Access to Capital in Rural Thailand: An Estimated Model of Formal vs. Informal Credit

Xavier Giné*
University of Chicago

August 10, 2001

Abstract

The aim of this paper is to understand the mechanism underlying access to credit. We focus on explaining two important aspects of rural credit markets in Thailand. First, moneylenders and other forms of informal financing coexist with formal lending institutions such as government or commercial banks, and more recently, micro-lending institutions. Second, potential borrowers face sizeable transaction costs obtaining external credit. We develop a model that provides a unified view of these facts and whose tractability allows a structural estimation. The results show large disparities between access to formal and informal credit. While for some households the cost of accessing a formal institution can be as large as the average amount borrowed, the transaction costs of credit from informal sources are negligible for everyone. In addition, the data strongly reject the hypothesis that access to formal credit is uniform across households. In fact, although proximity to a formal institution reduces the transaction cost, the importance of other measures suggest that informational asymmetries also play a role.

1 Introduction

Most productive activities entail a time lag between the acquisition of inputs and the time when the output is obtained. For this reason, when self-financing is not possible, the inputs must be purchased using credit from financial institutions or informal sources.

*Comments are welcome. Email:xgine@midway.uchicago.edu.
I benefited from the valuable comments of Chris Ahlin, Paco Buera, Joe Kaboski, Ivan Werning and especially Jason Abrevaya, Orazio Attanasio, Maitreesh Ghatak, Robert Townsend and Luigi Zingales. I also thank participants at the informal Growth and Development and Micro Lunch workshops at the University of Chicago. I am especially indebted to Robert Townsend for his constant guidance and support. Finally, I gratefully acknowledge financial support from the Bank of Spain and the University of Chicago. All errors are my own.

The financial contracts available in rural areas, vary substantially depending on the characteristics of the borrowers and lenders and the type of input being financed. Typical examples include small collateral-free and interest-free loans between friends and relatives, collateralized loans from commercial banks, and loans from moneylenders with no collateral requirements but relatively high interest rates.

This last form of lending has traditionally been viewed as unfair, with lenders taking advantage of their position to exploit the poorer borrowers. This view is at the heart of the policy interventions of several governments and NGOs in developing countries. These interventions devote considerable resources to helping supply credit to poor farmers and entrepreneurs who are otherwise denied formal credit.

From the experience of countries in Asia, Africa and Latin America, several case studies have come to challenge this old view of informal finance and have questioned the effectiveness of such policies. Siamwalla et al. (1993) and Bell (1993) have shown that despite the injection of formal credit, informal finance is still used and the interest rates charged have not been affected by the increased presence of formal credit[1].

In addition, two often neglected pieces of evidence of the behavior of farmers and businesses in rural Thailand seem to render this traditional view overly simplistic. First, borrowing businesses and farms with a larger fraction of collateralizable assets tend to be more active in the formal credit market[2]. Second, borrowers are often customers in both the formal and informal credit markets[3].

Despite these facts, Thailand is still a country with restricted access to formal credit. In villages without formal credit institutions, potential clients spend time and money every time they travel to the closest branch. Sometimes, it takes several trips before the loan is granted. In contrast, moneylenders usually live in the same village and will often themselves visit their clients thereby becoming more accessible. However, although proximity may be important in determining the recipients of formal credit, the case studies mentioned before indicate that informational asymmetries may also be at play.

This paper attempts to understand the mechanism under which access to credit is determined. We develop a model that provides a unified view of the facts mentioned above and whose tractability allows a structural estimation. In the spirit of Townsend (1978, 1983) and Greenwood and Jovanovic (1990), access to credit is modeled explicitly by assuming that a fixed cost must be foregone in order to obtain external credit. Unlike Greenwood and Jovanovic (1990), however, this cost may encompass not only money or time but also intangible assets, such as social capital or credit-worthiness, that attempt to overcome informational problems.

[1] On this point see also the collection of articles in Von Pischke, Adams and Donald (1983) and Braverman and Guasch (1986, 1993), Hoff and Stiglitz (1993) and Besley (1994).

[2] This point was also developed in the context of Thailand by Feder et al. (1988) and Feder (1993). They find that farmers with titled land have greater access to institutional credit. The land title enables the owner to sell, transfer and legally mortgage the land, and so it can be used as collateral.

[3] Siamwalla et al. (1993) document that 10 percent of households were active clients of both formal and informal sources. However, Udry (1993) and Aryeetey (1997) find little evidence of this in rural Africa. We do not claim that this fact is pervasive across developing countries but is relevant in our country of study, Thailand.

Two distinct approaches to modeling the inter-linkage between formal and informal lenders have been proposed in the literature. The first assumes that only informal lenders have access to institutional credit and then relend to poorer borrowers. The work by Hoff and Stiglitz (1997), Bose (1998) and Floro and Ray (1996) follow this approach[4]. The second considers formal institutions competing directly with informal lenders. Since the data from Thailand suggest that some households borrow from both sources, this second model may be more relevant. Several theoretical explanations have been offered to explain why some households decide to resort to multiple creditors. Bell et al. (1997) argue that the governments in some developing countries impose a limit on the amount of credit that formal institutions can grant and therefore, the demand for credit of some constrained borrowers may spill over to the informal sector. For the particular case of India, Kochar (1997) evaluates the empirical plausibility of this argument and finds little evidence of credit constraints. Jain (1999) and Conning (1996, 1998) postulate that if informal lenders have an informational advantage, the formal lenders will screen borrowers by partially financing the project, thus forcing the borrower to resort to an informal lender. In this way, they ensure that the project will be monitored. This argument assumes that formal lenders *know* that their clients engage in borrowing from informal sources. In addition, there are cases where "syndication" does not arise because typically the moneylender has first claim to output. In this situation, the bank would like to prevent their clients' dealings with the informal lender, but cannot prevent such behavior.

The model featured offers an alternative explanation. Suppose that a productive project requires an investment in both *fixed* and *working* capital. The difference between both types of capital is that fixed capital remains after production has taken place and hence it can be used as collateral, while working capital is fungible and transformed into output[5]. In addition, suppose that bank clients have the option to default on the contract before producing, in which case they keep the working capital but lose all savings deposited at the bank and the fixed capital which is seized. This imperfect enforceability effectively imposes a maximum amount of working capital that the bank is willing to lend.

In this scenario, some borrowers may find it profitable to seek an informal lender for additional working capital. If the technologies that households operate differ in the ratio of working to fixed capital, banks will tend to finance entrepreneurs whose technology is intensive in fixed capital, whereas entrepreneurs which require relatively more working capital, will be financed primarily by informal lenders.

In addition, if the transaction costs of formal finance are large, households that need less credit will tend to rely on informal lenders whereas those with large credit needs will be better off incurring the fixed costs in order to have access to a lower cost of capital[6]. More

[4] Another model related to this approach is presented in Ghosh and Ray (1999). They focus on loan enforceability when credit histories are not available to (informal) lenders. Although the information structure that they assume differs from ours, both models share the feature that limited enforceability restrict the amount of credit that lenders are willing to lend.

[5] We could also think of fixed capital as assets with relatively high scrap value, perhaps due to a well-functioning secondary market.

[6] This claim is also made in Braverman and Guasch (1986, 1993), Hoff and Stiglitz (1993) and Besley (1994).

generally, the estimation is well suited to assess how important enforcement problems are vis à vis informational asymmetries in the overall picture of credit markets.

The data used come from a cross-section survey conducted in Thailand in 1997. It contains detailed information on household characteristics and, thus, allows us to construct a rich individual measure of the cost of accessing credit. Thailand is also particularly interesting because it is often portrayed as a country with segmented markets and limited formal credit. In his study of the sources of growth in Thailand from 1976 to 1996, Jeong (1999) documents that access to intermediation along with occupation shifts and enhanced education accounts for 59 percent of per-capita income growth. Therefore, understanding the mechanism underlying access to credit seems to be a crucial step in designing successful policy interventions.

The estimation results show large disparities between access to formal and informal credit. While for some households the cost of access to a formal institution can be as large as the average amount borrowed, access to an informal source is negligible for everyone. In addition, the data strongly reject the hypothesis that the cost of accessing formal credit is uniform across households. In fact, although proximity to a formal institution contributes to reducing the transaction cost, the impact of other measures on transaction costs suggest that informational asymmetries are present. Also, even though the characteristics of the enterprise may determine the household's chosen choice source, we find little evidence of credit constraints. According to our model, then, access to credit rather than the presence of enforcement problems *per se* seems to be the key element in explaining why formal credit is not accessible to everyone.

The rest of the paper is organized as follows. Section 2 gives a brief overview of the formal financial institutions operating in Thailand. Section 3 describes the model. Section 4 focuses on the core of the model as given by a finance partition diagram. Section 5 describes in detail the data used. Section 6 presents further evidence based on a reduced-form selection model. Section 7 turns to the maximum likelihood estimation of the underlying parameters of the model. Section 8 presents the results and, finally, Section 9 concludes.

2 An Overview of the Thai Financial Institutions

This section gives a brief overview of the formal credit institutions in Thailand, giving special emphasis to those that operate in rural areas.

Commercial banks have traditionally dominated the Thai credit market in terms of asset size, geographical coverage, and role in mobilizing savings. As Table 1 shows, by the end of 1997 there were 15 Thai banks with 3,138 domestic branches and 56 overseas branches, and 20 foreign bank branches. The bulk of the bank lending was done in the manufacturing with 31 percent and trade sector with 17 percent. Only a 2.7 percent was devoted to the agricultural sector.

One of the major specialized financial institutions established by the Thai government for development purposes is the Bank for Agriculture and Agricultural Coopera-

Table 1: Thai Financial Institutions in 1997

	No.	**Branches**	**Assets**[a]
Regulated Institutions			
Commercial banks	35	3323	7,279,365
Finance companies[b]	91	52	1,616,948
Credit foncier companies	12	-	7,461
Securities companies	24	n.a.	32,423
Mutual fund	12	207	102,462
Specialized Government Fin. Inst.			
Government Savings Bank	1	565	280,933
Government Housing	1	203	310,195
Bank for Agriculture and Agr. Coops.	1	666	236,432
Industrial Finance Corp. of Thailand	1	23	217,500
Small Industry Credit Guarantee Corp.	1	-	580
Small Industry Finance Corp.	1	1	1,766
Export - Import Bank of Thailand	1	2	61,377
Other Institutions			
Life insurance companies	25	1,294	173,243
Agricultural Cooperatives	3,530	-	38,790
Savings Cooperatives[c]	1,270	-	276,230
Pawnshops[c]	390	-	16,900

[a] The asset figures are in Million baht.

[b] Finance Companies also include Finance and Securities Companies.

[c] Data for Savings Cooperatives and Pawnshops are estimated.

Source: Bank of Thailand

tives (BAAC). It was established in 1966 to replace the Bank for Cooperatives, which began operation in 1947. By the end of 1997, the BAAC had an extensive network of 81 branches, 494 district-branches, 91 sub-branches, and 791 field offices throughout the country. Since 1977, the BAAC has been providing direct credits to farmers with collateral requirements for loans exceeding $2,400 and also credit to farmer groups through agricultural cooperatives[7]. These group loans rely on joint-liability mechanisms to enforce repayment. The BAAC faces a legally imposed ceiling on the lending interest rates. Although it started as a supply-led credit institution, it also provides saving services, which by 1989, was the most rapidly growing source of funds. The BAAC also cooperates with both the government and the private sector in providing advice and support to farmers and cooperatives under different agricultural development projects. Due to structural changes with the agricultural sector, current regulation allows the BAAC to extend credit

[7]See Yaron (1994) for a more detailed description of the BAAC as well as three other rural finance institutions and an assessment of their financial performance.

to finance projects related to agriculture.

Agricultural and savings cooperatives also have a a strong presence in rural areas. Agricultural cooperatives are the most numerous, with 3,530 cooperatives in 1997. Typically, these cooperatives are organized by farmers in order to pool efforts for farming activities and make credit available to members. Their sources of funds are loans from the BAAC and member subscriptions. Savings cooperatives are organized by occupation. The major ones are those organized by school teachers, university employees and public employees. In 1997, there were 1,270 savings cooperatives in Thailand. The main source of funds comes from the minimum monthly contribution that each member is required to pay. The funds collected are primarily used for loans to members. The purpose of the loans varies from consumption loans to purchases of durable goods and home repairs. All cooperatives are regulated by divisions of the Ministry of Agriculture and Cooperatives.

Despite the existence of formal institutions that operate in rural areas, Thailand is still a country of limited formal credit. As will be seen in Section 5 when we describe the data in detail, only a small fraction of the sample use commercial credit rendering informal lenders an often used source of capital.

3 The Model

The model is static and deterministic. Agents differ in wealth b, entrepreneurial ability z, and the type of project (K, η) to be defined below. Each entrepreneur decides how to finance the project by choosing to self-finance, resort to a formal or informal institution, or engage in borrowing from both sources. In addition, all agents can deposit their wealth in the formal institution or bank at no cost.

A formal credit institution, in this paper, is a profit maximizing intermediation entity that relies exclusively on the existing legal system to enforce contracts. In contrast, informal lenders may resort to mechanisms other than the existing legal framework to enforce contracts[8]. Informal lenders lend out of their own wealth and may resort to a formal institution for additional funds to lend out, while formal institutions lend out of the collected deposits. The opportunity cost of funds is higher for the moneylender, however, because she can always deposit funds at the bank. Hence, there is a tradeoff between both sources of credit: while banks have access to a lower cost of funds, moneylenders can prevent their clients from "running away" with the borrowed capital.

The timeline of events is given in Figure 1. The enforcement problem is modeled by allowing bank clients to default on the contract by keeping the working capital *before*

[8]The idea behind this assumption is that informal lenders can terminate a credit relationship or exert psychological pressure or harm to their clients if they do not to repay back their loans. Quoting Aryeetey (1997),

> "To discourage default informal lenders go the homes of their clients to deliver verbal warnings."

Similarly, Aleem (1993) finds evidence of large switching costs between informal lenders, suggesting that reputation is important.

production takes place.

