A Friend in Need is a Friend Indeed: Theory and Evidence on the (Dis)Advantages of Informal Loans*

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Abstract

The paper explains why formal credit is prevalent in developed nations, despite the many advantages of informal credit. We study the choice between formal and informal sources of credit in a setting with strategic default due to limited enforcement. Informal loans (e.g., from friends or relatives) are enforced by the threat of severing ties, while formal loans (e.g., from banks) can only be enforced via a collateral. In equilibrium, informal loan contracts feature zero interest rates and require no physical collateral. In contrast, formal loans always charge positive interest and are collateral-based, making them *a priori* less attractive. For small investment needs and for projects with no or low default risk, borrowers are therefore more likely to choose informal credit. At the same time, however, physical collateral, unlike social capital, is divisible. Equilibrium default on formal loans is thus less costly than default on informal loans. As a result, the investment potential of informal credit is limited and borrowers optimally choose formal sources of credit for riskier (and larger) loans. Empirical results from a cross section of Thai households are consistent with the predicted pattern of formal versus informal credit.

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1 Introduction

Informal credit is the prevalent form of credit used by households in developing countries. A large fraction of informal credit originates from family or friends (e.g., Paulson and Townsend, 2004 for Thailand; Banerjee and Duflo, 2007 for India).[2] One standard explanation for the abundance of informal credit in developing economies are market imperfections, either caused by asymmetric information problems (e.g., Stiglitz and Weiss, 1981; Townsend, 1995) or by imperfect enforcement (e.g., Ligon et al., 2002). The widespread inability of the poor to pledge physical collateral, as well as high transaction costs relative to the loan size (due to lack of credit histories, financial illiteracy, lack of property titles, inefficient courts, etc.) leads to many poor borrowers being rationed out of the formal credit market.[3] This often leaves informal credit as the only option for many of the poor.[4]

The above explanation implicitly presumes that formal (market-based) credit, e.g., from commercial banks, is somehow superior to informal (non-market) credit from friends or relatives. We pose the question why this is the case. To put it differently – why is formal credit so prevalent in developed countries? While turning to friends, neighbors or relatives seems to be a viable option a priori, we do not observe that many inter-personal loans in developed countries: most people rely on banks if they need to borrow money.[5] At first glance, one could imagine banks having a comparative advantage in lending (e.g., expertise, risk diversification, etc.). But on second thought, this is not plausible for small sums of money. Turning to friends and relatives seems to be a better option in many circumstances: they have comparative advantage in monitoring and enforcement capacity being better informed about the personal circumstance of the borrower and not having to incur monitoring overhead costs. This is the 'peer monitoring' argument of Stiglitz (1990). For smaller sums of money, issues like risk aversion or liquidity constraints also seem less of a problem. Relatives and friends can do everything a bank can do (in other words, charge interest and require collateral) but have in addition the friendship value as a means of enforcing contract compliance. Thus, given the many advantages of informal credit, the tendency for market-based credit to go hand in hand with economic development, and the observed wide prevalence of formal credit in developed nations, poses a puzzle.

This paper sheds light on the issue. We analyze the optimal choice between formal and informal credit from the borrower's perspective in a setting with imperfect contract enforcement. We use the term "informal credit" as a catchall phrase for various arrangements the main characteristic of which

[2] Paulson and Townsend (2004) report that about 30% of households in their 1997 sample have debts to other households while only 3% have loans from commercial banks. Banerjee and Duflo (2007) document that in Udaipur, India about 2/3 of poor households have outstanding loans, of which 23% from a relative, 37% from a shopkeeper and only 6% from formal sources. The latter number is very similar in 12 other developing countries on which they report.

[3] See Ghosh et al. (2000) for a review of the theory on credit rationing in developing countries.

[4] The rapid spread of microfinance in recent years has provided another source of credit to poor households without collateral drawing on the "social collateral" feature of informal credit we highlight here.

[5] Detailed data on interpersonal informal loans in developed countries are hard to find (e.g., in the US there are tax implications if too low interest is charged). The US National Association of Realtors (2012) reports that 9% of home buyers in 2011 received an intra-family loan to help with the downpayment. Among immigrants, Basu and Parker (2001) study ethnic South Asian business startups in the UK and report that 55% had at least some reliance on family loans. In the US, Bates (1997) reports that among Asian immigrant entrepreneurs, borrowing from family is more frequent than bank borrowing. During the financial crisis in 2008, peer-to-peer lending sites such as Virgin Money which facilitate family loans experienced a significant increase in volume.

is that they all rely on informal or personal relationships and use social sanctions as a means for contract enforcement. The primary example we have in mind are loans from family, neighbours, or friends, although other institutions such as credit cooperatives, rotating savings and credit associations, and some agricultural credit associations may also fit the description. The term "formal credit", in contrast, will refer to market-based credit arrangements in which personal relationships are absent.

The main trade-off between formal and informal credit in our model is the following. Informal credit from relatives or friends uses 'social collateral' measured by the value of the friendship or kinship ties. This social collateral can serve as a substitute for the physical collateral required by formal lenders, enabling borrowers to commit not to behave opportunistically. Using the social collateral is always feasible and allows for favorable loan conditions (low interest rates, no physical collateral requirements). On the surface, this makes informal credit attractive, especially for poor people who lack collateralizable assets, and for small loans. However, using social collateral comes at a cost – unlike physical capital, the social capital embedded in a relationship is indivisible. If a borrower defaults on an informal loan, the relationship is severed (or severely damaged) and the embedded social collateral is lost in its entirety. As long as default may occur in equilibrium, the associated utility loss represents a strictly positive cost to the borrower. There is also a second important difference between social and physical collateral. Physical collateral can be seized or kept by the lender, who therefore recovers something in case of default. In contrast, with informal loans, both parties suffer from the loss of the social relationship. These factors imply that informal credit could be in fact more costly than formal credit and inefficient to use despite the lower interest rate or lack of physical collateral: friends are simply too costly to lose.

We show that even if informal lenders can use the same contractual terms as formal lenders (e.g., collateral, interest rate), they may refrain from using them in equilibrium, and rely solely on the lasting nature of their relationship as a means to enforce compliance. Indeed, we prove that the optimal informal loan contract does not require physical collateral and charges zero interest. In contrast, formal loan contracts always include a collateral requirement and – since the lender needs to be compensated for the costs associated with liquidating the collateral – feature strictly positive interest rates. This comparative disadvantage of formal loans in terms of direct monetary cost of borrowing notwithstanding, the loss of social capital associated with informal lending when default occurs prompts borrowers to choose formal over informal credit for a wide range of circumstances in the model; in particular, when the ratio of loan size to borrower wealth (the loan-to-wealth ratio) is relatively high which corresponds to higher equilibrium probability of default.

We derive, and take to the data, two empirically testable predictions of our theoretical model. First, the model implies that the probability of observing formal loans should on average increase in loan size, ceteris paribus. The second testable prediction concerns the loan-to-wealth ratio (LTW), which is positively related to the (equilibrium) default risk in our model. For low values of this ratio, the equilibrium default probability is zero and the model unambiguously predicts that informal credit is optimal due to the more favorable terms of personal lending. As the LTW ratio grows, default becomes a possibility and borrowers switch to formal credit since the friendship value lost in case of default is larger than the collateral that has to be paid to the formal lender. The optimal choice is reversed again for very high LTW ratios where formal credit becomes unavailable (the collateral

needed to secure a formal loan is too high compared to the borrower's wealth) and informal credit remains the only option.

