\right] \qquad (3)$$

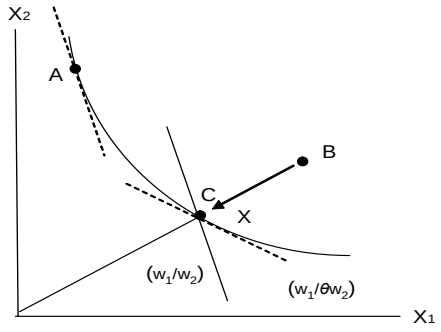

FIGURE 2. INPUT-ORIENTED COST EFFICIENCY.

The reasoning underlying the input-oriented cost function approach is illustrated for the two-input case in Fig. 2 The two inputs are x_1 and x_2, and all input combinations along the isoquant permit production of one unit of output. Given the input prices w_1 and w_2, *A* is the cheapest input combination that permits production of one unit of output, and thus corresponds to efficiency in production.

If a firm uses the input combination *B* to produce one unit of output, it is neither technically nor allocatively efficient. If all inputs were reduced by the proportion ϕ, to the input combination denoted by *C* in Figure 2, the firm would become technically efficient. It could still produce one

unit of output, but at lower cost. C is technically efficient but is not allocatively efficient, since it is not the cost minimising input combination. However, it would be the cost minimising input combination if the ratio between the input prices were $w_1 / \theta w_2$ rather than w_1 / w_2. Thus, ϕ can be seen as a measure of the technical inefficiency of the firm's actual input choice, and θ as a measure of the allocative inefficiency.

Given the discussion in section 2, we may note that although these shadow prices are normally interpreted as measuring inefficiencies due to poor input choices, in this setting the measured shadow prices of working capital can also be interpreted as the actual shadow prices facing the individual farmers.

5. Data

The study uses data from a survey of credit sources used by shrimp farmers in the Khulna district in Bangladesh (Holmgren, 2005). The survey was carried out in late 2004 and included questions on the farm's production of shrimp and other outputs and on the prices paid for these outputs. A number of questions addressed the farm households' demand and supply of inputs to production: the use of labour (own and hired) in farm production; wages paid to hired labour, the supply of labour for paid work elsewhere by the household and wages received for this; the use of land (own and leased); payment for leased land; leasing out of land and payment for this. The survey also included questions about household characteristics such as household size, education (if any) and so on. Finally, the survey asked about formal and informal loans taken, the purpose of the loans, the interest paid on each loan, and whether households would have liked to borrow more.

For the subdivision between formal and informal loans, we follow the standard practice of defining formal lenders as institutional lenders who mainly finance loans through deposits from others, while informal lenders are defined as private lenders who mainly finance loans from their own equity. In practice, this subdivision was straightforward to make.

In all the villages surveyed, there were functioning labour markets, land rental markets, and credit markets for working capital. All households are assumed to be price takers in the sense that, although different households faced different input prices (depending, for example, on whether they were net buyers or sellers of the input), it is assumed that none of them can affect the input prices that they pay or receive for the marginal unit purchased or sold. Thus, although some of the households had access to favourable prices on, for example, family labour from close relatives, it was assumed that the highest input price paid reflected the marginal input cost facing each household and that this price was unaffected by the household's demand for the input.

Similarly, it was assumed that for households that rented out labour or leased out land, the marginal value of that labour or land in own production was the price paid for it (because, presumably, the household would have used more of the labour or land in its own production if this had been more profitable). If these price-taking assumptions hold, farm production decisions will be based solely on the prices of the marginal unit of each input. Thus, although in practice the farm household is likely to make consumption, work, and production decisions jointly, the production decisions can nonetheless be analysed separately from the household's other decisions (Sadoulet and de Janvry, 1995).

Since the purpose of the study was to compare informal and formal loans for use in production, farmers who had borrowed for consumption purposes or who had not borrowed at all – approximately half the surveyed farmers – were removed from the sample. Descriptive statistics over borrowed capital, labour use, land use and agricultural production for the farmers remaining in the dataset are provided in Table 1. All farmers perceived themselves as credit constrained, in the sense that they all stated that they would have liked to borrow more money. This means they can all be assumed to have borrowed the full amount that they were able to. This simplifies the analysis considerably (see, e.g., Feder et al., 1990, for a discussion of the selection issues when this is not the case) and, with the framework used in section 2, implies that all the farmers belong either to category B (credit constrained, and financing all working capital requirements with formal loans) or category D (credit constrained, and financing at least some working capital requirements with informal loans).

Sixty-one per cent of the studied farmers took only formal loans, nine per cent took only informal loans, while the remaining group (30 per cent) took both formal and informal loans. Since the crucial distinction in our analysis is that between the farmers who do not borrow informally and those who do, the two groups of farmers who borrow informally (the ones who also borrow formally, and the ones who do not) are equivalent for the purposes of our study and are aggregated in the analysis.