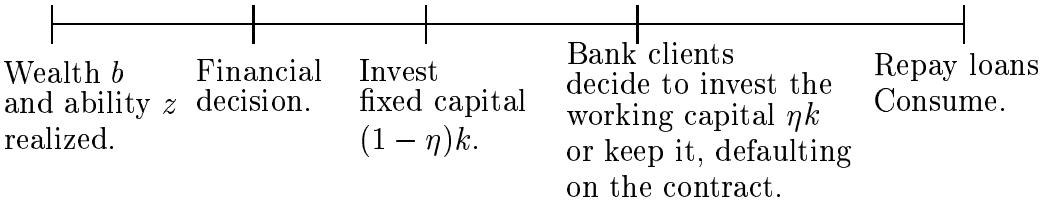

Figure 1: Timeline of the model

There is no uncertainty, so agents will simply seek to maximize end-of-period net income. Each entrepreneur has access to the following technology:

$$f(z,k;K,\eta) = zk + \tilde{\delta}(1-\eta)k, \quad \text{s.t.} \quad k \leq K, \tag{1}$$

where k denotes total capital invested and K is the maximum scale at which each individual can operate. The term $\tilde{\delta}(1-\eta)k$ captures the value of the fixed capital once production has taken place. The parameter $\tilde{\delta}$ may be interpreted as the fraction of non-depreciated capital and η denotes the fraction of working capital relative to fixed capital used in the production: if the ratio η is one, only working capital is used and the project has no scrap value, whereas if the ratio η is zero, all capital used is fixed and will remain after production has taken place. In other words, capital k is the sum of fixed capital k^F and working capital k^W. Then, $\eta = \frac{k^W}{k^W+k^F}$. We can simplify notation by letting $\delta = \tilde{\delta}(1-\eta)$. The parameter δ, which is individual specific through the dependency on η, captures the fraction of non-depreciated total capital.

Throughout the paper, we define a *constrained* household as the one that invests a level of capital below its capacity constraint, so that $k < K$. Similarly, an *unconstrained* household invests the optimal amount $k = K$.

We now proceed to compute the net income obtained from each financial choice. Net income Y depends explicitly on the household ability z, wealth b and the type of project (K,η). It is also subscripted by the financial choice: self-finance (S), bank (B), moneylender (M), and bank and moneylender (BM).

If the entrepreneur decides to self-finance (S), she will obtain a net income of

$$\begin{aligned} Y_S(z,b;K,\eta) = &\max_k zk + \delta k + (b-k)r_B \\ &\text{s.t.} \quad k \leq b, \qquad k \leq K. \end{aligned} \tag{2}$$

where r_B denotes the interest rate on deposits. Since technology is linear, we can write the optimal choice of capital as

$$k_S(z;K,\eta) = \begin{cases} K & \text{if } z \geq r_B - \delta \quad \text{and} \quad b \geq K, \\ b & \text{if } z \geq r_B - \delta \quad \text{and} \quad b < K, \\ 0 & \text{if } z < r_B - \delta. \end{cases} \tag{3}$$

In words, she will invest K if it is profitable and she has enough wealth, will invest her total wealth b if the maximum scale K is larger than her wealth, and will not invest at all if the return on the investment is lower than the interest the bank pays for deposits.

If she goes to the bank (B), her net income can be written as

$$\begin{aligned} Y_B(z,b;K,\eta) = &\max_k zk - l_B R_B + (b-k+l_B)r_B + \delta k - \Gamma_B \\ &\text{s.t.} \quad k \leq K \quad \text{and} \\ &\quad zk - l_B R_B + (b-k+l_B)r_B + \delta k \geq \eta k. \end{aligned} \tag{4}$$

The interest rate R_B denotes the cost of borrowing and the parameter Γ_B captures the (fixed) transaction cost of dealing with a bank[9]. The last constraint captures the enforcement disadvantage that banks face. Before producing, bank clients can "run away" with the working capital advanced, at the cost of losing all their deposited wealth as well as the fixed capital scrap value, which will be seized by the bank. Implicitly, we are assuming that although banks may fully observe their borrowers actions, they have no legal mechanisms to prevent the borrower from "consuming" the working capital. In essence, the contracts that banks offer have to satisfy an enforcement constraint.

Also implicit in the agent's problem stated in (4) is the notion that banks are competitive and will, therefore, offer contracts that maximize their client's income subject to a break-even constraint. In our case, assuming no intermediation costs, this constraint is simply

$$R_B = r_B. \tag{5}$$

The agent will borrow an amount $l_B = k - b$, (i.e. the difference between total capital invested k and wealth b), so we can rewrite the agent's net income in (4) as:

$$\begin{aligned} Y_B(z,b;K,\eta) = &\max_k zk - (k-b)r_B + \delta k - \Gamma_B \\ &\text{s.t.} \quad k \leq K \quad \text{and} \\ &\quad zk - (k-b)r_B + \delta k \geq \eta k. \end{aligned} \tag{6}$$

The optimal choice of capital for the entrepreneur depends on whether or not the enforcement constraint is binding. If it binds, the maximum amount of capital that the bank is willing to lend is given by:

$$k^c = \frac{br_B}{\eta - (z + \delta - r_B)} = \frac{br_B}{\eta(1+\tilde{\delta}) - (z + \tilde{\delta} - r_B)}. \tag{7}$$

The above expression is found using the enforcement constraint at equality and solving for k. Notice that capital k^c is increasing in wealth b and ability z, and decreasing in the ratio η and the fraction of non-depreciated capital $\tilde{\delta}$. The expression in (7) can be seen as a generalization of the parameter λ in Evans and Jovanovic (1989). In their paper, λ

[9]In principle one could assume a more general form. In the estimation we allow this cost to depend on the characteristics of the individual and the type of formal institution the agent is borrowing from.

measures the amount that can be borrowed from a bank as a proportion of wealth. Here it depends explicitly on the agent's characteristics.

The optimal choice of capital can now be written as

$$k_B(z;\eta,K) = \begin{cases} K & \text{if } z \geq r_B - \delta \quad \text{and unconstrained} \\ k^c & \text{if } z \geq r_B - \delta \quad \text{and constrained} \\ 0 & \text{if } z < r_B - \delta. \end{cases} \tag{8}$$

Figure 2 plots the optimal investment k as a function of ability z.

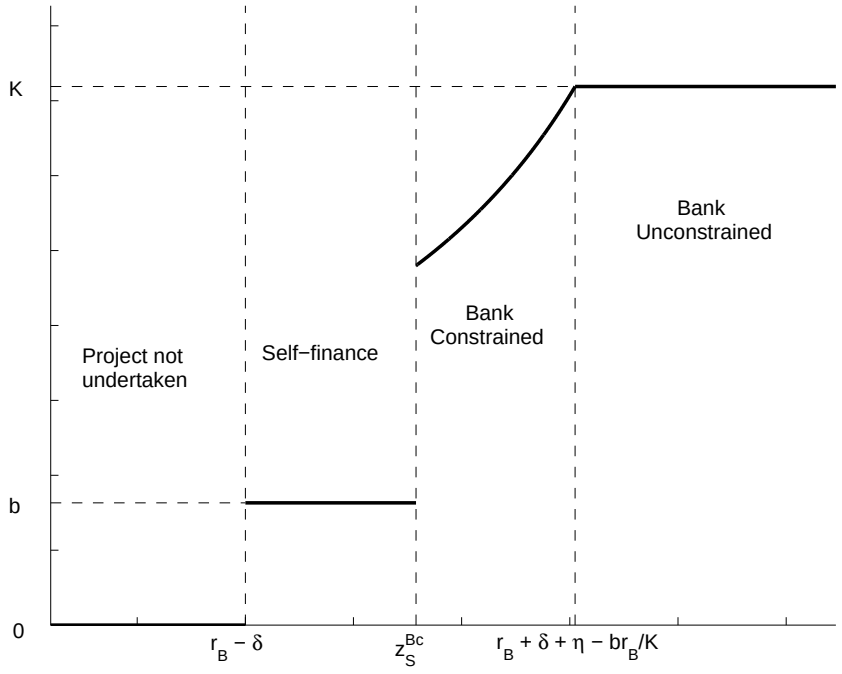

Figure 2: Optimal investment k

When the return on the investment $z + \delta$ is lower than the deposit rate r_B, it pays to keep the money in the bank. When ability is higher than the cutoff $r_B - \delta$ but lower than z_S^{Bc} the agent self-finances investing her total wealth. The cutoff ability z_S^{Bc} is found by equating the net incomes from self-financing and that of resorting to a bank but being constrained. The capital invested is larger than wealth b because the fixed cost Γ_B of transacting with the bank must be foregone. Notice also that in this segment investment is an increasing function of ability z until the capacity constraint K is reached. For higher ability values, the agent will be unconstrained.

Now suppose that the agent resorts to a moneylender. The amount borrowed is $l_M = k - b$ and her net income becomes:

$$\begin{aligned} Y_M(z,b;K,\eta) &= \max_k zk - (k-b)r_M + \delta k - \Gamma_M \\ &\text{s.t.} \quad k \leq K, \end{aligned} \tag{9}$$

where r_M denotes the interest rate charged by the moneylender. The optimal capital choice will be:

$$k_M(z;\eta,K) = \begin{cases} K & \text{if } z \geq r_M - \delta \\ 0 & \text{if } z < r_M - \delta. \end{cases} \tag{10}$$

Notice that the moneylender is not subject to enforcement problems and will therefore advance the optimal amount that the entrepreneur requires. In other words, the entrepreneur will never be constrained in dealing with a moneylender. We subscript the fixed cost, to indicate that it may differ among lenders.

Finally, the entrepreneur may find it in her interest to resort to both a bank and a moneylender (BM). This case will arise if the bank offers too little capital due to enforcement problems: the project may be intensive in working capital (high η) or the entrepreneur may not be talented enough to convince the bank that she will not default on the loan contract and run away with the capital. Since the opportunity cost of funds for the moneylender is higher than that of the bank, the optimal lending choices are given by $l_B = k^c - b$ and $l_M = K - k^c$. In words, the agent will obtain from the bank as much as the bank is willing to lend her and then will turn to the moneylender to finance the remaining capital requirement.

Using the fact that $r_B = R_B$ we can write net income as total revenues from investing the maximum scale $(z+\delta)K$ minus loan repayments and fixed costs. More formally,

$$\begin{aligned} Y_{BM}(z,b;K,\eta) &= zK - (k^c - b)r_B - (K - k^c)r_M + \delta K - \Gamma_B - \Gamma_M \quad \text{or} \\ Y_{BM}(z,b;K,\eta) &= Y_M(z,b;K,\eta) + (k^c - b)(r_M - r_B) - \Gamma_B \\ &= Y_B^c(z,b;K,\eta) + (K - k^c)(z + \delta - r_M) - \Gamma_M \end{aligned} \tag{11}$$

where $Y_B^c(z,b;K,\eta)$ denotes net earnings from dealing with the bank when capital is constrained.

4 The Finance Partition Diagram

An entrepreneur with wealth b and working to fixed capital ratio η facing interest rates r_B, r_M and fixed costs Γ_B, Γ_M, decides how to finance her project depending on her maximum scale K and entrepreneurial ability z.

The goal is to construct a diagram that determines the optimal financing choice for any point in the space of ability-scale (z,K). This space is chosen because ability z and scale K are precisely the unobserved variables[10]. The idea is simply to obtain cutoff scale values K as a function of ability z that leave an agent indifferent between any two lending choices. Thus, there are critical cutoff scales $K_S(z)$, $K_M^{Bu}(z)$, $K^{EC}(z)$, $K_{Bc}^{BM}(z)$, $K_{Bc}^{M}(z)$ and ability z_M^{BM} depicted in Figure 3 that determine the source of funds used by the agent[11]. It is crucial to understand that these critical levels depend on the variables

[10] See discussion below in Section 6 about the estimation strategy.

[11] Notice that the dependency on ability z has been dropped in Figures 3-6.

(b, η) and parameters $(r_B, r_M, \Gamma_B, \Gamma_M)$. In fact, for certain combinations of variables and parameters, some regions may not exist altogether[12].

Before we proceed to obtain these cutoff curves analytically, let us provide some intuition why these regions arise where they do. If the agent has a scale K below $K_S(z)$, she will self-finance (region **S**), whereas if it lies above, she will resort to external financing. So for a given capacity constraint K, the higher the entrepreneur's ability z, the more likely she is to look for outside funds. Intuitively, if the entrepreneur is not very talented it doesn't pay to incur the fixed costs in order to expand capacity.

When the entrepreneur decides to finance the project externally, region **M** becomes relevant if the scale K is lower than $K_M^{Bu}(z)$ or higher than $K_{Bc}^{M}(z)$. In the first case, the credit needed is small (the scale K is close to wealth b) and so the savings on interest payment if she went to the bank do not compensate its higher fixed cost that must be incurred. In the latter case, the amount of credit needed is large as measured[13] by high scale K. However, given her relatively low ability z the bank is not willing to advance enough capital to make savings on interest payment worthwhile, and so the entrepreneur is better off resorting to a moneylender. If the scale K is higher than the cutoff $K_{Bc}^{BM}(z)$ she will resort to both a bank and a moneylender (region **BM**). The intuition is simple: we know that the amount k^c that a bank is willing to lend is increasing in ability z, so for a given ability-scale pair (z, K) that falls in the region M just described, if we fix the scale K and increase the ability z we will reach a point where the entrepreneur will find it profitable to incur the fixed cost Γ_B and reduce total interest payment by borrowing less from the moneylender.

Finally, if the scale K falls between the cutoffs $K_M^{Bu}(z)$ and $K^{EC}(z)$ she will borrow from a bank and be unconstrained (region **Bu**), whereas if it falls between the cutoffs $K^{EC}(z)$ and $K_{Bc}^{M}(z)$ or $K_{Bc}^{BM}(z)$ she will still borrow from a bank but be constrained (region **Bc**). The intuition here is that entrepreneurial ability z captures also how much the entrepreneur values the project, and so for low ability levels, the bank will limit the amount of lending because the entrepreneur is tempted to "run away" with the capital if she was granted the maximum capacity K.

We now solve for the different cutoff curves analytically. The first and last segments of $K_S(z)$, denoted also $K_S^M(z)$ are found by equating the net incomes from self-financing Y_S with borrowing from a moneylender Y_M and solving for the scale K. We obtain

$$(z + \delta - r_M)(K - b) \geq \Gamma_M \quad \text{or} \quad K_M^S = b + \frac{\Gamma_M}{z - r_M + \delta}. \tag{12}$$

The vertical segment in $K_S(z)$ at the ability z_S^{Bc} is found be equating Y_S and the net income from borrowing from a bank and being constrained Y_B^c. This yields a quadratic[14]

[12] Figures 4-6 below show all other cases that may arise.