Empirically, we show that data from a 1997 survey of Thai households (part of the Townsend Thai Project, see http:\\cier.uchicago.edu) are consistent with our model's predictions. In particular, we document that loan size has a strong negative association with the likelihood of observing an informal loan. At the same time, the relation between type of loan source and the borrower's loan-to-wealth ratio is non-monotonic: low LTW ratios are associated with higher incidence of informal credit which decreases as the LTW ratio grows, controlling for loan size. Note that this finding is quite surprising, and even counterintuitive at first glance, as it implies that more leveraged loans (with higher risk) are taken from formal sources (e.g., banks), rather than from informal sources (e.g., friends or relatives). Our theory can account for this puzzle: the indivisibility of social capital makes such loans too expensive – if a borrower knows that he may default with positive probability, it is cheaper to default on a bank rather than on a friend since the physical collateral lost in case of a default can be adjusted to fit the loan size. The social capital lost in case of a default on a personal loan, in contrast, can not be adjusted. Only at very high loan-to-wealth ratios, for which the bank ceases to extend credit, do borrowers resort to informal loans again. In the data, this happens for the top-20 percent of loan-to-wealth ratios. We also show that these findings are robust to selection bias and the possible endogeneity of loan size.

Related literature

Our paper contributes to a relatively small but growing literature on the coexistence of formal and informal credit. Gine (2011) develops a model of limited enforcement and fixed transaction costs of accessing formal credit to formalize a trade-off between informal and formal credit. After structurally estimating the model using data from Thailand, he concludes that the limited ability of banks to enforce contracts, and not fixed costs, leads to the observed diversity of lenders.[6] This finding is consistent with our assumption of limited enforcement as the key friction in the credit market. Guirkinger (2008) examines the reasons why farm households seek informal loans in Piura, a commercial agriculture region in Peru, where formal lenders offer loans at a lower interest rate. His analysis using panel data reveals that the informal sector serves various types of clients: households excluded from the formal sector but also households who prefer informal loans because of lower transaction costs or lower risk. Jain (1999) proposes a model in which the formal sector's superior ability in deposit mobilization (economies of scale and scope, security of deposit insurance) is traded off against the informational advantage that lenders in informal sector enjoy about their borrowers. Barslund and Tarp (2008) study empirically the determinants of formal versus informal borrowing by households in rural Vietnam. They find that demand for formal credit is driven by factors such as total land and to a lesser extent, land tenure. Informal credit is positively associated with a bad credit history and the number of dependents, reflecting household need to smooth consumption and mitigate external shocks. When households have assets, they are better able to manage these needs without relying on informal credit.

[6]See also Madestam (2012) who, unlike here, models formal lenders (banks) as having a monitoring disadvantage relative to informal lenders (moneylenders) and shows that formal and informal sources can be substitutes or complements depending on banks' bargaining power.

Our paper is most closely related to Lee and Persson (2012) who independently build an alternative theoretical model emphasizing the role of social capital in informal borrower-lender relationships and its implications for the optimal choice between formal and informal credit. Unlike us, they model the social relationship as two-sided altruism – the borrower's utility enters the lender's and vice versa. Further, Lee and Persson assume that the lending relationship is subject to a moral hazard problem of diverting the funds to personal use. Social ties reduce the agency problem and lead to lower (even negative if the level of altruism is strong) informal loan interest rates and preference for formal loans when both sources are available. In further contrast to our paper, in their model the cost of informal loans is that they increase the entrepreneur's aversion to failure which undermines entrepreneur's willingness to take risk and may limit firm size. Our results do not rely on risk aversion and our emphasis is on the indivisibility of social collateral. We are also able to confirm our model's predictions in the data, while Lee and Persson's paper is purely theoretical.

A different perspective on formal versus informal credit arrangements can be found in Anderson and Francois (2008), who study the degree of formalism that rotating savings and credit associations (ROSCAs) use to help govern their relations in Kiberia, a Kenyan slum. Interestingly, and somewhat counter-intuitively, they present evidence that groups with stronger kinship ties rely more on formal rules, while groups with weaker inter-personal connections are more likely to use informal decision making and procedures. The authors attribute this pattern to the fact that groups of homogenous ethnicity find it more difficult to commit to punishment of recalcitrant group members; hence, the need for formal governance protocols. The theoretical model they develop to formalize this idea provides a convincing explanation for the observed group behavior, both across formalized and unformalized groups and across homogeneous and mixed-ethnicity groups. Our paper draws on their work since we emphasize that the social collateral destroyed when default occurs represents a loss not only to the borrower but also to the other members of the social group (friends or family in our case).[7]

More generally the paper contributes to the literature on social capital and the interdependence between economic development and the development of (financial) institutions. The theoretical foundations of sustaining cooperative outcomes in informal settings are two-fold. First, repeated interactions among members of the same social network improve enforcement (Hoff and Stiglitz, 1994; Besley and Coate, 1995). Second, informal lenders' better access to local information allows them to write contracts that are more state-contingent than formal contracts, and as such, reduce risk (Bond and Townsend, 1996; Bose, 1997; Kochar, 1997; Guirkinger, 2008). Similar insights underlie the attempts to improve lending to the poor by exploiting their information sharing in setting up joint-liability lending schemes (see for example Ghatak and Guinnane, 1999 or Morduch, 1999). The literature on social capital (see Woolcock and Naryan, 2000, for a survey) has also emphasized a downside of transactions based on ties between individuals, as the lack of these ties across other individuals can stifle the extent to which production can move beyond the kin group. Here, our focus instead is on how the possibility of losing the value of the personal relationship in a risky environment makes borrowers

[7]Further related to the 'social capital' basis of informal lending, Turvey and Kong (2010) study lending relationships involving trust using survey data from farm households in China. They find a relationship between trust and informal lending, and mistrust and formal lending. Informal borrowing in rural areas is very strong and culturally directed – over 67% of farm households borrow from friends and relatives. The case made in this paper is that trust combined with social preferences on the use of debt is a powerful economic force in rural China that can explain farm households' different uses of formal and informal credit.

substitute informal for formal credit arrangements.

The paper proceeds as follows. In Section 2 we develop the model and derive the optimal informal (Section 2.1) and formal (Section 2.2) credit contracts. The costs and benefits of the two credit types are compared and the optimal choice of credit source is analyzed in Section 3. Section 4 presents the empirical results. Section 5 concludes.

2 The Environment

The economy is populated by two types of agents: lenders and entrepreneurs (borrowers). The entrepreneurs are endowed with one investment project each, which has to be financed by taking a loan at $t = 0$. The projects vary in size, denoted by θ with $\theta \in (0, \bar{\theta}]$. A project requiring θ units of investment at $t = 0$ generates a stochastic return $y(\theta)$ at $t = 1$. The return $y(\theta)$ can take two possible values: $R\theta$ ('project success') with probability p, and 0 ('project failure') with probability $1-p$, where $R > 1$ and $p \in (0, 1)$. Borrowers are endowed with illiquid wealth (assets) $w > 0$ at $t = 0$, where w may differ across agents. We assume that the wealth is collateralizable but subject to risk. In particular, at time $t = 1$ only a fraction α of the value of an agent's wealth is usable as collateral, where α is a random variable with continuous cdf $G(\alpha)$, support $[\alpha_{\min}, 1]$ where $0 < \alpha_{\min} < 1$, and expectation $E(\alpha) \in (\alpha_{\min}, 1)$. One interpretation of the parameter α is as expenses that have to be incurred in acquiring or storing the asset. Alternatively, one can think of α as a shock to the $t = 1$ asset value – for example, a bad harvest reducing the value of the crop, an accident lowering the resale value of a car, or a drop in house or land prices.[8] Importantly, the realization of α is assumed unknown to both borrowers and lenders at $t = 0$ when the loan is taken but the $t = 1$ asset value αw is fully observable at $t = 1$ when repayment is due.

Both lenders and borrowers are risk-neutral and, for simplicity, do not discount the future. We assume an environment with limited enforcement – the project return y is non-verifiable which gives rise to the possibility of strategic default. Loan terms must therefore be such that borrowers have an incentive to pay the loan back. In addition, we assume that borrowers are subject to limited liability: if the project fails ($y = 0$), a borrower (involuntarily) defaults, in which case the lender cannot punish the borrower beyond seizing the posted collateral (if applicable). The lenders have access to a riskless technology, which converts one unit of investment good at $t = 0$ into one unit of consumption good at $t = 1$. The borrowers' outside option (if they do not invest in their project) is normalized to zero.