The average rate of interest paid by the farmers taking only formal loans was 13.6 per cent. Looking at the interest paid by each borrower on the last taka of formal loans (the marginal factor cost for formal loans), the marginal cost of capital was, on average, 14.3 per cent, i.e. almost the same. For farmers who also used informal loans, on the other hand, the differences in interest rates between the two types of loan meant that the marginal rate of interest on the last taka borrowed was substantially higher than the average rate of interest paid and was, on average, thirty five per cent.

The two categories show largely similar patterns in terms of labour use. Both groups mainly use own labour, but in both groups there are also farmers who, to some extent, supplement this with hired labour. Many households also supply labour outside of agricultural production, either by carrying out their own off-farm production as a side activity or by working for pay elsewhere. On average, labour use by the farm is roughly equal to the average labour supply by the farm household in both groups, but there is considerable variation within both groups.

For labour, it is difficult to calculate average factor costs since unpaid family labour plays an important role on most farms. However, for the last labour hour used on each farm, the two groups faced largely similar labour costs on average, but with considerable variation within groups.

Markets for land rental are well developed and both groups include farmers who rent, as well as farmers who hire, land. On average, the surveyed farmers rented more land than they hired out, but again, the variation was considerable in both groups.

Shrimp farming was the main farming activity on all surveyed farms, though not necessarily the main economic activity of the household. Many farms supplemented shrimp production with other agricultural production during other parts of the year. The main side activity was rice production, but many farmers also devoted time and resources to fish breeding, vegetable production, or both. It may be noted that although all groups display considerable variation, the average shrimp production is lower among the farmers who cover at least some of their working capital requirements through informal loans, and that the variation is smaller in this group than among the formal borrowers.

Table 1: Descriptive statistics for borrowed capital, labour use, land use and agricultural production

Farmer groups	Formal loans only				At least some informal loans			
Variables	Average	Standard deviation	Max	Min	Average	Standard deviation	Max	Min
Borrowed working capital, takas (1 taka is approximately 0.015 USD)	23571	32988	150000	3500	52917	61327	190000	1000
Average rate of interest, annualised %	13.6	5.3	24.2	5.0	24.4	19.2	60.0	2.6
Marginal rate of interest, annualised %	14.3	5.9	28.0	5.0	34.6	19.8	60.0	6.0
Labour used in agriculture, hours per year	17065	13147	53782	3483	19419	18919	84634	2731
Own labour supply, share of total labour use	1.01	0.43	1.78	0.17	1.08	0.40	1.67	0.16
Marginal cost of labour, takas per hour	10.6	3.4	18.8	1.0	13.1	12.1	59.2	0.6
Land use in bighas (in Bangladesh, a bigha is a unit of land defined as approximately 1350 m^2)	30.9	47.4	200.0	0.5	39.3	65.6	250.0	1.0
Own land, share of land used	0.73	0.46	1.60	0,00	0.76	0.45	1.60	0.00
Marginal cost of land in takas per bigha	357	39	430	300	344	30	400	324
Shrimp production in kgs	762	1545	8010	10	636	843	2520	20
Rice production in maunds (1 maund is approximately equal to 40 kg of rice)	149	153	640	0	86	86	280	0
Fish production in kgs	736	1534	8000	10	373	394	1280	20
Vegetable production, revenue in takas	1196	4038	20000	0	389	1145	4000	0
N	28				18			
Share of total sample (%)	98%				39%			

6. Econometric specification

In this paper we assume a Cobb-Douglas cost function. In the absence of inefficiencies, this cost function can be written as:

$$c(y, w; \beta) = \gamma_0 y^{1/r} \prod_n w_n^{\gamma_n} \qquad (4)$$

where c is the production cost, y is the agricultural production (in order to achieve a single measure, rice, fish, and vegetables are recalculated into the number of kilograms of shrimp that would give the same revenue), w_i are the input prices (w_1 is the hourly wage rate, w_2 is the interest rate on borrowed working capital and w_3 is the land rent), and r indicates the degree of homogeneity in the underlying production function. The restriction that $\sum_n \gamma_n = 1$ is imposed to satisfy the assumption of homogeneity of the cost function with respect to input prices.

In the absence of inefficiencies, the input demand equations, obtained by differentiating the cost function with respect to factor prices, would be given by

$$x_1(y, w; \beta) = \gamma_0 \gamma_1 y^{1/r} \prod_{n>1} \left(\frac{w_n}{w_1} \right)^{\gamma_n} \qquad (5)$$

$$x_2(y, w; \beta) = \gamma_0 \gamma_2 y^{1/r} \left(\frac{w_2}{w_1} \right)^{-1} \prod_{n>1} \left(\frac{w_n}{w_1} \right)^{\gamma_n}$$

$$x_3(y, w; \beta) = \gamma_0 \gamma_3 y^{1/r} \left(\frac{w_3}{w_1} \right)^{-1} \prod_{n>1} \left(\frac{w_n}{w_1} \right)^{\gamma_n}$$

where x_i are the quantities of inputs; x_1 is total number of labour hours per year, x_2 is the total amount of borrowed working capital, and x_3 is the land used in production, measured in bighas (a standard unit of area used in Bangladesh measuring one-third of an acre or approximately 1,350 m^2).