[13] Recall that wealth b is constant in Figure 3, so capital requirements increase with capacity constraint K.

[14] Note that when $\Gamma_B = 0$, the positive root is $z = r_B - \delta$ and the negative is $z = \eta - \delta$. The positive is chosen because it satisfies $z \geq r_B - \delta$ as required by Equation 8.

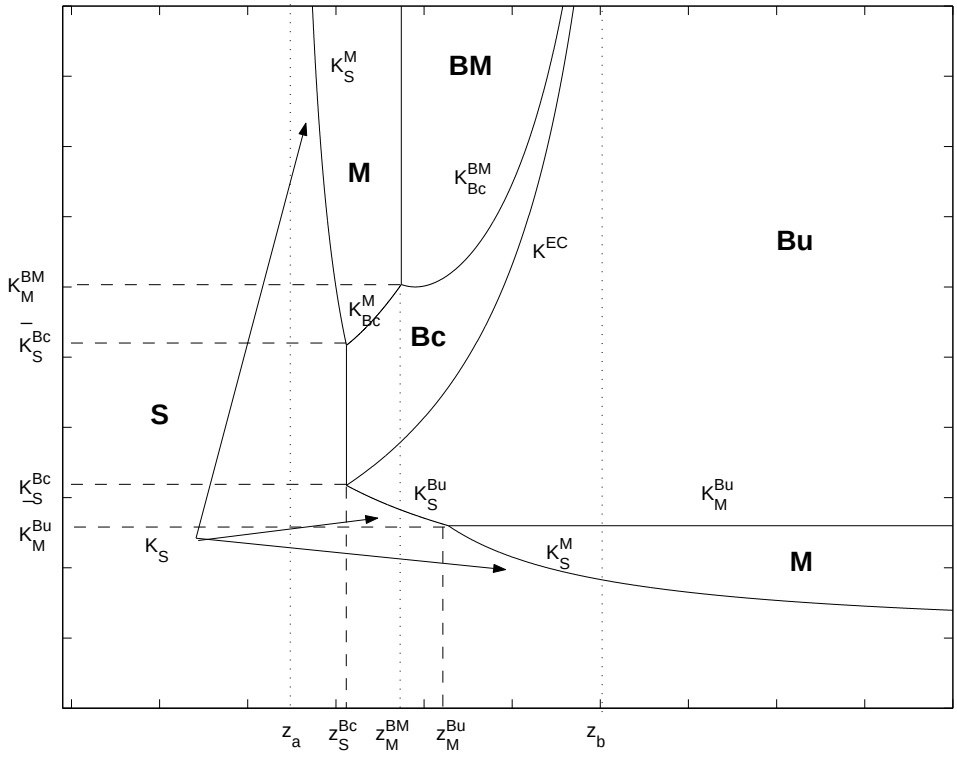

Figure 3: Finance Partition Map

expression in ability z that does not depend on the scale K:

$$b \geq \frac{\Gamma_B}{z+\delta-\eta}\left[\frac{\eta}{z+\delta-r_B}-1\right]. \tag{13}$$

Finally, the segment of the cutoff $K_S(z)$ denoted $K_S^{Bu}(z)$ comes from equating the net incomes from self-finance Y_S with going to the bank and obtaining unconstrained credit Y_B^u.

$$(z+\delta-r_B)(K-b) \geq \Gamma_B \qquad \text{or} \quad K_{Bu}^S(z) = b + \frac{\Gamma_B}{z-r_B+\delta}. \tag{14}$$

Note that the expressions in Equations 12 and 14 are very similar. Next, the cutoff level $K_M^{Bu}(z)$ is found by equating net income of unconstrained borrowing from the bank Y_B^u with the net income of resorting to a moneylender Y_M. This yields

$$b \leq K - \frac{\Gamma_B-\Gamma_M}{r_M-r_B} \quad \text{or} \quad K_M^{Bu}(z) = b + \frac{\Gamma_B-\Gamma_M}{r_M-r_B} \tag{15}$$

which does not depend on the ability z. We now turn to the cutoff curve $K^{EC}(z)$ which partition those agents that will obtain a constrained credit from those that will receive an unconstrained one. This curve is found using the enforcement constraint and solving for the scale K:

$$K^{EC}(z) = \frac{br_B}{\eta-(z+\delta-r_B)}. \tag{16}$$

The curve $K_{Bc}^{BM}(z)$ is found by equating the net incomes Y_B^c and Y_{BM}. This yields a quadratic expression in z,

$$\Gamma_M \geq (z + \delta - r_M) \left[K - \frac{br_B}{\eta - (z + \delta - r_B)} \right] \tag{17}$$

which in terms of K can be rewritten as

$$K_{Bc}^{BM}(z) = \frac{\Gamma_M}{z + \delta - r_M} + \frac{br_B}{\eta - (z - r_B + \delta)}. \tag{18}$$

Finally, we need to compare the net income Y_B^c with the net income Y_M and Y_M with Y_{BM} delivering the curve $K_{Bc}^{M}(z)$ and the cutoff ability z_M^{BM} respectively. Therefore, comparing Y_B^c with Y_M we obtain

$$\frac{\eta b r_B}{\eta - (z - r_B + \delta) - \Gamma_B} = zK - (K - b)r_M + \delta K - \Gamma_M \tag{19}$$

or in terms of K,

$$K_{Bc}^{M}(z) = \frac{1}{z + \delta - r_M} \left[\frac{b\eta r_B}{\eta - (z - r_B + \delta)} - br_M - (\Gamma_B - \Gamma_M) \right]. \tag{20}$$

Now comparing Y_M with Y_{BM} we get

$$b \left[\frac{r_B}{\eta - (z - r_B + \delta)} - 1 \right] = \frac{\Gamma_B}{r_M - r_B} \tag{21}$$

which does not depend on K. Solving for z, we obtain,

$$z_M^{BM} = \eta - \delta + \frac{\Gamma_B r_B}{\Gamma_B + b(r_M - r_B)}. \tag{22}$$

We now turn to the conditions that the variables (b, η) and parameters $(r_B, r_M, \Gamma_B, \Gamma_M)$ must satisfy to generate the regions depicted in Figure 3. Let us first find all ability levels z such that $K_{Bc}^{M}(z) = K_{Bc}^{BM}(z)$. From Figure 3 we know that z_M^{BM} is a root. Further, inspecting Equations 18 and 20 we find that $z_a = r_M - \delta$ and $z_b = r_B + \eta - \delta$ are also roots.

Note that $z_b > z_a$ as long as $\eta > r_M - r_B$. In addition, it is always the case that $z_b > z_M^{BM}$ because $r_M > r_B$ and $b \geq 0$ by assumption. Finally, some algebra indicates that $z_M^{BM} > z_a$ as assumed in Figure 3 as long as

$$b < \frac{\Gamma_B[\eta - (r_M - r_B)]}{(r_M - \eta)(r_M - r_B)} = \tilde{b}. \tag{23}$$

We now want to determine under what conditions $K_M^{Bu} > \underline{K}_S^{Bc}$. It is useful to define abilities $z_{M,Bu}^{EC}$ and z_M^{Bu} as the level of ability z such that $K^{EC}(z) = K_M^{Bu}(z)$ and $K_S^{Bu}(z) = K_S^M(z)$ respectively. Some algebra yields

$$z_{M,Bu}^{EC} = \eta - \delta + \frac{r_B(\Gamma_B - \Gamma_M)}{b(r_M - r_B) + \Gamma_B - \Gamma_M} \qquad \text{and} \qquad z_M^{Bu} = \frac{\Gamma_B r_M - \Gamma_M r_B}{\Gamma_B - \Gamma_M} - \delta. \tag{24}$$

It turns out that $K_M^{Bu} > \underline{K}_S^{Bc}$ whenever $z_{M,Bu}^{EC} > z_M^{Bu}$. We can write this last condition solving for wealth b as

$$b < \left[\frac{\Gamma_B - \Gamma_M}{r_M - r_B}\right] \frac{\Gamma_B(r_B - r_M) + \eta(\Gamma_M - \Gamma_B)}{\Gamma_B(r_M - \eta) - \Gamma_M(r_B - \eta)} = \hat{b}. \tag{25}$$

Finally, one can show by combining the expressions in (23) and (25) that $\hat{b} < \tilde{b}$ always.

Therefore, the variables (b, η) and parameters $(r_B, r_M, \Gamma_B, \Gamma_M)$ result in an ordering of wealth b or abilities z_a, z_b, z_M^{BM} and $z_{M,Bu}^{EC}, z_M^{Bu}$ along the z-axis which in turn determine what regions arise. There are 4 cases to consider:

- $0 \leq b < \hat{b}$ and $\eta > r_M - r_B$ or $z_a < z_M^{Bu} < z_{M,Bu}^{EC} < z_{BM}^{M} < z_b$. Here wealth b is so low that the separated regions M in Figure 3 where it is optimal to resort to a moneylender merge together. This case is shown in Figure 4.

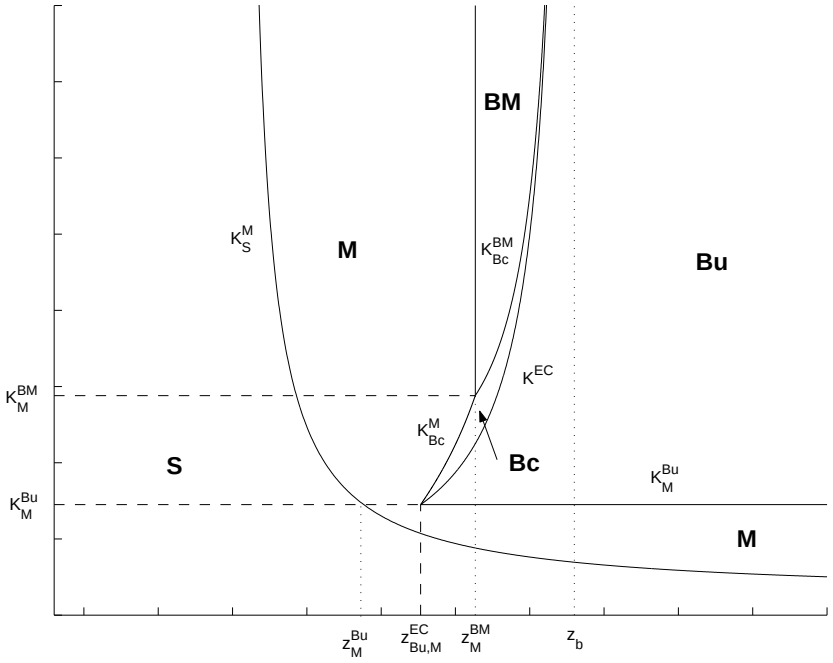

Figure 4: Finance Partition Map: $0 \leq b < \hat{b}$ and $\eta > r_M - r_B$

- $\hat{b} \leq b < \tilde{b}$ and $\eta > r_M - r_B$ or $z_a < z_M^{Bu} < z_{M,Bu}^{EC} < z_{BM}^{M} < z_b$ or as displayed in Figure 3.

- $b \geq \tilde{b}$ and $\eta > r_M - r_B$ or $z_{BM}^{M} < z_a < z_b$. The region where borrowing from a moneylender is preferred to borrowing from a bank and yet be constrained disappears because wealth b is high enough so that even though the agent is still constrained, the bank will advance enough capital. This case corresponds to Figure 5.

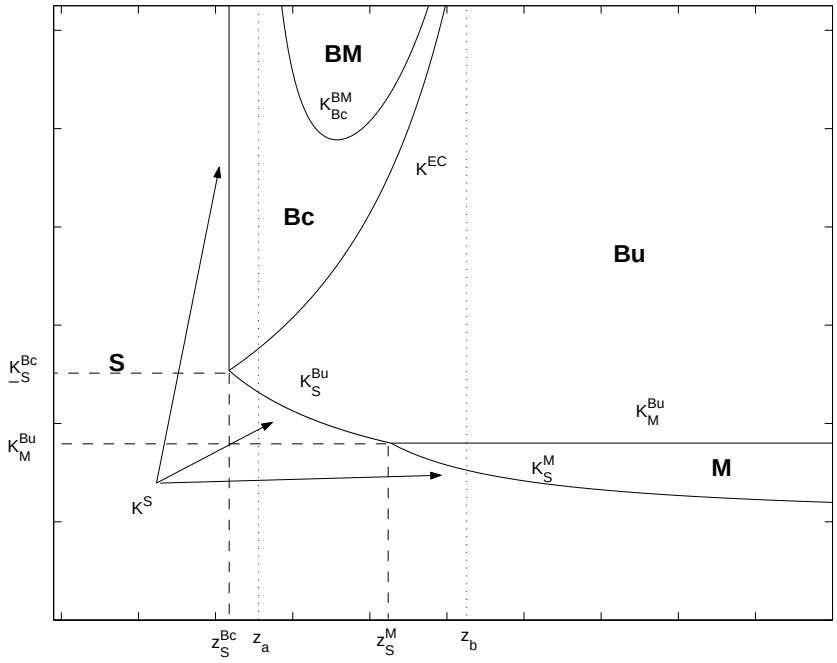

Figure 5: Finance Partition Map: $b \geq \tilde{b}$ and $\eta > r_M - r_B$

- $\eta < r_M - r_B$ or $z^M_{BM} < z_b < z_a$. Here the working to fixed capital ratio η is so low that banks have little problem in advancing funds. The regions where moneylenders alone and banks and moneylenders together are preferred disappear. This case is displayed in Figure 6.

Suppose we now fix the maximum scale K and let the working to fixed capital ratio η vary. As depicted in Figure 7, one still obtains that for a fixed ratio η, increases in ability z leads to higher probability of outside financing. More interestingly, if ability z is high enough, as the ratio η increases we move from bank unconstrained financing to bank and moneylending, to moneylending alone and finally self-financing. The intuition is that as the ratio η increases more working capital needs to be financed and therefore the incentive constraint becomes tighter. In other words, the amount of capital that the bank is willing to lend decreases as the ratio η increases and therefore the entrepreneur may be better off resorting to other external sources.