In what follows, we will distinguish between informal and formal credit. Informal creditors are relatives, friends, neighbours, members of the same ethnic group, etc. More generally, the defining characteristic of informal credit is that lenders have a (personal) relationship to the borrower characterized by *social capital*, i.e., a "friendship", whose value $\gamma > 0$ can be thought of as an alternative to physical collateral. We use the subscript I to denote informal creditors in what follows. Assume also that an informal lender has a maximum amount of $\bar{\theta} > 0$ funds available to lend out. In contrast, formal credit occurs when the lender is a stranger, that is, no personal relationship exists ($\gamma = 0$). In

[8] Note that we assume that the upper bound of α equals 1 for simplicity but our main results easily generalize for an upper bound $\alpha_{\max} > 1$ as long as $E(\alpha) < 1$.

the remainder of the paper for simplicity we refer to all such creditors as "formal" and denote them by the subscript F.

The timing is as follows. First, borrowers decide on a loan source. They can either borrow θ from an informal or formal lender, although, as will become clear below, depending on the parameters only one of these sources may be available in equilibrium. Next, the terms of the corresponding loan contract $\{r_i, c_i\}$, $i = I, F$ are determined, where the variable r_i refers to the required gross repayment (principal plus interest) if the borrower does not default (i.e., announces that the project was a success) and c_i denotes the value of required physical collateral in terms of borrower's assets which will be seized by the lender if the borrower defaults (i.e., announces that the project was a failure). Throughout the paper we assume that (nominal) interest rates cannot be negative, i.e., the required repayment cannot be less than the loan size,$r_i \geq \theta$ for $i = I, F$. We also assume that a forced liquidation of assets is costly in the sense that, due to transaction costs, each \$1 of assets in the hands of the borrower is worth only $\$\lambda \in (0, 1)$ in the hands of the lender.[9] Third, nature determines the value of α and whether the investment project has succeeded or failed. The former is observed by both parties. The latter is observed only by the borrower. Fourth, the contract terms are executed. Finally, payoffs are realized.

We impose the following assumption on the parameter values,

Assumption 1.

$$\textit{(i)}\ pR > \frac{1}{\lambda}\ \textit{and}\ \textit{(ii)}\ p > 1/2 \tag{A1}$$

Assumption A1 part (i) ensures that all investment projects are worth undertaking and that borrowers would be always willing to take a formal loan in equilibrium (see Section 2.2.2 below for the details). The second part (ii) assumes the probability of success p is sufficiently high, which allows us to simplify the analysis by eliminating some non-essential cases.

We also assume that the friendship value γ is sufficiently large so that people who borrow from informal lenders always have incentive to repay their loan in equilibrium (they never default strategically). To ensure this we impose (see Section 2.1.2 below for details)

Assumption 2.

$$\gamma > \frac{p(R-1)}{1-p}\bar{\theta} \tag{A2}$$

Note that Assumptions A1 and A2 imply $\gamma > \bar{\theta}$.

[9] Thus, the main technical difference between λ and the collateral value parameter α introduced earlier is that the cost λ only applies if the borrower declares she cannot repay r_i.

2.1 Informal Credit

2.1.1 The contracting problem

Informal credit allows the borrower and lender to use the threat of terminating their social relationship and the associated (utility) loss of $\gamma > 0$ for each party as a means to ensure compliance and repayment beyond what can be achieved by physical collateral. For simplicity and ease of exposition, we use a simple coordination ('handshake') game to represent social ties rather than building a full-blown model of friendship as a sequence of repeated interactions. In this game, the parties either confirm or reject the friendship which takes place at $t = 1$ after the project return has been realized and the contractually specified payment (r_I, c_I) has or has not been made.

Borrower \ Lender	confirm	reject
confirm	γ, γ	-1,0
reject	0,-1	0,0

This coordination game should be viewed as a reduced form of a repeated interaction between agents subject to limited commitment, as modelled for instance in Coate and Ravallion (1993) or Kocherlakota (1996) who study risk sharing via reciprocal transfers.[10] Similarly, Fafchamps (1999) shows how contingent credit can arise as an equilibrium of a long-term implicit risk sharing arrangement while Boot and Thakor (1994) provide conditions under which long-term lender-borrower relationships can achieve the first-best in a repeated moral hazard problem without risk-sharing motive.

In what follows, we assume that the Nash equilibrium (confirm, confirm) is played whenever the required loan repayment is made and the Nash equilibrium (reject, reject) is played otherwise. We also assume that the same game is played when a borrower is asking an informal lender for a loan. Consequently, there is an equilibrium where, if the lender refuses to give a loan, they also lose the friendship value γ.

In general, the amount of repayment required in an informal loan contract is not pinned down and would depend on the outcome of bargaining between informal borrowers and lenders. To simplify the analysis, we assume that borrowers have all the bargaining power, so the contract terms (r_I, c_I) are chosen to maximize the borrower's expected utility.

Before stating the formal optimization problem, note that for γ sufficiently large, the borrower would always try to avoid the loss of the friendship whenever possible. This implies that even when the project return is zero, and therefore the borrower cannot pay the lender directly, the borrower would not wish to default even if the formal collateral, c_I is zero. Instead, he will pay back r_I by liquidating his assets (which have $t = 1$ value αw). This is possible whenever $\alpha w \geq r_I$, i.e., $\alpha \geq \frac{r_I}{w}$ which happens with probability $1 - G\left(\frac{r_I}{w}\right)$. Hence, when contracting with an informal lender, a borrower would only default if he is *unable* to repay the lender, i.e., if $y(\theta) = 0$ *and* $r_I > \alpha w$, which happens with joint probability $(1 - p)G(\frac{r_I}{w})$. The friendship value γ is lost in that case. Suppose the contract specifies

[10] In these papers the agents share risk ('cooperate') on the equilibrium path by making transfers to each other depending on their income. Cooperation is supported by the threat of punishment of autarky forever if an agent reneges on the agreement.

physical collateral, $c_I \geq 0$ – i.e., in case the borrower does not or cannot repay r_I, an amount worth c_I of borrower's assets is seized provided $c_I \leq \alpha w$. Otherwise, if $c_I > \alpha w$, all borrower assets are liquidated and taken by the lender. The actual transfer from the borrower to the lender therefore equals $\min\{\alpha w, c_I\}$ which is worth $\lambda \min\{\alpha w, c_I\}$ to the lender.[11]

Given the discussion above, the $t = 0$ contracting problem between an informal lender and a borrower with project size $\theta \in (0, \bar{\theta}]$, friendship value $\gamma > 0$, and initial wealth $w > 0$ can be written as:

$$\max_{r_I, c_I} \quad p(R\theta - r_I) - (1-p)\left[\left(1 - G\left(\frac{r_I}{w}\right)\right) r_I + G\left(\frac{r_I}{w}\right)\gamma + \int_{\alpha_{\min}}^{r_I/w} \min\{c_I, \alpha w\} dG(\alpha)\right] \tag{OBJ$_B$}$$

$$\text{s.t.} \quad \left[p + (1-p)\left((1 - G(\frac{r_I}{w})\right)\right] r_I - (1-p)G\left(\frac{r_I}{w}\right)\gamma + (1-p)\lambda \int_{\alpha_{\min}}^{r_I/w} \min\{c_I, \alpha w\} dG(\alpha) - \theta \geq -\gamma \tag{PC$_L$}$$

$$p(R\theta - r_I) - (1-p)\left[\left(1 - G\left(\frac{r_I}{w}\right)\right) r_I + G\left(\frac{r_I}{w}\right)\gamma + \int_{\alpha_{\min}}^{r_I/w} \min\{c_I, \alpha w\} dG(\alpha)\right] \geq 0 \tag{PC$_B$}$$

$$r_I \leq \gamma + c_I \tag{IC$_B$}$$

$$r_I \geq \theta \text{ and } c_I \geq 0 \tag{NN}$$

The objective function is the borrower's expected payoff which is the sum of the payoff under project success (the first term) and the payoff under failure (the second term). The first constraint (PC$_L$) is the lender's participation constraint: if the lender makes the loan, she receives r_I in case the project succeeds (which occurs with probability p) or if the project fails but the borrower can repay by liquidating assets which occurs with probability $1 - p$ times $1 - G(\frac{r_I}{w})$. Otherwise, if the project fails and the borrower cannot repay in full, both she and the lender lose the friendship value γ and the lender receives the collateral or asset value net of transaction costs, $\lambda \min\{\alpha w, c_I\}$. The opportunity cost of lending θ is θ. The right hand side of (PC$_L$) reflects the fact that if an informal lender refuses to make the loan then he would also lose the social value γ. The second constraint, (PC$_B$) is the borrower's participation constraint stating that the borrower's expected utility from taking a loan with terms (r_I, c_I) must exceed her outside option of zero if a loan is not taken. The third constraint (IC$_B$) is the incentive constraint for the borrower to pay back the loan if she has the money, as opposed to reneging and losing γ plus any pledged collateral. We assume that the friendship value γ is sufficiently large so that this constraint would never bind at the optimum (the exact conditions are provided below). The final constraint (NN) reflects our assumption of non-negative interest rate and collateral requirement. Naturally, a subset of all constraints may bind at the optimal contract.