Following Kumbhakar and Lovell (2000), technical inefficiency is introduced into the model by replacing the intercept of the cost function by $\gamma_0 \exp(-\Delta D)$, where D is dummy variable indicating one if the farmer belongs to a particular group and zero otherwise, thus $\exp(-\Delta)$ is the relative technical efficiency of this group compared to the other group. Allocative inefficiency enters the model through the assumption that farmers minimise costs with respect to shadow prices rather than market prices. The input demand equations are then given by:

$$\ln x_1 = \ln \gamma_0 - \Delta D + \ln \gamma_1 + \frac{1}{r} \ln y + \gamma_2 \ln \left[\theta_{21} \left(\frac{w_2}{w_1} \right) \right] + \gamma_3 \ln \left[\theta_{31} \left(\frac{w_3}{w_1} \right) \right] \qquad (6)$$

$$\ln x_2 = \ln \gamma_0 - \Delta D + \ln \gamma_2 + \frac{1}{r} \ln y + (\gamma_2 - 1) \ln \left[\theta_{21} \left(\frac{w_2}{w_1} \right) \right] + \gamma_3 \ln \left[\theta_{31} \left(\frac{w_3}{w_1} \right) \right]$$

$$\ln x_3 = \ln \gamma_0 - \Delta D + \ln \gamma_3 + \frac{1}{r} \ln y + \gamma_2 \ln \left[\theta_{21} \left(\frac{w_2}{w_1} \right) \right] + (\gamma_3 - 1) \ln \left[\theta_{31} \left(\frac{w_3}{w_1} \right) \right]$$

In order to see if there is a difference in efficiency between farmers who only take formal loans and farmers who either take only informal loans or use both types of loans, we follow Stefanou and Saxena (1988), Kumbhakar and Bhattacharyya (1992), Bhattacharyya et al. (1994), and Wang et al. (1996), and model inefficiency as a function of firm specific variables. The technical and allocative efficiency parameters are modelled as:

$$\Delta D = \alpha \cdot \mathit{informal} \tag{7}$$

$$\theta_{n1} = \exp(\beta_n + \beta_{\mathrm{inf},n}\, \mathit{informal}) \quad n = 2, 3 \tag{8}$$

$$\theta_{11} = 1$$

where *informal* is a dummy variable which is set to one if the farmer has taken any type of informal loans and zero if only formal credits have been used. The functional form used in equation (7) means that only differences in technical efficiency between the two groups, and not overall technical efficiency, can be measured. This is unavoidable when cross-sectional data are used.

To evaluate the model, and to see if there is any difference in efficiency between farmers using different types of credit schemes, a number of hypotheses regarding the parameters are tested. We start by testing the null hypothesis that there is no allocative inefficiency in either group, and no difference in technical efficiency. The null hypothesis is then written as:

$$\alpha = \beta_n = \beta_{\mathrm{inf},n} = 0 \tag{9}$$

The second hypothesis specifies that there is no significant difference in efficiency between the farmers who rely only on formal credits and those who use informal credit schemes.

$$\alpha = \beta_{\mathrm{inf},n} = 0 \tag{10}$$

Third, we test the hypothesis that the farmers in our sample are allocatively efficient.

$$\beta_n = \beta_{\mathrm{inf},n} = 0 \tag{11}$$

Fourth, we test the hypothesis that there is no difference in relative allocative efficiency between the two groups.

$$\beta_{\mathrm{inf},n} = 0 \tag{12}$$

The above hypotheses are tested with Wald tests. We also test the individual parameters using t-tests. Finally we calculate the cost of inefficiency for each farmer. Following Kumbhakar and Lovell (2000), the total expenditure can be written as:

$$\ln E = \ln c(y, w; \beta) - \Delta D + \left\{ \sum_{n>1} \gamma_n \ln \theta_{n1} + \ln \left[\gamma_1 + \sum_{n>1} \left(\frac{\gamma_n}{\theta_{n1}} \right) \right] \right\} \tag{13}$$

where the first term is the natural logarithm of the minimum cost, the second term is the share of overall expenditure caused by technical inefficiency, and the expression within the brackets is the share of overall expenditure caused by allocative inefficiency.