Again, we should make clear that some of the regions featured in Figure 7 may not exist depending on the variables and parameter values. In particular Figure 7 is obtained if the scale K satisfies $K < K^M_{Bu}$.

5 Data

The data used in this paper come from a specialized but substantial cross sectional survey conducted in Thailand in May 1997. It contains a wealth of pre-crisis socio-economic and

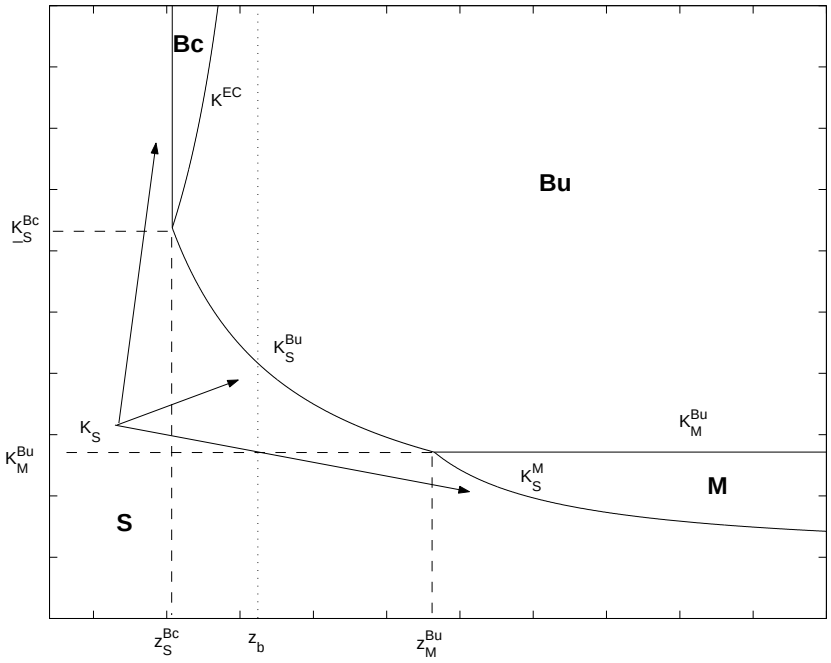

Figure 6: Finance Partition Map: $\eta < r_M - r_B$

financial data on 2,880 households and 606 small businesses[15]. The sample is special in that it was restricted to two provinces in the relatively poor semi arid Northeast and two provinces in the more industrialized central corridor around Bangkok. Within each province, 48 villages were selected in a stratified clustered random sample. Thus the sample excludes urban households. Within each village 15 households were selected at random.

The survey instruments collected current and retrospective information on wealth (household, agricultural, business and financial), occupational history, access and use of a wide variety of formal and informal financial institutions (commercial banks, agricultural banks, village lending institutions, moneylenders, as well as friends, family and business associates). The data also provide detailed information on household demographics, education and entrepreneurial activities.

Because these data provide rich and detailed information about the household and the financial intermediaries, they are particular well suited for the present study.

In this section we first describe how the variables relevant to the model are constructed from the original data, and then we turn to a brief description of some of the salient features of the data and constructed variables[16].

[15]See Townsend et al. (1997) and Binford et al. (2001) for more details on the sampling methodology and the data.

[16]See Paulson and Townsend (1997, 2001) study of entrepreneurship for a complementary examination of the data.

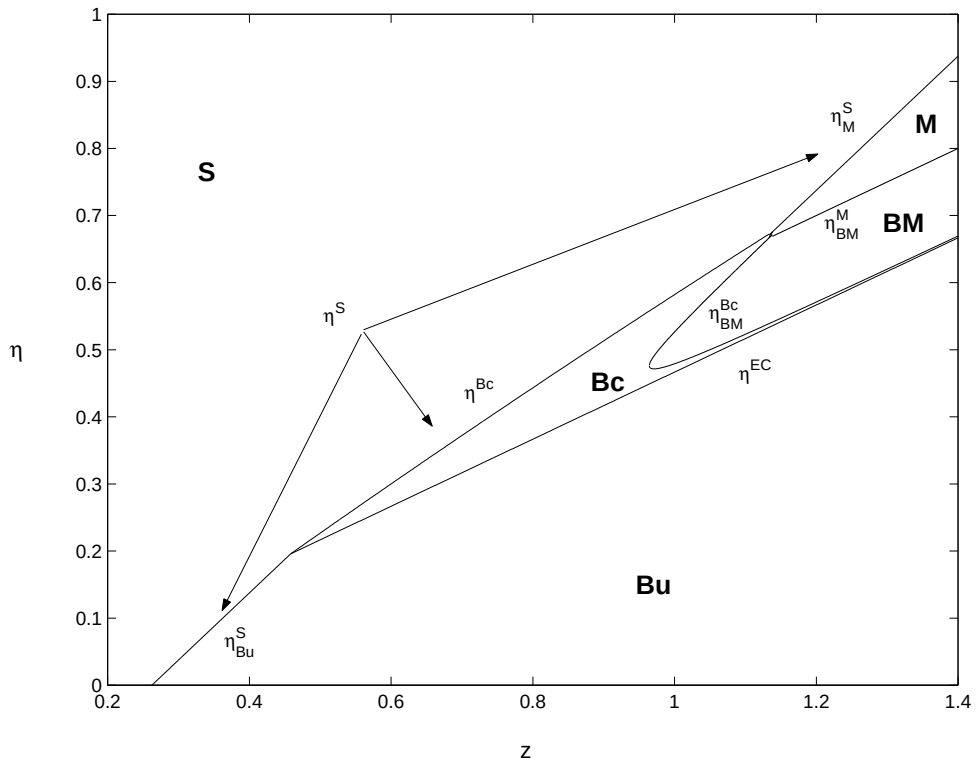

Figure 7: Finance Partition Map: η vs. z

5.1 Construction of Variables

The data set contains wage earners, farmers and business owners. The model does not consider wage earners, so we should select from the data farmers and business owners only. Rather than restricting the sample to these observations, we keep track of the occupation of the household[17]. We use reported occupation,[18] but since a household is made up of several members who may engage in different occupations we need a criterion to assign a unique occupation to each household[19].

We use the head's occupation if he or she is less than 70 years old, otherwise the occupation of the member with most high school if he or she is older than 18 and if none of these conditions are satisfied, we use the occupation of the spouse. The first condition is used for 88 percent of the sample, the second condition for 9 percent, whereas the last condition is used in the remaining 3 percent of the sample.

[17]The inclusion of the subsample of wage earners helps in the overall accuracy of the estimation. See Section 7 below for details.

[18]Alternatively, we could have also classified households into different occupations according to their largest source of income. However, reported occupation is more correlated with farming and business expenditures and thus provides a more accurate measure of the household employment.

[19]The average household has roughly 4.56 members, including 1.59 adult females, 1.44 adult males and 1.53 kids (less than 18 years old). Only 42 percent of the households surveyed have all members reporting the same occupation.

5.1.1 Wealth of the Household b and Scale k

According to the model, while the scale k at which the household operates its project consists of all assets and inputs used in the production, wealth b is the portion of the scale k owned or purchased using own resources. The following three examples illustrate that some judgment calls must be made in order to find the counterparts of scale k and wealth b in the data.

Consider first a farmer that owns a plot of land and a walking tractor. In addition, he buys seeds and fertilizer and has no outstanding loans. Second, consider a villager that uses a room in his house as a general store. The room is divided into two sections: the back is used as storage place, while the front, near a window, is furnished with wooden shelves containing food cans, groceries and other items. Every morning, this villager drives his truck to the nearest town to buy new goods to replenish the shelves. Finally, suppose that the farmer in the first example took out a loan from the BAAC and has not yet repaid it.

The first example gives the easiest correspondence between model variables and the data. Since the farmer does not borrow, his wealth b and the scale k at which he operates his project, are the same and should include the current value of the land, the walking tractor and the baht amount of the intermediate inputs purchased. The second example points to the difficulty of classifying certain assets as productive or non-productive. Should we consider the truck and the house as productive assets? Finally, the last example concerns the treatment of loans. Has the loan been spent yet? And if so, what fraction of the total assets used are owned and how much of the expenditures were made with own savings?

With these examples in mind, we include the current value of the (owned) house and other household assets. This comprehensive measure of scale k includes, besides the house, the current value of landholdings, ponds, buildings, vehicles, equipment, livestock and other household, agricultural and business assets. Depending on the asset[20], households are asked the current or historical value of the asset. If the historical worth is given, we compute the current value by first converting the purchasing price to 1997 Baht using the Thai consumer price index, and then depreciating the asset at a 10 percent rate per year[21].

With regards to the loan treatment, we have two options given that we do not know whether it has been spent. If we assume that the loan has already been spent, then part of the measured assets and expenditures have been purchased with funds given in the loan. In this case, the collection of assets that we observe correspond to the scale k (rather than wealth b), but we can obtain a measure of the household wealth b by simply subtracting the loan amount l from the observed scale k. If, on the contrary, we assume that the loan has not been spent yet, then the collection of assets reported by the household amounts to

[20] Households report the *current* value of landholdings, livestock and the house and the *historical* value of ponds and all other assets. Typical household assets include refrigerators, washing machines and furniture. Under agricultural assets one finds tractors, machinery and tools, and under business assets there are inventories, equipment and furniture.

[21] A similar procedure is used in Paulson and Townsend (1997, 2001).

household wealth b rather than the scale k,which can be computed by simply adding the loan amount l to the observed wealth b. More formally, if the loan is spent, we observe $k = \sum A_i$, where A_i is the current value of a given asset i. We then infer wealth by computing $b = k - l$. Analogously, if the loan is not spent, we then observe $b = \sum A_i$ and estimate the scale as $k = b + l$. Both approaches have obvious drawbacks. While assuming that the loan has already been spent (when it has not), results in an underestimated (and sometimes negative[22]) measure of wealth, assuming the opposite yields to double-counting those assets and expenditures paid using borrowed funds. Although there is no obvious solution, we assume that the loan has not yet been spent.

Finally, a few words about the loan amount l. There are many reasons why households borrow[23]. Although agents in the model borrow only for productive purposes, we do not discard loans that were granted for other purposes because loans are rather fungible: the reason for borrowing does not always coincide with the final use of the loan. In addition, given our interest in determining access to credit, we should include all loans irrespective of their purpose since the transaction costs of accessing capital is independent of the loan purpose. As we mentioned before and will be seen in the next section in detail, households often have multiple loans. The loan amount l is the sum of all outstanding loans[24].

5.1.2 Working to Fixed Capital η

According to the model, fixed capital is the value of those assets that can be used as collateral. We have data on the value of assets pledged by borrowing households that were clients of institutions that required collateral. We regress this variable against a constant and several potential measures of fixed assets and compute our estimate of fixed capital as the sum of all assets that are statistically significant.

We use owned titled[25] and non-titled land – cultivated and other –, ponds, buildings used for business and agricultural purposes and large vehicles such as tractors, trucks and pick-up trucks also used for business and agricultural purposes. Table 2 shows the results[26].

[22]Households with negative wealth range from 1 percent to 20 percent of the sample depending on the collection of assets considered in the measure of wealth.

[23]From the loans recorded in the survey, 63 percent were taken for productive purposes, 17.67 percent were consumption loans, 6.45 percent were used pay for ceremonies, educational and medical expenses, another 5.46 percent was used to relend or to repay past outstanding loans. The remaining 7.4 percent of the loans had other purposes. The category "productive purposes" includes loans to purchase or repair vehicles, buildings and equipment, as well as livestock and fertilizer, pesticide, herbicide and seeds.

[24]Because we have data on financial savings, we could substract this variable from the total borrowed amount. However, there are reasons to believe that the quality of this variable is poor, so we do not use it.

[25]As described in Feder et al. (1988), the Thai Government issues different land property documents depending on the legal status, transfer rights and other stipulations. For our purposes, it is important to note that not all land titles can be used as collateral.

[26]In previous regressions, we included the value of (owned) housing, but found a negative and significant impact. This counterintuitive finding seems to suggest that households with more valuable houses tend to pledge less assets as collateral. In fact, though, banks in Thailand are banned by law to accept houses as collateral. We thus decided to drop it from the regression.

Table 2: Collateral Regression

Variable	Coefficient	S.E.
Constant	203665.8*	57121.7
Titled cultivated land	0.1857*	0.0109
Titled other land	0.0348*	0.0132
Non-titled cultivated land	0.1577	0.1028
Non-titled other land	0.1670	0.4070
Ponds	7.3839*	2.9959
Buildings for agricultural purposes	11.6873*	5.0458
Vehicles for agricultural purposes	5.0023	2.9365
Buildings for business purposes	4.9645	5.8898
Vehicles for business purposes	7.2981	6.9313
Number of Observations	737	
Adjusted R^2	0.3444	

Note: An * indicates that the variable is significant at a 5% level. The dependent variable is the value of assets pledged as collateral for loans that required collateral. The regression is estimated using OLS methods.
Source: Survey Data.

Based on the results above, our estimate of fixed capital should include all titled land (cultivated and other), ponds and buildings for agricultural purposes. The working to fixed capital ratio η is then computed as

$$\eta = 1 - \frac{k_F}{k} \tag{26}$$

where k_F denotes the fixed or collateralizable assets variable just described. Notice that if a household borrows to undertake an investment in one of the asset types found significant in the regression above, then the loan amount will be included in the fixed capital estimate k_F. In other words, the estimate of fixed capital k_F (as well as the estimate of scale k), includes owned assets and those purchased with the loan.

One final point about the classification of assets into fixed and working capital. The model does not emphasize the nature of the asset *per se* but rather its ability to be used as collateral. Consider two otherwise identical farmers, one holding a full title to the land whereas the other holds a "land use" certificate. Since only the first farmer can legally pledge the value of the land as collateral, the implied variable η for both farmers will be different. Therefore, even though they may be using an equal technological mix of land and intermediate inputs, their ratio of working to fixed capital as defined in the model, and ultimately their ability to access to formal credit, will differ.

5.2 Description of the data

In this section we provide some summary statistics and report the salient features of the data. We first describe the characteristics of outstanding household loans and we next turn to a description of the variables constructed in the previous section that will be used in the estimation.

5.2.1 Description of the loans

The survey reveals that households are very active in the credit market. As Table 3 shows, only about a third of the households reports has no outstanding loans and roughly half of the sample has between one and two loans.