[11] Note that we assume no cost λ if the borrower voluntarily liquidates the asset herself. This can be relaxed easily. What is important is the reasonable assumption that transaction costs are higher if the lender has to seize or liquidate the assets.

2.1.2 The optimal informal loan contract

We start the analysis of the optimal informal loan contract with the following observation.

Lemma 1. *The lender's participation constraint, (PC_L) for an informal loan is not binding – under Assumptions A1 and A2 it is satisfied for any r_I, c_I satisfying non-negativity, (NN).*

Proof: see Appendix.

Intuitively, for sufficiently large friendship value informal lenders never find it optimal to refuse a loan and lose a friend knowing that, for the same reason, the borrower has incentives to repay whenever feasible. Next, looking at the objective, observe that it is optimal to set r_I and c_I as low as possible as long as all constraints are satisfied. We already know from Lemma 1 that lender participation is of no concern. In addition, Assumption A2 ensures $\gamma \geq \overline{\theta}$ which means (IC_B) is always satisfied at $r_I = \theta$. We therefore obtain:

Lemma 2. *The optimal informal credit contract consists of zero interest rate, $r_I^* = \theta$ and no physical collateral, $c_I^* = 0$.*

What remains to be checked is the borrower's participation constraint (PC_B). At $r_I^* = \theta$ and $c_I^* = 0$, (PC_B) is equivalent to

$$(pR-1)\frac{\theta}{w} + (1-p)G(\frac{\theta}{w})(\frac{\theta}{w} - \frac{\gamma}{w}) \geq 0 \tag{1}$$

There are three possible cases depending on the value of the (project) loan size to wealth ratio (LTW), $\frac{\theta}{w}$.

1. Case I1 (low loan-to-wealth ratio): $\frac{\theta}{w} \leq \alpha_{\min}$. In this case $G(\theta/w) = 0$. Hence, (PC_B) given by (1) is satisfied for any such loan size θ since $pR > 1$ by Assumption A1(i). No default ever occurs for such small relative to the borrower's wealth loans and no social capital is lost (friendships broken) in equilibrium – informal loans with size $\theta \leq \min\{\bar{\theta}, \alpha_{\min} w\}$ are riskless.

2. Case I2 (high low loan-to-wealth ratio): $\frac{\theta}{w} \geq 1$. Then $G(\theta/w) = 1$ and hence, in this case (PC_B) given by (1) is violated for any loan size $\theta \in [0, \bar{\theta}]$ since $\gamma > \frac{p(R-1)\bar{\theta}}{1-p}$ by Assumption A2. Thus, no informal loans are taken for such values of the ratio $\frac{\theta}{w}$. This case applies to either very poor borrowers (low w) or, more generally, to borrowers who have large investment needs relative to their collateralizable wealth. Note also that it is the borrowers, not the lenders, who refuse informal loans in this case.

3. Case I3 (intermediate low loan-to-wealth ratio): $\alpha_{\min} < \frac{\theta}{w} < 1$. From cases I1 and I2 we know that, for given w, the borrower's participation constraint (PC_B) is always satisfied when $\frac{\theta}{w}$ is sufficiently low and always violated for $\frac{\theta}{w}$ sufficiently high. Let $\hat{\alpha}_I(w) \in (\alpha_{\min}, 1)$ be the value of the ratio $\frac{\theta}{w}$ for which (1) holds with equality.[12] We thus obtain that in this case informal loans are taken

[12] By continuity such value always exists since at $\frac{\theta}{w} = \alpha_{\min}$ (Case I1) the LHS of (1) is strictly positive, while at $\frac{\theta}{w} = 1$ (Case I2) it is negative and since the LHS is a continuous function. See Lemma A1 in the Appendix for sufficient condition for uniqueness of $\hat{\alpha}_I(w)$.

for loan-to-wealth ratios satisfying $\alpha_{\min} < \frac{\theta}{w} \leq \min\{\hat{\alpha}_I(w), \frac{\bar{\theta}}{w}\}$. Note that in Case I3 it is possible for the borrower to be unable to repay the full amount $r_I = \theta$ in equilibrium, depending on the realization of α. Thus, such loans are risky and some friendships are broken with positive probability.

The above analysis is summarized in

Proposition 1 (Informal Credit)**.** *Suppose Assumptions A1 and A2 hold. Then,*

a) informal credit is unavailable for sufficiently large projects – those with $\theta > \bar{\theta}$.

b) for projects with $\theta \leq \bar{\theta}$ for which informal credit is available, we have

i) no informal credit is taken in equilibrium for 'high default risk' (high loan-to-wealth ratio) projects – those with $\frac{\theta}{w} > \hat{\alpha}_I(w) \in (\alpha_{\min}, 1)$;

(ii) for 'low default risk' (low loan-to-wealth ratio) projects – those with $\theta \leq \bar{\theta}$ and $0 < \frac{\theta}{w} \leq \hat{\alpha}_I(w)$, informal credit is taken in equilibrum. All such loans feature no physical collateral and zero interest i.e., $c_I = 0$ and $r_I = \theta$. If $\frac{\theta}{w} > \alpha_{\min}$ default occurs and the friendship value γ is lost with positive probability;

Intuitively, very small loans or loans that are not too large relative to the borrower's wealth, namely those with $\frac{\theta}{w} \leq \alpha_{\min}$, are available and mutually beneficial since there is no risk of default – the borrower has sufficient assets to repay even in the worst state of the world. For higher loan-to-wealth ratios, $\frac{\theta}{w} > \alpha_{\min}$, default occurs and the social capital γ is lost with positive probability in equilibrium. In this case, the borrower must weigh the risk of default against the expected utility gain from undertaking the project. The latter outweighs the former provided that $\frac{\theta}{w} < \hat{\alpha}_I(w)$. Proposition 1 also shows that informal credit is always characterized by no physical collateral requirement and zero interest rate (this will be largely confirmed in the data in Section 4). Note that this is a result of our model and not an assumption – we only ruled out negative interest rates.[13]

Finally, for high LTW values, $\frac{\theta}{w} > \hat{\alpha}_I(w)$, informal credit is feasible but undesirable by borrowers. Even though an informal loan will be given and would involve zero interest and collateral, it is not optimal to ask one's friends or relatives for it: the risk of losing the friendship when the project fails and the borrower cannot repay dominates.

2.1.3 Comparative statics

We analyze how the loan-to-wealth ratio threshold $\hat{\alpha}_I(w)$ from Proposition 1 depends on the parameters p, R, w and γ. Remember, this threshold determines the extent of informal credit in equilibrium. Using the definition of $\hat{\alpha}_I(w)$, evaluating *(1)* at $\hat{\alpha} \equiv \hat{\alpha}_I(w)$ yields

$$(pR - 1)\hat{\alpha} + (1 - p)G(\hat{\alpha})(\hat{\alpha} - \frac{\gamma}{w}) = 0 \tag{2}$$

[13] Of course, we also need that the bargaining power of the lender is not too large.