7. Results

Since the demand equations in the equation system (6) have correlated disturbances and cross-equation restrictions, the system was estimated using a nonlinear seemingly unrelated regression technique (Zellner, 1962) in TSP. The motivation for using this method is that it makes better use of the information than if the equations had been estimated separately. Table 2 shows the parameter estimates and Table 3 gives the results from the hypothesis tests.

Table 2: Results

Parameter	Coefficient
$\ln \gamma_0$	2.64** (0.84)
$\ln \gamma_1$	-2.43** (1.05)
$\ln \gamma_2$	-0.64** (0.18)
α_1	0.091 (0.15)
$1/r$	0.66** (0.048)
β_2	2.38** (1.18)
$\beta_{\text{inf }2}$	-1.29** (0.33)
β_3	1.57** (0.37)
$\beta_{\text{inf }3}$	0.35 (0.28)
R^2 labour	0.57
R^2 capital	0.51
R^2 land	0.82
LM labour	0.29
LM capital	2.92*
LM land	0.16

As can be seen in Table 2, the R^2 measures for the individual equations range from 0.51 to 0.82. The LM test indicates that there might be a problem with heteroscedasticity in the working capital equation.

TABLE 3: HYPOTHESIS TEST

Hypothesis	χ^2 statistic
$\alpha = \beta_n = \beta_{\text{inf},n} = 0$	50.56^{**}
$\alpha = \beta_{\text{inf},n} = 0$	27.57^{**}
$\beta_n = \beta_{\text{inf},n} = 0$	44.11^{**}
$\beta_{\text{inf},n} = 0$	19.94^{**}

The results suggest that there are allocative inefficiencies in shrimp farming, and that there is a significant difference in allocative (though not technical) efficiency between the farmers who only rely on loans from formal lenders and those who take at least some loans from informal lenders. The estimated values of θ_{21} and θ_{31} are higher than unity for both groups, suggesting that the farmers over-utilise labour in relation to both land and working capital.

From the parameter estimates, it can be seen that the over-allocation of labour in relation to working capital is significantly smaller in the group using informal credits; the implicit shadow price of working capital is substantially higher in the group that only takes formal loans (154 per cent on average) than in the group that also uses informal loans (103 per cent on average), even though the market price (as seen in the descriptive statistics) is considerably lower for the formal loans.

Both groups are allocatively inefficient in the land-labour allocation, in the sense that they have implicit shadow prices for land that are considerably higher than the market price, but there is no significant difference between the two groups. Using the significant parameters to calculate the share of overall expenditure caused by allocative inefficiency, we conclude that the costs of inefficiency are approximately 70 per cent of the overall expenditure among the farmers using informal credits, while the corresponding share for those farmers using only formal loans is 77 per cent.

8. Conclusions

This study has analysed efficiency differences between shrimp farmers who rely on formal credits for all their working capital needs and farmers who also borrow informally. The sample was small, and the results may not be representative for the overall formal and informal markets for small-scale credits. However, some results from the study nonetheless deserve some attention.

All the farmers in our sample perceived themselves to be credit constrained. This was true both for those who financed all their working capital through formal borrowing, as well as for those who also borrowed informally. The fact that both groups act as though the shadow price of working capital is substantially higher than the price that they actually pay is further indication of this. Thus, improved access to working capital credit remains an important issue for rural smallholders, even in Bangladesh, where formal microcredit schemes have been available for a considerable length of time.

It is also worth noting that the farmers who borrow informally were, on average, more efficient in their use of inputs than the farmers who only borrow formally. On average, their shadow price of working capital was also considerably lower than that for the farmers who only borrowed formally. This indicates that, at least in this part of Bangladesh, the formal credit schemes currently available to smallholder farmers have not been successful in selecting the farmers who are most likely to use the borrowed funds successfully.

Formal microcredits are an important improvement compared to the previous attempts at providing formal credit to small-scale rural farmers, in that repayment rates are far better. This means that, unlike previous formal credit schemes aimed at smallholder farmers, the microcredits are likely to remain financially viable and hence remain available as a source of credit for the foreseeable future. As noted in section 2, the availability of cheap working capital through formal microcredits represents a welfare improvement for farmers, even when the cheap working capital is not large enough to have a direct impact on their production decisions.

Nonetheless, the indication from our study is that work still remains to be done in identifying the most suitable borrowers, and to make sure that they have access to the amount of credit they need. The informal lenders have better information on individual borrowers and are therefore more successful than the formal credit sources in assessing what borrowers are likely to make the best use of additional funds. Finding ways of making this information available to the formal lenders remains an important issue.

There is a strong poverty angle to these findings, considering how many poor rural people in Bangladesh depend on the shrimp industry for their livelihoods. Export industries such as shrimp offer an important route out of poverty, and if supply constraints caused by limited access to credit can be reduced, the potential exists to increase the welfare for large numbers of rural poor. This is opportunity should not be foregone lightly.

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