Table 3: Number of Loans per Household

	Freq.	Percent
No loans	929	32.36
1 loan	1,009	35.14
2 loans	561	19.54
3 loans	243	8.46
4 or more	129	4.49
Total	**2871**	

Source: Survey data.

Table 4 displays the characteristics of the loans by different lenders. Each loan then is an observation. The Com. Bank category includes Finance and Insurance Companies. BAAC loans, which make up 39 percent of the sample, are divided into individual loans, which are backed by collateral, and group loans, which only require guarantors. Under Village-level Intitutions we include loans from Village Funds, Rice Banks , Buffalo Banks and Production and Credit Groups. Under "Informal P" we include Moneylenders, Store Owners, Landlords and purchasers of output. Finally, the category "Informal R" includes friends and relatives.

The formal sector, especially through the BAAC, does the bulk of the lending by accounting for 69 percent of total lending. The BAAC alone lends out 36.5 percent. When we consider number of loans, the formal sector still dominates the informal giving out 59 percent of the total number of loans[27].

Because the share of total lending by the formal sector is larger than that of the total number of loans, the average amount granted L tends to be larger for formal loans. Indeed, loans backed with collateral are the largest. Although the standard deviations

[27]This significant presence of the formal sector is in contrast with the findings of Udry (1993) and Aryeetey (1997) in rural Africa, where formal credit remains small.

are also high, the hypothesis that the average amounts are equal across lenders can be rejected at a 5% level. In turns out that the average group loan given by the BAAC, the Agricultural Cooperatives and village-level institutions is smaller than the average amount granted by informal "professional" lenders. The average loan given by relatives or friends is even smaller, at about 20,209 Thai baht which at the official exchange rate when the survey was conducted would roughly correspond to 800$.

Given this evidence, it remains unclear how to interpret the fact that formal loans from collateral-based institutions are larger than those from institutions that do not require collateral. Enforcement problems may be the reason for low amounts but it may also be that the institutions granting lower amounts may be constrained in the amount of loanable funds and thus may choose to ration clients rather than increase the interest rate.

Table 4: Loan Characteristics by lender

	Obs.	L	$\sigma(L)$	Length	r	r_c	Collat.	Z. Int.
Com. Bank	118	195,682	245,642	54	0.2208	0.2326	83.1%	5.1%
BAAC	1,293	41,031	80,080	20	0.2232	0.2239	29.4%	0.3%
Individual	380	75,154	129,826	30	0.1273	0.1273	100.0%	0.0%
Group	913	26,829	37,330	16	0.2631	0.2643	0.0%	0.5%
Ag. Coop	353	43,069	69,185	18	0.1373	0.1385	36.3%	0.9%
Vil. Inst.	174	46,718	102,738	32	0.1036	0.1639	9.2%	36.8%
Informal P	553	51,315	157,101	21	0.4203	0.5176	20.1%	18.8%
Informal R	820	20,209	43,856	17	0.2736	0.5499	4.9%	50.2%
Formal	**1,960**	**51,311**	**105,585**	**23**	**0.1948**	**0.2041**	**31.9%**	**4.6%**
Informal	**1,373**	**32,737**	**106,353**	**18**	**0.3327**	**0.533**	**11.0%**	**37.6%**

Note: Com. Bank includes Finance and Insurance Companies. Column L reports the average loan size and column $\sigma(L)$ its standard deviation. The figures in both columns are in baht. The length of the loan is in months. The interest rates r and r_c are net and yearly compounded. Column "Collat." reports the number of loans that required collateral. Finally, column "Z. Int." reports the number of loans given interest-free.
Source: Survey Data.

The average length of the loans is surprisingly high, specially if compared with the findings of Aryeetey (1997). He reports an average maturity of loans from moneylenders of 3 months, although he finds that the practice of rolling over short-term debt is widespread. The large standard deviation of the duration of the loans suggests sizeable disparities in the maturities. The median length is 47 months for loans from commercial banks and 12 months for the rest of formal and informal institutions.

We also report two net interest rates r and r_c. The former is computed using all loans whereas the latter only uses loans that have a positive interest rate. As expected, informal lenders tend to charge a higher interest rate. Among formal loans, it is the institutions that require collateral that charge lower interest rates. Given that these institutions tend

to disburse larger amounts, this may reflect lower cost of funds or lower intermediation costs. We also report the fraction of loans that required collateral. As expected, loans from commercial banks, and by construction, individual BAAC loans are mostly backed by assets. Finally we report the fraction of loans that were given interest-free. The bulk of those loans is concentrated in the relatives and friends category.

5.2.2 Description of the variables

We now turn to the description of the variables that the model suggest will be relevant in determining the source of credit used. Table 5 reports the average capital requirements $k-b$, wealth b and income by source of credit. The category "Own" includes households who do not have outstanding loans. Under "Formal C" we include institutions that require collateral. Based on column "Collat." in Table 4, we include Commercial Banks, Finance and Insurance Companies and BAAC individual loans. Next, the category "Formal NC" includes BAAC group loans, loans from Agricultural Cooperatives and loans from village-level institutions. We also merge "Informal P" and "Informal R" into Informal. Finally, we report households that were actively borrowing from both formal and informal sources under the rubric "Both". From the sample of 2871 households, 929 households or 32.36 percent of the sample self-finance, 12.99 percent of the sample borrow only from a formal institution that requires collateral, 22.12 percent of the sample borrow only from a formal institution that does not require collateral, 18.63 percent borrow from an informal lender only and 13.90 percent of the sample borrow from both a formal and an informal lender. In addition, roughly 90 percent of those who borrow from both sources are clients of formal institutions that do not require collateral. These numbers are large if compared to those of Aryeetey (1997) where only 16 percent of all households interviewed in the Ghana Living Standards Measurement Survey reported borrowing from the formal sector.

Observed capital requirements $k-b$ are largest for members of a formal institution that requires collateral and of both a formal and informal institution. This fits well with the prediction of the model that institutions with higher fixed costs should cater households with higher capital requirements. By construction, households that self-finance have zero capital requirements. We construct a test of equal mean capital requirements across lending choices that is easily rejected by the data. The F-value is 72.52.

Those who borrow from a formal institution are also wealthier than those who borrow from an informal source or both sources. Those who self-finance are, on average, wealthier than informal borrowers but the high standard deviation suggests that there is more dispersion. The top panels of Figure 8 complements Table 5 by displaying the whole distribution of the log of wealth b and capital requirements $k-b$. The distribution is approximated using kernel density estimation[28].

We also report total average yearly income reported by the household. It becomes evident that capital requirements are not large relative to income. Households who borrow from a formal institution that requires collateral have capital requirements that correspond

[28]Kernel density estimation is a non-parametric technique that refines the use of histograms. The kernel used is Epanechnikov. See Silverman (1986) for details.

Table 5: Summary of Model Variables

	Own	Formal C	Formal NC	Informal	Both
Capital Requirements					
Mean	—	125	40	39	143
Std. Dev.	—	294	61	96	305
Wealth					
Mean	1,954	2,292	1,239	1,000	1,214
Std. Dev.	6,585	6,413	4,559	4,495	5,003
Income					
Mean	145	204	144	119	191
Std. Dev.	335	397	291	351	536
Working to Fixed Cap. ratio					
Mean	0.656	0.545	0.722	0.766	0.721
Std. Dev.	0.333	0.305	0.309	0.282	0.298
Profitability					
Mean	0.072	0.058	0.097	0.096	0.080
Std. Dev.	0.167	0.083	0.117	0.150	0.087
Average Household Charact.					
Years of education	3.862	4.263	4.428	3.836	4.506
Past client of formal inst.	0.314	0.951	0.939	0.241	0.947
Past client of informal inst.	0.061	0.090	0.106	0.427	0.461
Formal inst. present in village	0.297	0.755	0.740	0.455	0.759
Savings in formal institution	0.495	0.819	0.827	0.308	0.790
Member of a village committee	0.055	0.117	0.130	0.067	0.128
Observations	924	469	538	536	399

Note: Capital requirements, wealth and income figures are in 1,000 baht.
Source: Survey Data.

to 61.5 percent of annual income, those that borrow from a formal institution without collateral borrow on average an amount equivalent to 27.7 percent of their annual income. Those that borrow from informal lenders borrow on average 32.4 percent of their annual income and finally those that borrow from both sources are granted on average 75.2 percent of their annual income.

Table 5 also reports[29] the average working to fixed capital ratio η and a measure of profitability (or ability) z obtained from dividing business and farming income by the scale k at which they operate their enterprise. As mentioned before and documented by Feder

[29]Since some households report scale $k = 0$, we have fewer observations to compute z. We are left with 785 observations in the Own category, and 370, 624, 491, 391 for Formal C, Formal NC, Informal and Both respectively.

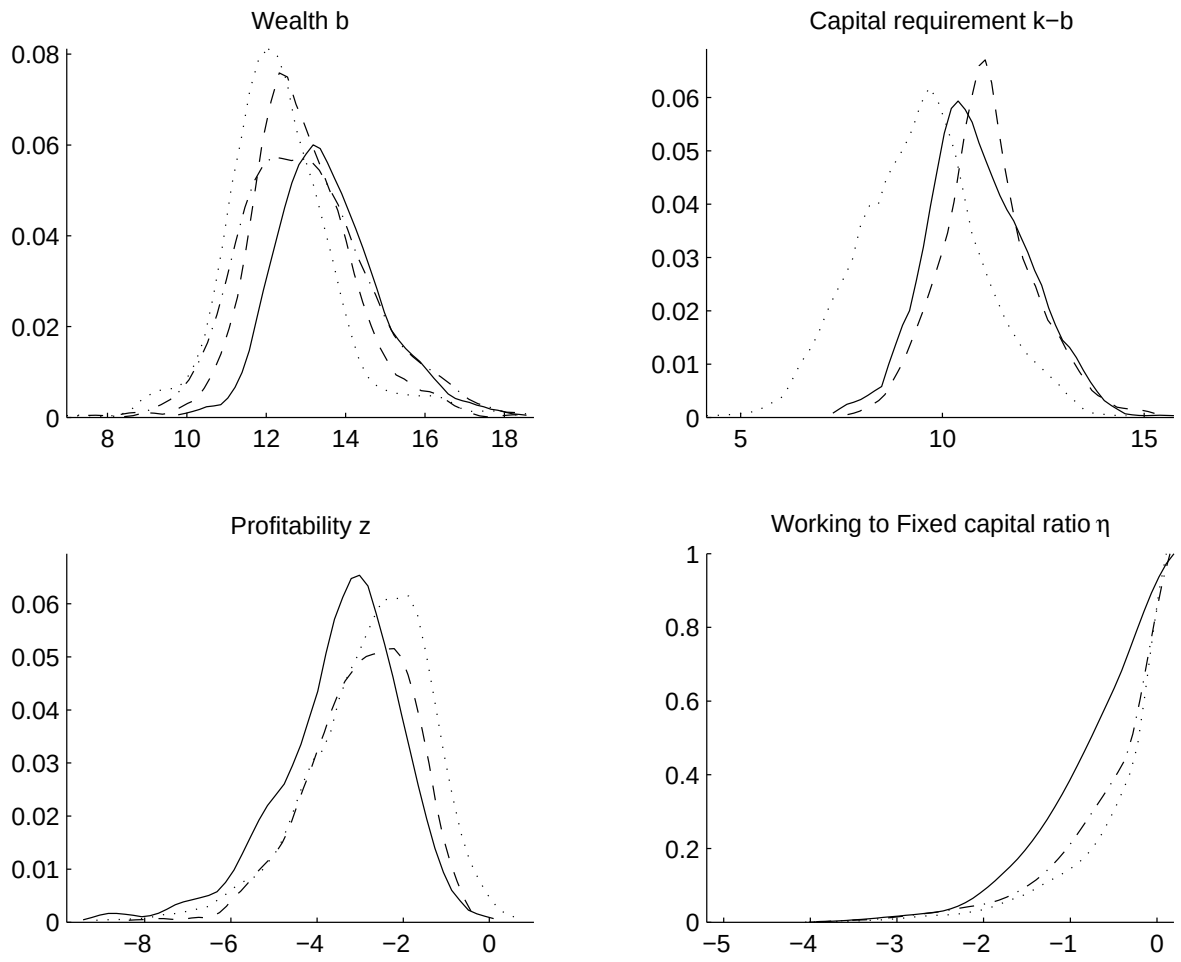

Figure 8: Kernel Density Estimations
Legend: Formal C "-", Informal "· · ·" Both "- -",
Own "-." (top left panel) and Formal NC "-." (lower right panel).

et al. (1988) and Feder (1993), the mean ratio η behaves as the model predicts. Clients of banks that require collateral have the lowest average ratio η, households that borrow from informal lenders only have on average a higher ratio, whereas those who borrow from both have the highest ratio. Despite the large standard deviation, the hypothesis of equal means across lending choices is easily rejected. The F-value is 38.23, rejected at any confidence level. In addition, profitability z seems to track the interest rate charged by the institutions roughly well too, although it is off in levels.

The lower left panel of Figure 8 displays profitability z for "Formal C", "Informal" and "Both". It seems that "Informal" has higher profitability z on average than "Both" or "Formal C". This may seem to suggest that most borrowers that resort to informal lenders are in the lower region M of the Figures 3-6. The lower right panel of Figure 8 plots the cumulative distribution of the log of ratio η for the categories "Formal C", "Formal NC"

and "Informal". Even though the standard error is high, the point estimates suggest that borrowers from formal institutions tend to own more collateralizable assets, relative to those who borrow from informal lenders.

Finally, Table 5 reports several household characteristics given the source of financing. Since all but years of schooling are dummy variables, the means are also percentages. It is clear that current borrowers of formal institutions have also borrowed on average from these institutions in the past, and the same is true for informal borrowers. Interestingly, those who borrow from a formal institution are more likely to be members of village committees and therefore may be better "connected". Also as expected, those who borrow from formal institutions tend live in villages where these institutions are located. Finally we report the average years of education. It turns out that this variable has very little variance since most observations are clustered around four years of schooling[30].

6 A double selection model

In this section, we develop a double selection model based on Tunali (1986) that will help us identify the relevant variables that affect access to credit and thus our measure of the fixed cost. In addition, since the specification is suited for determining what variables affect also the interest rate charged by lenders, the results may shed light into the plausibility of our assumption that all borrowers face the same cost of capital.