By Assumption A1, for this equality to hold it must be that $\hat{\alpha} < \frac{\gamma}{w}$, so we can write (2) as:

$$G(\hat{\alpha}) = \frac{(pR-1)\hat{\alpha}}{(1-p)(\frac{\gamma}{w}-\hat{\alpha})} \tag{3}$$

The left and right hand sides of (3) can be viewed as functions of $\alpha = \frac{\theta}{w}$ on the interval $[\alpha_{\min}, 1]$ with equality holding when evaluated at $\alpha = \hat{\alpha}$. Both sides are strictly increasing in α. The left hand side equals 0 at $\alpha = \alpha_{\min}$ and 1 at $\alpha = 1$. The right hand side is positive at $\alpha = \alpha_{\min}$ and less than 1 at $\alpha = 1$.[14] Hence, assuming a unique crossing $\hat{\alpha}$ (see Lemma A1 in the Appendix for sufficient conditions), the graph of the right hand side of (3) as function of α crosses the left hand side from above at $\hat{\alpha}$. We thus have the following comparative statics:

1. An increase in the friendship value γ shifts the graph of the right hand side of (3) down, thus the threshold $\hat{\alpha}$ decreases in γ ceteris paribus – less informal loans are given. The intuition is that informal loans become more costly to both parties due to the risk of losing the friendship.

2. An increase in the borrower's assets w shifts the graph of the right hand side of (3) up, thus the threshold $\hat{\alpha}$ increases ceteris paribus. Intuitively, a larger wealth can support a wider range of loan sizes.

3. An increase in the project's return upon success, R shifts the graph of the right hand side of (3) up, thus the threshold $\hat{\alpha}$ increases ceteris paribus. Intuitively, a higher project return can support a wider range of loans.

4. An increase in the project's probability of success p shifts the graph of the right hand side of (3) up, thus the threshold $\hat{\alpha}$ increases ceteris paribus. The intuition is that a higher probability of success supports more loans.

The effects from varying w, R and p are intuitive – better 'quality' borrowers can access informal credit for a wider range of project/loan sizes. The effect of varying the friendship value γ is perhaps less obvious ex-ante as it implies that closer friends (with higher γ) are *less likely* to lend to each other ceteris paribus (the feasible range of project sizes that can be funded by informal credit is smaller). The reason is the loss of social collateral γ when default can happen in equilibrium. However, note that borrower-lender pairs with very low γ may be unable to support any informal loans (here this outcome is ruled out by Assumption A2 but it would easily obtain if we relax this assumption).

2.2 Formal Credit

2.2.1 The contracting problem

There are two main differences between formal and informal credit, or between borrowing from a formal lender (e.g., a bank) versus borrowing from an informal lender (e.g., a friend). First, we

[14] The latter follows noting that at $\alpha = 1$ we have $w = \theta$ and using Assumption A2.

assume that, unlike informal lenders, formal lenders have 'unlimited' funds: i.e., there is no ex-ante cap on the maximum loan size as long as sufficient collateral is available. Second, there is no 'social capital' or friendship value γ when taking a formal loan. Consequently, in the presence of limited enforcement, formal loans need to be secured by posting physical collateral – otherwise borrowers cannot commit not to always claim project failure, $y(\theta) = 0$ and pocket the project return.

We treat formal and informal loan sources as symmetrically as possible subject to these two differences. We also maintain the assumption that borrowers have the entire bargaining power. In other words, formal lenders can be thought of as perfectly competitive and thus the optimal formal loan contract maximizes the borrower's utility subject to participation and incentive compatibility. Limited liability still applies – if the borrower does not pay back the required gross repayment amount r_F, the lender cannot do anything beyond seizing the posted collateral, c_F. In case the project fails and $y(\theta) = 0$ (with probability $1-p$), the borrower can supply the specified collateral amount c_F only if $c_F \leq \alpha w$. Otherwise, the borrower's assets backing the collateral need to be sold off and the lender receives their $t = 1$ value αw. The actual transfer from borrower to lender upon project failure thus equals $\min\{c_F, \alpha w\}$ which is worth $\lambda \min\{c_F, \alpha w\}$ to the lender.

If the project succeeds (with probability p), the borrower can either announce truthfully $y = R\theta$ and pay back r_F or strategically default (announce $y(\theta) = 0$) after observing α. In the latter case the lender collects $\min\{c_F, \alpha w\}$ as explained above. It must be that $r_F \leq c_F$ in the optimal formal loan contract to prevent the borrower from always strategically defaulting and forfeiting the collateral. However, the borrower can still find it optimal to default strategically after observing α if $\alpha w < r_F$ ($\leq c_F$). Hence, the payment to the lender in the case of project success equals $\min\{r_F, \alpha w\}$ which is worth to the lender either r_F when the realization of α is such that $r_F \leq \alpha w$ or $\lambda \alpha w$ when α is such that $r_F > \alpha w$ and the default triggers costly asset liquidation. The fact that the borrower may choose to default strategically depending on α is an important difference with the informal credit case in which we assumed that the social value γ is sufficiently high to prevent strategic default.

Using analogous notation to that in the informal credit section, the contracting problem between a formal lender and a borrower with project size $\theta > 0$ and assets $w > 0$ is:

$$\max_{r_F, c_F} \quad p\left[R\theta - \int_{\alpha_{\min}}^{1} \min\{r_F, \alpha w\} dG(\alpha)\right] - (1-p) \int_{\alpha_{\min}}^{1} \min\{c_F, \alpha w\} dG(\alpha) \tag{OBJ$_B$}$$

$$\text{s.t.} \quad p[\int_{\alpha_{\min}}^{r_F/w} \lambda \alpha w dG(\alpha) + (1 - G(\frac{r_F}{w}))r_F] + (1-p)\lambda \int_{\alpha_{\min}}^{1} \min\{c_F, \alpha w\} dG(\alpha) \geq \theta \tag{PC$_L$}$$

$$p[R\theta - \int_{\alpha_{\min}}^{1} \min\{r_F, \alpha w\} dG(\alpha)] - (1-p) \int_{\alpha_{\min}}^{1} \min\{c_F, \alpha w\} dG(\alpha) \geq 0 \tag{PC$_B$}$$

$$r_F \leq c_F \tag{IC}$$

$$r_F \geq \theta \text{ and } c_F \geq 0 \tag{NN}$$

The optimal formal credit contract maximizers the borrower's expected utility (OBJ$_B$) subject to the

following constraints. The first constraint, (PC_L) is the lender's participation constraint which ensures that the lender breaks even in expectation. The expected value of making the loan and collecting the respective repayment under success or failure (the left hand side) must be larger than the opportunity cost of lending, θ (the right hand side). Constraint (PC_B) is the borrower's participation constraint, stating that her expected payoff from taking the loan with terms (r_F, c_F) must exceed her outside option of zero. Constraint (IC) is the incentive constraint for the borrower so that she does not always strategically default. The last constraint, (NN) ensures the non-negativity of the interest rate and the collateral requirement.

2.2.2 The optimal formal loan contract

Note first that, in the objective (OBJ_B) it is optimal to set r_F and c_F as low as possible while satisfying all constraints. Also, note that because of the (IC) constraint we must have $r_F = c_F$ at optimum. This implies that formal loans always require positive collateral, $c_F = r_F \geq \theta > 0$. Note the difference with the informal loans case.

Evaluating the expected payoff of the lender (the left-hand side of (PC_L)) at zero interest, $r_F = \theta = c_F$, we have

$$\begin{aligned} & p[\int_{\alpha_{\min}}^{\theta/w} \lambda \alpha w dG(\alpha) + (1 - G(\frac{\theta}{w}))\theta] + (1-p)\lambda \int_{\alpha_{\min}}^{1} \min\{\theta, \alpha w\} dG(\alpha) \\ & \leq p\theta + (1-p)\lambda\theta < \theta \end{aligned}$$

The first inequality follows since $\alpha \leq \frac{\theta}{w}$ and so $\lambda\alpha w \leq \lambda\theta < \theta$ holds inside the integral whenever it is well-defined (thus the value of the integral in the first term is less than $G(\frac{\theta}{w})\theta$), and since $\min\{\theta, \alpha w\} \leq \theta$ and $\lambda < 1$. Overall, this implies that whenever a formal loan is feasible (a solution to the above problem exists) the interest rate charged by formal lenders must be strictly positive ($r_F > \theta$) for them to break even. Again, note the difference with the informal loans case (see below for discussion).