The structure considered is as follows: agents first decide whether to borrow or not, and if they decide to do so, they choose whether to resort to a formal or informal lender.

We have data on whether the household borrowed or not, the type of lender chosen and the interest rate charged. The variables considered in the analysis are presented in Table 6. An observation here is a loan, so households that do not borrow or have one outstanding loan, appear once, but households that borrow more than once are included for each loan. No attempt is made to treat these household differently[31]. In addition, only loans that report a positive interest rate are included. The reason is that since there are very high interest rates we decided to use the logarithm of the interest rate instead[32]. Finally, since we use the logarithm of the wealth we drop 7 percent of the sample reporting zero wealth. We are left with 3,229 observations out of 3,408.

Besides controls for household, loan and lender characteristics, following Petersen and Rajan (1994), Uzzi (1999) and Guiso, Sapienza and Zingales (2000) among others, we include measures of the household social capital and its ties with their lenders. We proxy for social capital using data on household membership in different committees. Membership may capture social characteristics such as sense of duty, trustworthiness and popularity among fellow villagers. For our purposes, being respected and well-known in the community may result in greater access to funds and lower the cost of capital.

[30] As Paulson and Townsend (2001a) indicate, four years of schooling was the minimum statutory education when most interviewees where in schooling age.

[31] As mentioned earlier, 32.5 percent of the households have multiple loans.

[32] Siamwalla et al. (1993) follow a similar strategy.

Table 6: Description of Variables

Name	Description	Mean	Std. Dev.
Household Characteristics			
formv	Presence of a formal institution in the village	0.5985	0.4903
lb	Logarithm of Wealth	12.9802	1.4112
eta	Fraction of Working to Fixed Capital	0.6919	0.3074
work	Worker	0.1976	0.3982
farm	Farmer	0.5236	0.4995
bus	Businessman	0.2788	0.4485
dform	Past client of formal institution	0.8350	0.3713
dinfor	Past client of informal lender	0.3033	0.4598
edyrh	Years of Education	4.2111	2.6114
region	Region where household lives	0.5275	0.4993
Loan Characteristics			
bloan	Loan for business purposes	0.6524	0.4763
lsize	Logarithm of the size of the loan	9.8713	1.3255
length	Length of Loan	21.8185	28.6770
col	Use of Collateral to secure the loan	0.2747	0.4464
Social Capital			
hpostc	Member of a tambon committee	0.0208	0.1426
hposvc	Member of a village committee	0.1060	0.3079
hposcrin	Member of credit institution committee	0.0169	0.1291
hposwg	Member of wife group	0.0290	0.1677
hposhwg	Member of housewife Group	0.0481	0.2140
Lender-Borrower Relationship Characteristics			
frlf	Fraction of loan in total formal borrowing	48.1385	41.8622
frli	Fraction of loan in total informal borrowing	21.3070	36.8362
nfinst	Num. formal inst. currently borrowing from	1.1591	0.4139
niinst	Num. of informal inst. currently borrowing from	1.1518	0.4296
sav	Savings in formal institution	0.5031	0.5001
both	Current client of formal and informal lenders	0.3245	0.4683
Type of Lender			
combk	Lender is a com. bank or fin. comp.	0.0411	0.1985
govbk	Lender is a gov. bank or ag. coop	0.6043	0.4891
vinst	Lender is a village-level institution	0.0403	0.1968
infpro	Lender is a professional moneylender	0.1646	0.3709
infrel	Lender is a relative or friend	0.1496	0.3568

Source: Survey Data.

However, in the case where membership in these committees grants power to divert funds for private, non-productive purposes, then membership may be correlated with greater risk of default and therefore we would expect members to face a higher cost of capital for their loans.

We use several measures that characterize the ties that households have with the different lenders. First, we record whether the household has previously borrowed from the lender. If the borrower is an old client, the lender will have more accurate information and will be keen to extending credit and possibly to lowering the cost of capital. Second, we measure the strength of the relationship by looking at the concentration of borrowing. We include the number of different institutions that the household is currently borrowing from and the fraction of each loan relative to total formal or informal borrowing. In rural Thailand, where the "rule of law" is arguably weak, multiple creditors may be a problem if seigniority is not well defined before the loan is granted. In this case, since creditors face a higher risk in the case of default, we would expect households with multiple creditors to face higher borrowing costs. In addition, we measure the complexity of the relationship by looking at whether households have savings deposits with a formal institution. The argument here is that these non-loan services can be used by the creditor to monitor the household or obtain additional information thereby reducing the expected cost of such loans. Finally, in order to incorporate the "syndication" argument of Jain (1999) and Conning (1996, 1998) we code a dummy for whether a household is currently borrowing from formal and informal sources simultaneously.

The estimates are reported in Tables 7 and 8. There is no evidence of selection since ρ is not significant.

The dependent variable in the "Access to Credit" column takes the value one if the household is currently borrowing. The results indicate that access to formal credit is enhanced by the presence of a formal institution in the village and the type of occupation by the head of the household. Indeed, if the head is a farmer or runs a business, he or she is more likely to borrow. Also, households living in the Northeast are more prone to borrowing. Interestingly, being a member of a village committee also enhances significantly access to credit. Yaron (1994) provides anecdotal evidence that the local village heads assist the BAAC branch managers in selecting and approving borrowers. All the other measures of social capital have the right sign but are not significant.

The dependent variable in the "Type of Lender" column takes the value zero if the creditor is a formal institution and one if the lender is informal. As expected, the presence of a formal institution has a negative sign, implying that borrowing from a formal source is more plausible. In addition, the positive and significant sign in the ratio of working to fixed capital confirms the finding of Feder et al. (1988) and Feder (1993): a high fraction of working to fixed capital η (eta) will result in borrowing from an informal lender. All loan characteristics are significant and have the expected sign. If the loan is for business purposes, the lender will tend to be a formal institution. Furthermore, the previous lender is a good predictor of the current one, indicating the presence of switching costs. From the measures of social capital included, only member in the village committee is significant. As expected, social capital fosters formal credit.

Table 7: Selection Regressions

	Access to Credit		Type of Lender	
Variable	Coefficient	S.E.	Coefficient	S.E.
constant	-0.4140	0.2570	1.0627*	0.2977
Household Charact.				
formv	0.9046*	0.0492	-0.3363*	0.1563
lb	-0.0164	0.0201	—	
eta	—		0.4593*	0.0954
farm	0.6541*	0.0623	—	
bus	0.4893*	0.0730	—	
edyrh	0.0330*	0.0104	-0.0141	0.0127
region	0.3773*	0.0523	—	
Loan Charact.				
bloan	—		-0.2310*	0.0610
dform	—		-1.8627*	0.1193
dinfor	—		0.8599*	0.0641
Social Capital				
hpostc	0.2656	0.2069	-0.2513	0.1915
hposvc	0.2750*	0.0916	-0.2179*	0.1043
hposcrin	0.5108	4.9099	0.0321	0.2124
hposwg	0.1374	0.1770	-0.1522	0.1619
hposhwg	0.1898	0.1320	-0.0031	0.1374
rho	-0.3929	0.3531		
Number of obs.		3,654		
Wald		785.84		
Log-likelihood		-2880.39		

Note: An * indicates that the variable is significant at a 5% level. The dependent variable in the "Access to Credit" probit is whether the household has borrowed or not. In the "Type of Lender" probit, the dependent variable takes value one if the lender is informal and zero if formal. The standard errors are computed using 1,000 replications of bootstrap samples.
Source: Survey Data.

We now turn to Table 8 which reports the estimates of the interest rate regression controlling for the double selection into borrowing and type of lender. As it turns out, the sector Mills ratio for the informal interest rate determination is significant and hence, failure to control for selection would result in biased estimates.

The variables that appear to determine the formal interest rate are the size of the

loan, its length, and the type of lender. Siamwalla et al. (1993) find similar evidence although they do not control for selection. The negative impact of the size of the loan and length on the interest rate may reflect increasing returns to the cost of administering a loan, as suggested by Braverman and Guasch (1986, 1993). However, these variables are determined simultaneously and so it is impossible to determine the causality without imposing more structure. In addition, membership to a village committee results in an *increase* in the cost of capital. This finding may be seen as evidence in favor of the story that committee members use their social capital to obtain credit but their ability to divert funds to non-productive uses makes them riskier. Financial institutions will respond charging them a higher interest rate. Notice also that the coefficient on "both" is positive but only significant at the 10 percent level. Counter to the "syndication" argument, formal institutions seems to perceive lenders from both sources as being riskier. Indeed, as Petersen and Rajan (1995) suggest, this may be evidence of little trustworthiness or low entrepreneurial ability. The household is forced to resort to different lenders since no creditor will grant the full amount required. In any event, the data is at best silent about such arguments.

There seems to be more variables that significantly impact the informal interest rate. Interestingly, there is weak evidence that if the household had previously borrowed from a formal institution, the informal lender will charge higher rates. Analogously to the formal interest rate regression, both the size of the loan and the duration are significant in reducing the interest rate charged. Reinforcing the effect found in the formal interest rate regression, we find stronger evidence of higher interest rates charged to household who simultaneously borrow from formal and informal sources. Contrary to the "syndication" view, this evidence supports the claim of weak rule of law and poorly specified claim rights between the borrower and the creditors.

In summary, there is ample evidence that access to credit differs across households. In addition, even though the results provide weak evidence of informal interest rates tailored to borrowers based on their characteristics, it is not the case for formal lenders. Therefore, the assumption of the model that all heterogeneity among borrowers operates though the fixed cost of accessing the different lenders, rather than the cost of capital itself, seems to be warranted.

We now turn to the estimation strategy of the model presented in Section 3 and 4.

7 Estimation of the Model

Our goal is to compute the likelihood predicted by the model that a given entrepreneur chooses a given means of financing. According to the model, this decision depends only on the variables wealth b, the fraction of working to fixed capital η, ability z and scale K, given the fixed costs Γ_B, Γ_M prices r_B, r_M and the fraction of non-depreciated capital $\tilde{\delta}$. Further, if wealth b and the fraction of fixed to working capital η are observable while ability z and the maximum scale K are not, then the likelihood that the entrepreneur chooses any means of financing can be determined entirely as in the finance diagrams of

Table 8: Interest Rate regression

Variable	Formal Interest Rate Coefficient	S.E.	Informal Interest Rate Coefficient	S.E.
constant	-1.1442**	0.6146	1.2002*	0.4389
Household Charact.				
dform	0.1373	0.4052	0.5239**	0.2882
dinfor	0.0302	0.1269	-0.1974	0.1579
edyrh	0.0067	0.0092	-0.0068	0.0200
region	-0.0178	0.0514	0.0868	0.1078
Loan Charact.				
lsize	-0.0940*	0.0336	-0.2664*	0.0339
length	-0.0119*	0.0013	-0.0120*	0.0044
col	0.0147	0.0498	0.1303	0.1216
Lender Charact.				
govbk	-0.2833*	0.1192	—	
vinst	-0.2808**	0.1679	—	
infrel	—		0.0541	0.0874
Social Capital				
hpostc	-0.0576	0.1123	0.4628	0.3272
hposvc	0.1716*	0.0646	0.1144	0.1261
hposcrin	-0.1034	0.1641	0.0724	0.4134
Relationship Charact.				
frlf	-0.0004	0.0008	—	
frli	—		0.0006	0.0014
nfinst	-0.0101	0.0568	-0.0241	0.1386
niinst	0.0849	0.0823	0.0910	0.0778
sav	-0.0618	0.0506	—	
both	0.1099**	0.0566	0.2280*	0.1061
Mills ratio (access)	0.1332	0.1272	-0.0996	0.2074
Mills ratio (sector)	0.1477	0.2578	-0.5745*	0.2612
Number of Observations	1,870		857	
Adjusted R^2	0.1550		0.2069	

Note: * indicates that the variable is significant at a 5% level, and ** at a 10% level. The dependent variable in each regression is the logarithm of the interest rate. Both regressions are estimated using OLS methods. The standard errors are computed using 1,000 replications of bootstrap samples.
Source: Survey Data.

Figures 3-6 from the cutoff curves $K^i_j, i, j = \{S, B, M, BM\}$ and the joint distribution of ability z and scale K. We do not use[33] the information on profitability nor total investment k as a proxy for ability z and scale K respectively but rather we assume that the log of ability z and the log of maximum scale K follow a bivariate normal distribution

$$(\zeta, \kappa) \sim BVN(\mu_\zeta, \mu_\kappa, \sigma^2_\zeta, \sigma^2_\kappa, \rho), \tag{27}$$

where $\zeta = \log(z)$ and $\kappa = \log(K)$. Now let θ denote the vector of parameters of the model, $\theta = (\Gamma_B, \Gamma_M, \tilde{\delta}, \mu_\zeta, \mu_\kappa, \sigma_\zeta, \sigma_\kappa, \rho)$ and let ν_i denote the vector of variables $\nu_i = (b_i, \eta_i)$. Suppose we have a sample of n entrepreneurs and let $l_i = \{S, B, M, BM\}$ denote the financial decision taken. Then, with $f(l_i|\nu_i, \theta)$ denoting the likelihood that an entrepreneur with characteristics ν_i facing parameters θ will choose l_i as a source for her investment, we can write the likelihood function as

$$L_n(\theta) = \sum_{i=1}^{n} f(l_i|\nu_i, \theta) \tag{28}$$

The appendix derives explicitly the form of the likelihood $f(l_i|\nu_i, \theta)$ for a given lending decision $l_i = \{S, B, M, BM\}$.

The derivatives of the likelihood function in Equation 28 can be determined analytically, and then with the given observations of the database, standard maximization routines can be used to search for the maximum numerically[34].

We consider a benchmark model, where each entrepreneur faces the same fixed costs Γ_B and Γ_M, and an alternative one where we allow these fixed costs to vary among entrepreneurs. In particular, we assume that $\Gamma_{Bi} = (x_{Bi})'\gamma_B$ and $\Gamma_{Mi} = (x_{Mi})'\gamma_M$, where x_{ji} is the column vector of characteristics of household i relevant to the fixed cost Γ_j. We use the results of the reduced-form model presented in the previous section to guide the choice of relevant variables x_B's and x_M's.