It follows that the optimal bank loan contract consists of gross repayment r_F and collateral requirement c_F satisfying $c_F = r_F \equiv r_F^*$ and such that the lender's participation constraint (PC_L) holds with equality. That is, r_F^* solves

$$\lambda \int_{\alpha_{\min}}^{r_F^*/w} \alpha dG(\alpha) + (p + (1-p)\lambda)(1 - G(\frac{r_F^*}{w}))\frac{r_F^*}{w} = \frac{\theta}{w} \tag{4}$$

Next, we discuss the conditions under which a solution, r_F^* to (4) exists and characterize it. As in the case of informal credit, there are three possible cases depending on the loan-to-wealth (LTW) ratio, $\frac{\theta}{w}$.

In addition to the previous assumptions, assume that

Assumption 3.

$$\frac{E(\alpha)}{\phi} > \alpha_{\min} \text{ where } \phi \equiv \tfrac{1}{p+(1-p)\lambda}. \tag{A3}$$

As will become clear below, Assumption A3 ensures that formal loans are possible equilibrium outcomes not only in situations where informal loans are infeasible due to $\theta > \bar{\theta}$.

1. Case F1 (low loan-to-wealth ratio): $\frac{\theta}{w} \leq \frac{\alpha_{\min}}{\phi}$. In this case $r_F^* = \phi\theta$ solves (4) and satisfies $r_F^* \leq \alpha_{\min} w$, i.e., $r_F^* \leq \alpha w$ for all α and $G(\frac{r_F^*}{w}) = 0$. The borrower always has sufficient funds to repay the loan and there is no risk for the lender. In case of project failure the money comes from liquidating part of $t = 1$ assets, αw. There is neither strategic nor involuntary default in equilibrium. Since $r_F^* = \phi\theta > \theta$, positive interest is charged because of the liquidation cost λ. Also, observe that the threshold value, $\frac{\alpha_{\min}}{\phi}$ for the LTW ratio $\frac{\theta}{w}$ is lower here than in the analogous informal credit case (Case I1) – relatively smaller loans are riskless for the lender or, in other words, given w some loans that are riskless under informal credit are risky under formal credit.

2. Case F2 (high loan-to-wealth ratio): $\frac{\theta}{w} \geq \frac{E(\alpha)}{\phi}$. In this case we have,

$$\theta \geq w\frac{E(\alpha)}{\phi} \geq \frac{1}{\phi}\int_{\alpha_{\min}}^{1} \min\{r_F^*, \alpha w\} dG(\alpha) = \frac{1}{\phi}\int_{\alpha_{\min}}^{r_F^*/w} \alpha w dG(\alpha) + \frac{1}{\phi}(1 - G(\frac{r_F^*}{w}))r_F^* >$$

$$> \lambda \int_{\alpha_{\min}}^{r_F^*/w} \alpha w dG(\alpha) + (p + (1-p)\lambda)(1 - G(\frac{r_F^*}{w}))r_F^* = \theta$$

The second inequality holds since $\alpha w \geq \min\{r_F^*, \alpha w\}$ for all α and hence $w\frac{E(\alpha)}{\phi} = \frac{1}{\phi}\int_{\alpha_{\min}}^{1} \alpha w dG(\alpha) \geq \int_{\alpha_{\min}}^{1} \min\{r_F^*, \alpha w\} dG(\alpha)$. The third inequality follows since $\frac{1}{\phi} > \lambda$. Thus, for $\frac{\theta}{w} \geq \frac{E(\alpha)}{\phi}$ the lender's break-even constraint (PC_L) cannot be satisfied (no feasible r_F, c_F exist due to the possibility of strategic default when α is small). Note that the loan-to-wealth threshold $\frac{E(\alpha)}{\phi}$ is smaller than 1 which was the corresponding threshold under informal lending (see Case I2 in the previous section). This implies that very 'risky' loans can be given by informal but not formal lenders. The intuition is that the threat of losing the (indivisible) friendship value can support such loans while the costlier-to-seize physical collateral cannot.

3. Case F3 (intermediate loan-to-wealth ratio): $\frac{\alpha_{\min}}{\phi} < \frac{\theta}{w} < \frac{E(\alpha)}{\phi}$. From cases F1 and F2 we know that, for given w, the lender's participation constraint (PC_L) is always satisfied when $\frac{\theta}{w}$ is sufficiently low and always violated for $\frac{\theta}{w}$ sufficiently high. By continuity, there exists a threshold value $\hat{\alpha}_F(w) \equiv \frac{r_F^*}{w}$ with $\hat{\alpha}_F(w) \in (\frac{\alpha_{\min}}{\phi}, \frac{E(\alpha)}{\phi})$ such that formal loans are feasible for $\frac{\theta}{w} \in (\frac{\alpha_{\min}}{\phi}, \hat{\alpha}_F(w)]$ and not otherwise. The optimal repayment r_F^* solves (4). Such value exists by continuity (see cases F1 and F2) and satisfies $r_F^* > \phi\theta$. Note that in Case F3 it is possible for the borrower to be unable to repay r_F^* in equilibrium, depending on the realization of α – default can occur in equilibrium.

Finally, we need to check the borrower's participation constraint (PC_B) for cases F1 and F3 in which

formal loans are feasible. From (OBJ_B) and (4), the borrower's expected utility U_{F1} in case F1, where $r_F^* = \phi\theta$ equals $\theta(pR - \phi)$ which is positive by Assumption A1(i) since $\phi < \frac{1}{\lambda}$. In case F3, the borrower's expected utility U_{F3} in the optimal formal loan contract equals

$$\begin{aligned} U_{F3} &= pR\theta - \int_{\alpha_{\min}}^{1} \min\{r_F^*, \alpha w\} dG(\alpha) = \\ &= pR\theta - \int_{\alpha_{\min}}^{r_F^*/w} \alpha w dG(\alpha) - (1 - G(\frac{r_F^*}{w}))r_F^* > \\ &> pR\theta - \frac{\theta}{\lambda} > 0 \end{aligned}$$

where the first inequality follows by (4) and $\lambda < 1$ and the second inequality holds by Assumption A1. Thus, (PC_B) is always satisfied when formal loans are feasible. Of course, this is not surprising since the borrower takes the all the gains from trade.

Proposition 2 (Formal Credit)**.** *Suppose Assumptions A1 and A2 hold. Optimal formal credit contracts are characterized as follows:*

a) no formal credit is given for 'high default risk' (high LTW ratio) projects – those with $\frac{\theta}{w} > \hat{\alpha}_F(w)$.

b) positive-collateral and positive-interest formal loans, with $r_F = c_F = r_F^* = \phi\theta$, are given for 'low risk' (low LTW ratio) projects – those with $\frac{\theta}{w} \leq \frac{\alpha_{\min}}{\phi}$. The lender always receives r_F^* from the borrower either from the project return or by seizing the collateral – there is no default risk.

c) positive-interest, positive collateral formal loans, with $r_F = c_F = r_F^* > \phi\theta$ where r_F^* solves (4) are given for 'intermediate default risk' (intermediate LTW ratio) projects – those with $\frac{\alpha_{\min}}{\phi} < \frac{\theta}{w} \leq \hat{\alpha}_F(w)$. There is default in equilibrium, i.e., depending on the realization of α, the lender sometimes receives only αw from the borrower which is less than the required repayment r_F^*.

The intuition for these results follows by recalling that, since the optimal formal loan contract requires collateral which is larger than the loan size, the lender faces only one type of risk, namely that the ex-post value of the borrower's assets, αw falls short of the posted collateral or required repayment. Project failure by itself is otherwise irrelevant to the lender. Hence, projects with high default risk (high LTW ratio) are ineligible for formal loans since the lender cannot break even on them as the expected payout in case of a default is too small. Low-risk projects, those with loan-to-wealth ratio less than $\frac{\alpha_{\min}}{\phi}$, are charged lower (and size-independent) interest rate relative to riskier, higher LTW ratio projects.