8 Results

The model imposes certain preliminary restrictions on the data. First, wealth should be positive so we drop all households that report zero wealth. In addition, after inspecting Figure 6 it becomes clear that the model assigns zero probability to those households that report borrowing from both sources and yet have a working to fixed capital ratio η that satisfies $\eta < r_M - r_B$.

We run the maximum likelihood algorithm using two different samples. We consider the whole sample (including wage earners) and the subsample of entrepreneurs and farmers. After dropping observations, we are left with a sample of 2,843 and 2,204 observations

[33]Even though profitability and the total investment k provide information to narrow down ability z and scale K, the more information we use, the likely it is to run into zero probability events. As an example, if the household borrows from an informal lender, it will operate at the optimal capacity K_i so that $k_i = K_i$. However, it may be the case that no parameters can be found that deliver a region M at the scale k_i.

[34]In particular, we used the MATLAB routine `fmincon` starting from a variety of predetermined guesses.

respectively. It turns out that the estimates for the fixed costs in the benchmark model do not differ much using either sample, but we obtain a more accurate estimation of the assumed bivariate distribution of unobservables using the whole sample. We thus report the estimates using the whole sample.

Another issue that deserves mentioning is the determination of prices r_B and r_M. We use[35] the sample average interest rate charged to households by formal and informal lenders respectively. The gross formal and informal interest rates used are, respectively, 1.1993 and 1.3536. Notice that these differ slightly from those reported in Table 4 above. The interest rates computed in the table are averaged across all loans, whereas the rates we use are averages across all loans for each household, and then averaging over households.

Table 9 reports the estimates of the underlying parameters of the benchmark model (Common Access) and the alternative model where the fixed cost is household-specific (Differentiated Access). The standard errors[36] are computed using the outer product of gradients (OPG) estimator. We chose this over the standard Hessian because for the alternative model the Hessian was indefinite.

In the benchmark specifications, the fraction of non-depreciated capital $\tilde{\delta}$ is estimated at its upper bound of 1. The standard error cannot be computed because the estimated parameter is not an interior solution. In the alternative specification, this technology parameter $\tilde{\delta}$ is slightly below one, at 0.846. The distributional parameters are somewhat similar between both specifications. The point estimates of the correlation between log ability ζ and log maximum capacity κ seem to differ. One can easily obtain the distribution of scale K and ability z by using the log-normal distribution formulas[37]. For the alternative model, ability z is distributed with mean 0.0494 and variance 0.0019 whereas the scale K has mean 1,601,098 baht and a (large) variance of 46,828 billion baht. The estimated coefficient of correlation is 0.4024. The estimated mean of scale K is slightly larger than the mean wealth of 1,538,295 Thai baht. When the transaction costs of external finance are common across households, they are estimated at 88,785 baht and 0 baht for formal and informal credit respectively. In the case of formal lending, this cost amounts to 1.73 times the average formal loan size or 45 percent of the average loan from a commercial bank.

[35]Since there is evidence of geographical dispersion in interest rates, we also consider the village-level interest rate after trying different geographical units. From smaller to larger they are, village, tambon, amphoe, changwat and finally region. For each geographical area, we performed an ANOVA to assess whether the dispersion within each unit is significantly lower than that across them. It turns out that this happens only in the case of the village-level interest rate. We thus compute the formal and informal interest rate prevailing in each village by averaging all outstanding loans of households residing in it. When no loans were granted in the village, we used the average over the next larger geographical unit. The results using this sample do not differ much from the ones presented and hence are omitted.

[36]Since the ML estimation yields estimates that are functions of the parameters of interest, we use the Delta Method to obtain the desired standard errors.

[37]Suppose that $x = log(X)$ and $y = log(Y)$. Then if (x, y) follow a bivariate normal distribution with parameters $(\mu_x, \mu_y, \sigma_x^2, \sigma_y^2, \rho)$, then the distribution of X has mean $\mu_X = e^{\mu_x + \frac{\sigma_x^2}{2}}$ and variance $\sigma_X^2 = e^{2\mu_x + \sigma_x^2}(e^{\sigma_x^2} - 1)$. Analogous expressions can be derived for Y. Finally, the coefficient of correlation is $\rho_{XY} = \frac{e^{\rho\sigma_x\sigma_y} - 1}{\sqrt{e^{\sigma_x^2} - 1}\sqrt{e^{\sigma_y^2} - 1}}$.

Table 9: ML Estimates

	Common Access		Differentiated Access	
Variable	Coefficient	S.E.	Coefficient	S.E.
Technology				
$\tilde{\delta}$	1.000	—	0.846	0.2284
Distribution				
μ_ζ	-1.116	2.8624	-3.293	3.0131
μ_κ	15.178	2.6272	12.807	7.0951
σ_ζ	1.132	0.7465	0.754	0.3057
σ_κ	3.695	0.4588	1.720	0.7323
ρ	0.148	0.3431	0.708	0.2884
Formal Access				
constant				
Village Inst.	—		2,001	367
BAAC	—		1,091	782
Ag. Coop	—		2,569	1,223
Other	88,785	7,140	21,693,372	8,498,130
vform	—		0.531	0.1448
dform	—		0.148	0.0505
dinform	—		1.247	0.2759
hpvc	—		1.790	0.7729
edh	—		0.980	0.0309
sav	—		0.696	0.1468
region	—		0.994	0.2286
Informal Access				
constant	0	3,847	0	0.0050
Number of Obs.	2,843		2,843	
Likelihood	-3901.09		-2161.81	

However, when we allow this costs to vary across households, we obtain a very different picture. The formal cost is very sensitive to the type of formal lender. The intercept becomes 2,001 baht or $80 if the lender is a village-level institution, 1,091 baht for the BAAC, 2,569 baht for an agricultural coop and 21.7 million baht if it is a commercial bank. This amount corresponds to the cost that a household would face if its vector of characteristics was zero in all the variables. The coefficients that affect the cost of accessing a formal institution are *multiplicative* of this constant term. More formally, the fixed cost is estimated as follows:

$$\Gamma = e^{\gamma_0+\gamma_1 \text{vinst}+\gamma_2 \text{baac}+\gamma_3 \text{agcoop}+\gamma_4 \text{vform}+\gamma_5 \text{dform}+\gamma_6 \text{dinform}+\gamma_7 \text{hpvc}+\gamma_8 \text{edh}+\gamma_9 \text{sav}+\gamma_{10} \text{region}}. \quad (29)$$

The coefficients displayed are also exponential form, so the coefficient for the village institution intercept is $e^{\gamma_0+\gamma_1}$, the one in "vform" is e^{γ_4} and so on. From the exponential form, if the coefficient is larger than one, the variable *increases* the cost, and the opposite is true for a coefficient lower than one. Thus, the presence of a formal institution in the village lowers the cost by roughly 47 percent. In the same fashion, having borrowed from a formal institution previously lowers the fixed cost 85 percent. Besides the type of lender, this is clearly the variable that has contributes the most in lowering the cost of external finance. It seems that acute informational asymmetries may be present because the lender benefits significantly from information gathered previously about their clients. In addition, if the household has savings with a formal institution, it will benefit from a reduction in the fixed cost of roughly 30 percent. Again, informational problems are at play because banks seem to benefit from offering non-loan services to their clients. It is also interesting to notice that households who previously borrowed from an informal source will face a higher cost than those who did not. The point estimate in "dinform" is larger than one but the its standard error indicates that the coefficient is not significantly different from zero. The data does not support the "syndication" argument developed in Jain (1999) and Conning (1996, 1998). Most of the times, having borrowed from a moneylender *hinders* access to formal credit. Also, both education and living in the northeast help in accessing formal institutions but neither coefficient is significant. Finally, social capital does not foster access because the coefficient on whether the household is a member of a village committee (hpvc) larger than one.

The cost of accessing an informal lender is negligible in both specifications. The large standard errors suggest that they are not significantly different from zero. This finding complements the work of Siamwalla et al. (1993) also in Thailand or Udry (1993) and Aryeetey (1997) in Africa. They find that information asymmetries are unimportant within rural communities, and since informal lender often live in the same villages, they are easily accessible.

We restrict access to informal credit to be common for all households because since the cost of access is very low to begin with, all household specific characteristics were insignificant in previous specifications. Indeed, a likelihood ratio test of the reported specification versus another where the informal fixed cost is allowed to depend on household characteristics cannot reject the hypothesis that both specifications are equal. The data, however, strongly rejects the hypothesis that access to credit is uniform across households.

Figure 9 portrays the estimated finance maps that guides the financial choice for households in each lending category. In constructing these maps, we use the estimated parameters of the "Differentiated Access" specification. Recall that the map depends on the household variables (b, η) and parameters $(r_B, r_M, \Gamma_B, \Gamma_M)$. We divide the sample according to the household's borrowing choice and we use the median wealth b, ratio η and fixed formal cost Γ_B for each group. Thus, an entrepreneur that finances her project using own resources, with a wealth b and ratio η equal to the median wealth and ratio of all households that also self-finance will face exactly the finance map displayed in the upper left panel of Figure 9.

The plots also display the contour levels of the joint density of the log ability ζ and

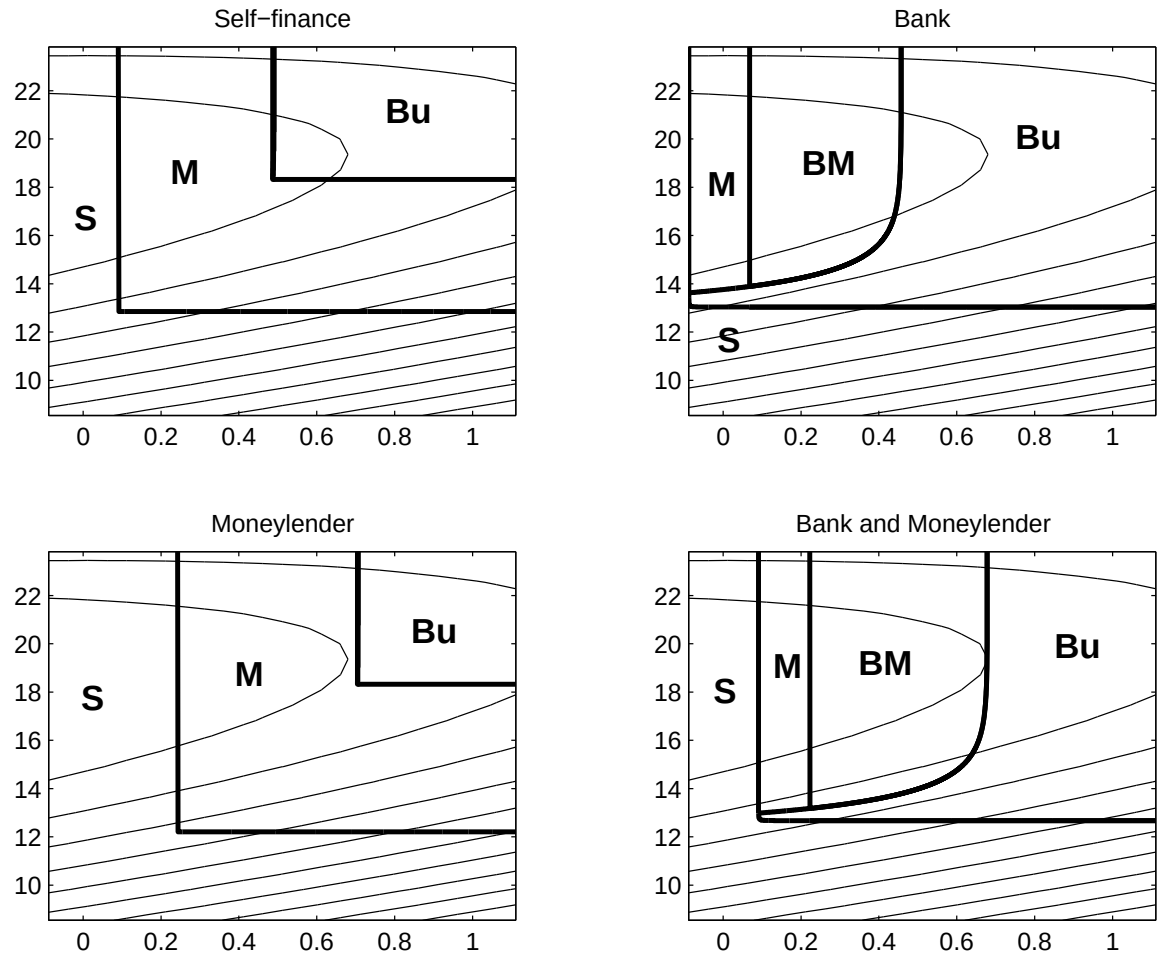

Figure 9: Estimated Finance Maps

log scale κ. The highest density is located at the point (-3.29,12.8) but it falls outside the scale of the maps. There is a sense in which the plots shows a relatively larger area where the density is higher, corresponding to each lending choice. This is particularly true for the map of the median household that resorts to a moneylender and both sources. Notice that while the maps corresponding the median household that self-finances and resorts to informal finance are versions of the finance partition map in Figure 5, those for the household that borrows from a bank or resorts to both sources are versions of the finance partition map in Figure 3. The regions **BM** and **Bc** in the upper and lower left panels of Figure 9 have been collapsed, while the same is true for the lower region **M** and **Bc** in the upper and lower right panels of the same figure.

Although those entrepreneurs that borrow from the bank do not seem to be constrained, we should not infer that enforcement problems are unimportant. The model suggests that households select into other forms of financing precisely because they would be constrained if they were to resort to a bank.

Finally, Table 10 presents a measure of fit for the model using the "Differentiated Access" specification similar in spirit to the one reported in the work of Laroque and Salanié (2000). For each subsample, it reports the actual and predicted[38] percentage of households in each lending category. For the whole sample then, the data contains 32.5 percent of households who report Self-financing, 35.42 percent who report borrowing from a bank, 18.82 percent who borrow from a moneylender and the last 13.26 percent who borrow from both sources. The model is able to replicate these proportions fairly well, although it under-predicts the fraction of households who borrow from the bank and over-predicts those who borrow from both sources.