3 The Choice between Formal and Informal Credit

We now use the results from Propositions 1 and 2 to compare the optimal formal and informal credit arrangements and their respective pros and cons from the borrower's perspective. The advantage of using informal arrangements is twofold. First, because of the social capital that can be pledged to secure the loan, informal credit can be extended to borrowers with relatively low assets. This is the main premise of microcredit institutions that extend small loans to poor borrowers who typically lack collateral, steady employment, or verifiable credit history on the basis that group lending can harness the social collateral. Formal lenders such as banks, in contrast, require physical collateral to ensure compliance and repayment. Second, because of said social capital, informal loans are also cheaper. Informal sources such as friends and relatives do not require the borrower to pay back the loan with interest or to post physical collateral. The reason is that they do not need to be compensated for additional risk of default – even if the project fails, they know that the borrower would want to pay them back to preserve the friendship. If the actual default risk (the risk of losing the social collateral) is too great, the borrower would not want to enter the credit agreement in the first place.

Borrowing from informal sources, however, comes with a cost, although it may be less obvious. In particular, two characteristics of informal credit arrangements put them at a disadvantage relative to formal credit. First, there is an upper limit $\bar{\theta}$ on how much one can borrow – friends and relatives generally do not have unlimited loanable funds. Second, the friendship value γ which acts as collateral to secure the loan is *indivisible*, implying that the entire amount γ is pledged to support repayment, even though for smaller loans only a fraction would suffice. This has broader implications (not modeled here) about which person from the set of one's friends one would turn to depending on the needed loan size.

We next analyze formally the optimal choice between formal and informal credit given the parameters w, p, R, γ. To begin with, recall that $\hat{\alpha}_I(w) \in (\alpha_{\min}, 1)$ is the upper bound on the loan-to-wealth ratio θ/w for which informal credit is feasible, implicitly defined by (1) holding with equality. Loans with LTW ratios above this threshold are too costly in terms of the risk of losing the friendship. For formal credit, the corresponding upper bound on the LTW ratio $\frac{\theta}{w}$ is $\hat{\alpha}_F(w) \in (\frac{\alpha_{\min}}{\phi}, \frac{E(\alpha)}{\phi})$ implicitly defined by (4) holding with equality. For larger LTW ratios, formal credit is not feasible as the borrower does not have sufficient collateral to secure repayment and the lender cannot break even. Thus, only borrowers with $\frac{\theta}{w} \leq \min\{\hat{\alpha}_I(w), \hat{\alpha}_F(w)\}$ can borrow from both formal and informal lenders.

To characterize the optimal loan choice, we next answer the question: if one is able to borrow from both sources, which source does one prefer? Assume that $\theta \leq \bar{\theta}$, that is, informal credit is *a priori* feasible. There are three possible cases.

Proposition 3 (Low-risk loans)**.** *Suppose $\frac{\theta}{w} \leq \alpha_{\min}$. Borrowers make exclusive use of informal credit with zero interest rate and no collateral. No default occurs in equilibrium.*

Proof: Suppose first $\alpha_{\min} < \hat{\alpha}_F$, so formal loans are feasible over the entire range $\frac{\theta}{w} \leq \alpha_{\min}$. If $\frac{\theta}{w} \leq \frac{\alpha_{\min}}{\phi}$, since $\phi > 1$, Propositions 1 and 2 imply $r_F^* = \phi\theta > \theta = r_I$ and $G(\frac{\theta}{w}) = 0$. In this range of loan-to-wealth ratios, the actual default risk is zero for both formal and informal lenders. The borrower's expected utility from taking an informal loan is equal to $U_I = (pR - 1)\theta$ while her

expected utility if she goes to a formal lender is $U_F = \theta[pR - \phi] < \theta(pR - 1) = U_I$. Due to the liquidation cost ($\lambda < 1$), informal loans are thus strictly preferred whenever feasible. The same result obviously holds for the LTW ratio range $\frac{\theta}{w} \in (\frac{\alpha_{\min}}{\phi}, \alpha_{\min}]$ since in it the formal interest rate is higher, $r_F^* > \phi\theta$ (see the discussion surrounding Proposition 2), in addition to what was said above. Formal loans could therefore be used only if $\theta > \bar{\theta}$ in this case. Finally, if $\alpha_{\min} \geq \hat{\alpha}_F$, the above argument applies for all values $\frac{\theta}{w} \leq \hat{\alpha}_F$ while for values $\frac{\theta}{w} \in (\hat{\alpha}_F, \alpha_{\min}]$ formal loans are infeasible and the claim follows trivially.

Proposition 4 (Intermediate-risk loans)**.** *Suppose $\alpha_{\min} < \hat{\alpha}_F$ and consider loan-to-wealth ratios $\frac{\theta}{w} \in (\alpha_{\min}, \min\{\hat{\alpha}_I, \hat{\alpha}_F\}]$, borrowers optimally use informal credit for lower values of the loan-to-wealth ratio and formal credit otherwise. Default occurs with positive probability in equilibrium.*

Proof: By Proposition 2, r_F^* solves (4) while we have $r_I^* = \theta$ from Proposition 1. For such $\frac{\theta}{w}$ we have $G(\frac{\theta}{w}) \in (0, 1)$ and $\gamma > \theta$. The borrower's expected utility from using informal credit is

$$U_I = (pR - 1)\theta - (1 - p)G(\frac{\theta}{w})(\gamma - \theta)$$

which she would compare to the expected utility from using formal credit. The optimal loan source choice now depends on the parameter values. Recall from the previous discussion that: (i) $U_I > U_F$ at $\theta/w = \alpha_{\min}$, (ii) $U_I = 0$ at $\theta/w = \hat{\alpha}_I(w)$, and (iii) $U_F > 0$ always. Thus, informal loans are preferred for relatively small θ/w ratios while formal loans are chosen for larger θ/w ratios in the assumed LTW ratio range. Also note that the case where $\alpha_{\min} \geq \hat{\alpha}_F$ is contained in Proposition 3.

Proposition 5 (High-risk loans)**.** *Consider loan-to-wealth ratios in the range $\min\{\hat{\alpha}_I(w), \hat{\alpha}_F(w)\} < \frac{\theta}{w} \leq \max\{\hat{\alpha}_I(w), \hat{\alpha}_F(w)\}$. If $\hat{\alpha}_I(w) > \hat{\alpha}_F(w)$ then borrowers use informal credit since formal credit is not available. Otherwise, if $\hat{\alpha}_I(w) \leq \hat{\alpha}_F(w)$, borrowers optimally use formal credit. In both cases default occurs with positive probability in equilibrium. Borrowers with $\frac{\theta}{w} > \max\{\hat{\alpha}_I(w), \hat{\alpha}_F(w)\}$ would not or cannot borrow from any source – either the cost of social collateral is too high or the lender cannot break even.*

Proof: The results follow directly from the previous propositions.

Empirical Implications

Our model has a number of implications about the equilibrium choice between formal and informal credit, several of which we are able to investigate empirically using data on Thai rural households available to us. Naturally, not all model parameters and variables are present in the data – for example, finding a proxy for the parameter α describing the riskiness in the value of borrowers' collateralizable wealth is difficult. To derive properties of the model that can be linked to our dataset on household finances in Thailand, we concentrate on variables for which we have corresponding data, namely the loan size θ, the collateral requirement c, the net interest rate r/θ, and the loan-to-wealth ratio θ/w.

The first conclusion that emerges from the model is that the likelihood of observing formal loans should, on average, increase in loan size θ, holding other variables constant. On the one hand, this

is a straightforward implication of the fact that friends and family do not have unlimited funds, i.e., informal loans larger than $\bar{\theta}$ cannot be extended. One might imagine that borrowers can tap into multiple informal sources if their credit requirements exceed $\bar{\theta}$. But adding such loans will increase the risk of equilibrium default, which in turn implies a costly loss of social capital. The main point to take home is that if borrowers default, they would much rather default with a formal lender such as a bank than with an informal lender such as their friends and family. In addition, from Propositions 4 and 5 we know that, when both loan sources are available for given w, formal credit is used for larger loans.