Table 10: Goodness of Fit

	Data					Model			
	Obs.	S	B	M	BM	S	B	M	BM
All Sample	2,843	32.50	35.42	18.82	13.26	33.58	33.27	18.25	14.90
Region C	1,416	42.16	30.44	17.66	9.75	39.99	27.36	20.93	11.72
Region NE	1,427	22.92	40.36	19.97	16.75	27.22	39.13	15.59	18.06
Low Wealth	1,422	31.43	28.76	25.67	14.14	34.59	25.20	23.61	16.60
High Wealth	1,421	33.57	42.08	11.96	12.39	32.56	41.34	12.89	13.20
Low η	1,422	35.09	39.66	14.06	11.18	35.64	41.39	12.48	10.49
High η	1,421	29.91	31.18	23.57	15.34	31.51	25.14	24.03	19.32
Low Educ.	547	43.14	25.41	23.40	8.04	41.42	24.12	23.78	10.68
Med. Educ.	1,847	30.43	38.33	17.05	14.19	31.20	35.97	16.52	16.31
High Educ.	449	28.06	35.63	20.49	15.81	33.79	33.32	18.62	14.27
Bank in V.	1,561	17.68	48.17	15.57	18.58	22.85	45.63	10.90	20.61
No Bank in V.	1,282	50.55	19.89	22.78	6.79	46.64	18.21	27.20	7.95
In Vil. Com.	263	19.39	47.53	13.69	19.39	22.70	44.34	11.52	21.44
Not in Vil. Com.	2,580	33.84	34.19	19.34	12.64	34.69	32.14	18.94	14.24
Savings in Bank	1,753	26.24	47.29	9.41	17.06	24.73	43.92	11.65	19.70
No Sav. in Bank	1,090	42.57	16.33	33.94	7.16	47.81	16.14	28.87	7.18

We stratify the sample according to different variables and report the predicted probabilities using the estimated parameters for the whole sample. The model does better in the Central region than in the Northeast, with high-wealth households and low ratio η households. The model also performs better in the low and median education categories. Interestingly, it is able to replicate better the choices of households who reside in a village without a bank, who are not members of village committees and who have savings in the bank. Overall, the fit is fairly accurate, even in subsamples of the original data.

[38]The predicted frequency is obtained by adding the likelihood of each lending choice for the whole sample.

9 Conclusions

This paper sheds light into the mechanism underlying access to credit. Several conclusions arise from the results. First, the data strongly reject the hypothesis that the cost of accessing formal credit is uniform across households. Second, there seems to exist large disparities between access to formal and informal credit. Although the large magnitudes found may be an artifact of the structure imposed by the model, a clear patterns emerges when one compares the relevant variables affecting the cost of transacting with external lenders. Indeed, although proximity to a formal institution contributes to reducing the transaction cost, the impact of other measures on transaction costs suggest that informational asymmetries are present. In the light of this evidence, it becomes clear why policies designed to provide cheap credit to rural households may not be effective. Efforts should be focused towards mitigating the informational problems that arise between borrowers and lenders. One of them, could be the creation of agencies that specialize in sharing credit histories, as suggested by Pagano and Jappelli (1993). Also, linking savings to loan disbursements can help reduce informational problems, as indicated by Yaron (1994).

A Likelihood Function

For an entrepreneur with lending $l_i = L$ and characteristics ν_i, the likelihood will be given formally by,

$$f(L|\nu_i) = \int_{\zeta \in L_\zeta(\kappa)} \left[\int_{\kappa \in L_\kappa(\zeta)} h(\zeta, \kappa)\, d\kappa \right] d\zeta \tag{A1}$$

where $h(\zeta, \kappa)$ denotes the joint density of the log ability ζ and log scale κ and the sets $L_j(i)$with $i, j = \zeta, \kappa$ and contain all points j that would yield lending L as the best source for an entrepreneur with variable i held fixed. Given that $h(\zeta, \kappa)$ follow a bivariate normal distribution, we know that

$$\kappa\,|\zeta \sim N\left(\alpha_\zeta + \beta\zeta, (1-\rho^2)\sigma_\kappa^2\right), \quad \text{where} \quad \alpha_\zeta = \mu_\kappa - \beta\mu_\zeta \quad \text{and} \quad \beta = \rho\frac{\sigma_\kappa}{\sigma_\zeta}. \tag{A2}$$

Therefore, we can write $f(L|\nu_i)$ as

$$\begin{aligned} f(L|\nu_i) &= \int_{\zeta \in L_\zeta(\kappa)} \phi\left(\frac{\zeta - \mu_\zeta}{\sigma_\zeta} \middle| \, \zeta \geq \underline{\zeta} \right) \left[\int_{\kappa \in L_\kappa(\zeta)} \phi\left(\frac{\kappa - \alpha_\zeta - \beta\zeta}{\sqrt{1-\rho^2}\sigma_\kappa} \right) d\kappa \right] d\zeta \\ &= \frac{1}{1 - \Phi(\underline{\tilde{\zeta}})} \int_{\tilde{\zeta} \in L_{\tilde{\zeta}}(\tilde{\kappa})} \left[\Phi\left(\widetilde{\overline{\kappa}}_L(\tilde{\zeta}) \right) - \Phi\left(\widetilde{\underline{\kappa}}_L(\tilde{\zeta}) \right) \right] \phi(\tilde{\zeta})\, d\tilde{\zeta} \end{aligned} \tag{A3}$$

where ϕ and Φ denote the probability and cumulative densities of a standard normal distribution. In addition, $\widetilde{\kappa}_L(\tilde{\zeta})$ is short-form notation for

$$\widetilde{\kappa}_L(\tilde{\zeta}) = \frac{\kappa_L(\tilde{\zeta}) - \alpha_\zeta - \beta(\mu_\zeta + \sigma_\zeta\tilde{\zeta})}{\sqrt{1-\rho^2}\sigma_\kappa} = \frac{\kappa_L(\tilde{\zeta}) - \mu_\kappa - \rho\sigma_\kappa\tilde{\zeta}}{\sqrt{1-\rho^2}\sigma_\kappa} \tag{A4}$$

so that a tilde in a variable denotes the normalized variable. Clearly, $\overline{\kappa}_L$ and $\underline{\kappa}_L$ are the critical scale values of Figures 3-6 which depend on the lending decision L. For example, if the agent self-finances ($L = S$), then $\overline{\kappa}_S = \log(K_S^M)$ and $\underline{\kappa}_S = -\infty$.

The integral in A3 is partitioned into different integrals with general support $[a, b]$ and possibly $[a, \infty)$. We approximate numerically an integral with support $[a, b]$ using Gauss-Legendre quadrature with 48 points in $[-1, 1]$ with an appropriate rescalement. Analogously, an integral with support $[a, \infty)$ is approximated using Gauss-Laguerre with 48 points in $[0, \infty)$.

References

[1] I. Aleem. Imperfect Information, Screening, and the Costs of Informal Lending: A Study of a Rural Credit Market in Pakistan. In K. Hoff, A. Braverman, and J. Stiglitz, editors, *The Economics of Rural Organization: Theory, Practice, and Policy*, pages 131–153, New York, N.Y., 1993. Oxford University Press for the World Bank.

[2] E. Aryeetey. Rural Finance in Africa: Institutional Developments and Access for the Poor. In *Annual World Bank Conference on Development Economics 1996*, pages 149–173, Washington, D.C., 1997. The International Bank for Reconstruction and Development/The World Bank.

[3] C. Bell. Interactions between Institutional and Informal Credit Agencies in Rural India. In K. Hoff, A. Braverman, and J. Stiglitz, editors, *The Economics of Rural Organization: Theory, Practice, and Policy*, pages 186–213, New York, N.Y., 1993. Oxford University Press for the World Bank.

[4] C. Bell, T.N. Srinivasan, and C. Udry. Rationing, Spillover and interlinking in Credit Markets: The Case of Rural Punjab. *Oxford Economic Papers*, 49:557–587, 1997.

[5] T. Besley. How Do Market Failures Justify Interventions in Rural Credit Markets? *The World Bank Research Observer*, 9(1):27–47, 1994.

[6] M. Binford, T. J. Lee, and R. Townsend. Sampling Design for an Integrated Socioeconomic and Ecologic Survey Using Satellite Remote Sensing and Ordination. mimeo, University of Chicago, 2001.

[7] P. Bose. Formal-informal interaction in rural credit markets. *Journal of Development Economics*, 56:265–280, 1998.

[8] A. Braverman and J. L. Guasch. Rural Credit Markets and Institutions in Developing Countries: Lessons for Policy Analysis from Practice and Modern Theory. *World Development*, 14(10/11):1253–1267, 1986.

[9] A. Braverman and J. L. Guasch. Administrative Failures in Government Credit Programs. In K. Hoff, A. Braverman, and J. Stiglitz, editors, *The Economics of*

Rural Organization: Theory, Practice, and Policy, pages 53–69, New York, N.Y., 1993. Oxford University Press for the World Bank.

[10] J. Conning. Mixing and Matching Loans: Credit Rationing and Spillover in a Rural Credit Market in Chile. mimeo, Williams College, 1996.

[11] J. Conning. Pirates and Moneylenders: Product-Market Competition and the Depth of Credit Relationships. mimeo, Williams College, 1998.

[12] D. Evans and B. Jovanovic. An Estimated Model of Entrepreneurial Choice under Liquidity Constraints. *Journal of Political Economy*, 97:808–827, 1989.

[13] G. Feder. The Economics of Land and Titling in Thailand. In K. Hoff, A. Braverman, and J. Stiglitz, editors, *The Economics of Rural Organization: Theory, Practice, and Policy*, pages 259–268, New York, N.Y., 1993. Oxford University Press for the World Bank.

[14] G. Feder, T. Onchan, Y. Chalamwong, and C. Hongladarom. *Land Policies and Farm Productivity in Thailand*. John Hopkins University Press, Baltimore, Maryland, 1988.

[15] M. Floro and D. Ray. Vertical Links between Formal and Informal Financial Institutions. mimeo, Boston University, 1996.

[16] P. Ghosh and D. Ray. Information and Enforcement in Informal Credit Markets. IDE Discussion Paper series, number 93, Boston University, 1999.

[17] J. Greenwood and B. Jovanovic. Financial Development, Growth, and the Distribution of Income. *Journal of Political Economy*, 98:1076–1107, 1990.

[18] L. Guiso, P. Sapienza, and L. Zingales. The Role of Social Capital in Financial Development. NBER Working Paper 7563, 2000.

[19] K. Hoff and J. Stiglitz. Imperfect Information and Rural Credit Markets: Puzzles and Policy Perspectives. In K. Hoff, A. Braverman, and J. Stiglitz, editors, *The Economics of Rural Organization: Theory, Practice, and Policy*, pages 33–52, New York, N.Y., 1993. Oxford University Press for the World Bank.

[20] K. Hoff and J. Stiglitz. Moneylenders and bankers: price-increasing subsidies in a monopolistically competitive market. *Journal of Development Economics*, 52:429–462, 1997.

[21] A. Jain. Symbiosis vs. Crowding-Out: The Interaction of Formal vs. Informal Credit Markets in Developing Countries. *Journal of Development Economics*, 59:419–444, 1999.

[22] H. Jeong. *Education and Credit: Sources of Growth with Increasing Inequality in Thailand*. PhD thesis, University of Chicago, Chicago, Illinois, 1999.

[23] K. Judd. *Numerical Methods in Economics.* The MIT Press, Cambridge, Massachusetts, 1998.

[24] J. Kaboski and R. Townsend. Borrowing and Lending in Semi-Urban and Rural Thailand. mimeo, University of Chicago, 1999.

[25] A. Kochar. An empirical investigation of rationing constraints in rural credit markets in India. *Journal of Development Economics*, 53:339–371, 1997.

[26] G. Laroque and Bernard Salanié. Temps partiel féminin et incitations financières à l'emploi. INSEE working paper G 2000 / 11, 2000.

[27] Bank of Thailand. Financial Institutions and Markets in Thailand. Bank of Thailand report, 1998.

[28] M. Pagano and T. Jappelli. Information Sharing in Credit Markets. *Journal of Finance*, 48(5):1693–1718, 1993.

[29] A. Paulson and R. Townsend. Entrepreneurship and Financial Constraints in Thailand. mimeographed, 2001.

[30] A. Paulson and R. Townsend. The Nature of Financial Constraints: Distinguishing the Micro Underpinnings of Macro Models. mimeographed, 2001.

[31] M. Petersen and R. Rajan. The Benefits of Lending Relationships: Evidence from Small Business Data. *Journal of Finance*, 49:3–37, 1994.

[32] A. Siamwalla, C. Pinthong, N. Poapongsakorn, P. Satsanguan, P. Nettayarak, W. Mingmaneenakin, and Y. Tubpun. The Thai Rural Credit System and Elements of a Theory: Public Subsidies, Provate Information, and Segmented Markets. In K. Hoff, A. Braverman, and J. Stiglitz, editors, *The Economics of Rural Organization: Theory, Practice, and Policy*, pages 154–185, New York, N.Y., 1993. Oxford University Press for the World Bank.

[33] R. Townsend. Intermediation with Costly Bilateral Exchange. *Review of Economic Studies*, 45(3):417–425, 1978.

[34] R. Townsend. Financial Structure and Economic Activity. *American Economic Review*, 73(5):895–911, 1983.

[35] R. Townsend principal investigator with, A. Paulson, S. Sakuntasathien, T. Jeong Lee, and M. Binford. Questionnaire design and data collection for NICHD grant 'Risk, Insurance and the Family' and NSF grants. mimeographed, 1997.

[36] I. Tunali. A General Structure for Models of Double-Selection and an Application to a Joint Migration/Earnings Process with Remigration. In R. Ehrenberg, editor, *Research in Labor Economics*, volume 8B, pages 235–282, Greenwich, Conn., 1986. JAI Press.

[37] C. Udry. Credit Markets in Northern Nigeria: Credit as Insurance in a Rural Economy. In K. Hoff, A. Braverman, and J. Stiglitz, editors, *The Economics of Rural Organization: Theory, Practice, and Policy*, pages 87–108, New York, N.Y., 1993. Oxford University Press for the World Bank.

[38] B. Uzzi. Embeddedness in the Making of Financial Capital: How Social Relations and Networks Benefit Firms Seeking Financing. *American Sociological Review*, 64:481–505, 1999.

[39] J.D Von Pischke, D.W. Adams, and G. Donald. *Rural Financial Markets in Developing Countries*. The John Hopkins University Press for the World Bank, Baltimore, Maryland, 1983.

[40] J. Yaron. What Makes Rural Finance Institutions Successful. *The World Bank Research Observer*, 9(1):49–70, 1994.