The second implication of the model concerns the loan-to-wealth (LTW) ratio $\frac{\theta}{w}$. For low LTW values, the model unambiguously predicts informal credit. As the LTW ratio grows, borrowers switch to formal credit despite the fact that it has less favourable terms (higher interest rate and positive collateral) since the friendship value lost in case of default is larger than the collateral cost. Defaulting with banks is preferable to defaulting with friends because physical collateral is divisible while social capital is not. As the LTW ratio grows further, Proposition 5 shows that one of two situations can occur. Either, formal credit is still available, and thus preferred for the just mentioned reason, or formal credit becomes unavailable. In this latter case, informal credit is used again (as long as $\theta \leq \bar{\theta}$) since the required collateral to guarantee such high-LTW loans is too high for formal loans to be extended. In sum, the model predicts that either a) the desirability of informal loans is strictly decreasing in the LTW ratio everywhere, or that b) the relationship is U-shaped: informal loans become less attractive as the LTW ratio grows initially, but will be more prominent again for higher values of the LTW ratio.

4 Empirical Analysis

4.1 Data Description

We test the empirical predictions of our model with data on rural households in Thailand. The data source is a socio-economic survey of 2880 Thai households conducted in 1997 by the Townsend Thai Project to gather information on the existence and use of informal and formal financial mechanisms and institutions.[15] The sample comes from four provinces located in two distinct regions of Thailand – the more developed Central region located near Bangkok, and the poorer, semi-arid Northeast region (see Figure 1). The dataset provides a wealth of socioeconomic and financial variables, including current and retrospective information on wealth, occupational history, household demographics, entrepreneurial activities, and education. Most importantly for our purposes, the data provide unique detailed information the usage of a variety of formal and informal financial institutions such as commercial banks, agricultural banks, village lending institutions, moneylenders, as well as friends, family, and business associates.

Households were asked detailed questions about their borrowing and lending activities such as their

[15]The survey was fielded in May, prior to the economic/financial crisis which began with the devaluation of the Thai baht in July 1997. For further details, including sample selection and the administration of the survey see the Townsend Thai Project website http://cier.uchicago.edu/about/.

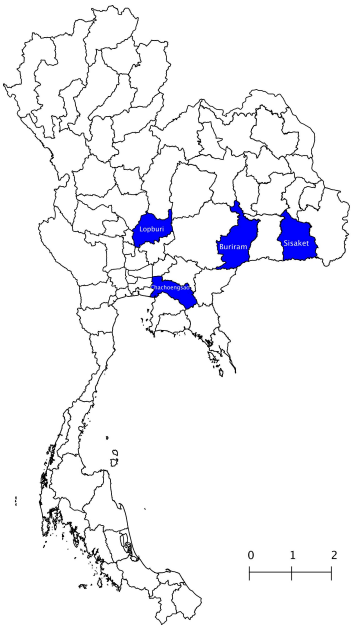

Figure 1: Thailand

total number of outstanding loans, the value of each loan, the date it was taken, the length of the loan period, the reason why the money was borrowed, and whom it was borrowed from. The latter category contains a range of possible answers: a neighbor, a relative, the Bank for Agriculture and Agricultural Cooperatives (BAAC), a commercial bank, an agricultural cooperative, a village fund, a moneylender, a store owner or other business, a landlord, or other. Table 1 breaks down the loan sources into the respective categories. We see that borrowing from neighbors and family comprises about 25% of all loans in the sample. Borrowing from commercial banks, in contrast, is relatively rare (3% of all loans), reflecting the fact that a large fraction of households in this rural sample do not have access to commercial banks. Instead, they more often resort to moneylenders or the Bank for Agriculture and Agricultural Cooperatives (BAAC). The BAAC is a state-owned bank which was created to provide loans primarily for "agricultural infrastructure" (Ministry of Finance, Thailand, 2008). While most of the loans it gives are to individuals, the latter are often organized in borrowing groups with a joint liability clause. The interest rates of BAAC loans are usually about 1% to 2 % lower than those of commercial banks. Since the BAAC is a hybrid institution in terms of our model – it charges interest and often requires collateral but may use informal relations to secure repayment – we will largely exclude those loans from the analysis below, focusing on commercial bank loans

Table 1: Loan Source

Source	Freq.	Percent
neighbor	272	7.94
relative	552	16.11
BAAC	1,185	34.58
Commercial Bank	106	3.09
Agricultural Cooperative	347	10.13
Village Fund	32	0.93
moneylender	338	9.86
store owner	141	4.11
other	454	13.25
Total	3,427	100.00

[a] **Note:** Category "Other" includes the following possible answers: Rice Bank, Landlord, Purchaser of Output, Supplier of Input, as well as the answer "other" (the latter has 344 observations). Some households hold multiple loans.

and moneylender credit versus loans from relatives and neighbours. We perform robustness checks including BAAC loans in Section 4.3.

Given the above, we define 'formal' credit as loans from commercial banks or moneylenders and 'informal' credit as loans from neighbours or relatives. While moneylenders may arguably be considered 'informal' lenders, what matters for our theory is not formality in terms of registration or regulation but whether or not personal/social ties are employed to secure the loan. In that sense, we group moneylenders along with commercial banks. We drop the remaining households. We do consider robustness checks to our definitions of formal and informal credit in Section 4.3 below.

Summary statistics of the data are provided in Table 2. The categorical variable 'salary' indicates whether the household draws a regular monthly or weekly income or works for the government. The binary variable 'tenure' equals one if the household has resided in the village for more than six years and zero otherwise. The variable 'bank' is an indicator variable that is set to one if the household was a customer of a commercial bank. All other variables listed in the Table are self-explanatory. As a reference, note that the average annual income in Thailand in 1996 was 105,125 baht, or roughly $4,200 (Paulson and Townsend, 2004).

Motivated by our theoretical findings, we investigate empirically the relationship between the loan source and two main explanatory variables: household wealth and loan size. Before doing so, however, it is instructive to look at two other important loan characteristics about which our model also makes predictions: collateral requirements and interests rates. Although the survey did not directly ask about loan interest rates, we were able to compute those from the data by using the length of the loan period, the total required repayment value, and the initial loan size. Figure 2 a) shows the mean and median loan interest rates and ratios of collateral to loan size ('collateral ratio') for the four different

Table 2: Summary Statistics

Variable	Obs.	Median	Mean	St. Dev	Min	Max	Units
yearly household income	1,441	60.50	158.84	579.24	0.00	15,710.00	1,000 baht
wealth (assets)	1,444	488.55	1,027.78	1,810.86	9.00	21,166.30	1,000 baht
loan-to-wealth ratio (LTW)	1,444	0.04	0.08	0.16	0.00	3.54	
number of outstanding loans	1303	1	1.54	0.94	0.00	6	indicator variable
value of outstanding loans	1451	30	72.07	179.21	0.27	3,220	1,000 baht
age	1426	47	48.95	12.72	19	101	years
education	1426	3	3.44	1.81	1	11	categorical variable
gender (1=female)	1426	0	0.15	0.35	0	1	indicator variable
marital status (1=married)	1441	1	0.48	0.37	0	1	
collateral (1=yes)	1,449	1.00	0.63	0.48	0.00	1.00	indicator variable
interest	1,274	0.10	0.28	1.76	0.00	48.32	percent/100
salary (1=yes)	1,319	0.00	0.18	0.38	0.00	1.00	indicator variable
tenure (1 = yes)	1,437	1.00	0.95	0.22	0.00	1.00	indicator variable
bank access (1=yes)	1,450	0.00	0.27	0.44	0.00	1.00	indicator variable

[a] **Note:** Observational units are households. Any personal demographics refer to the household head. A household's wealth was computed by adding up the (self-reported) value of all assets of the household as given in the data, including house and land holdings, durable assets (TV, car, etc.), agricultural assets (tractor, seeds), fishing assets (boat), animals, and business assets.

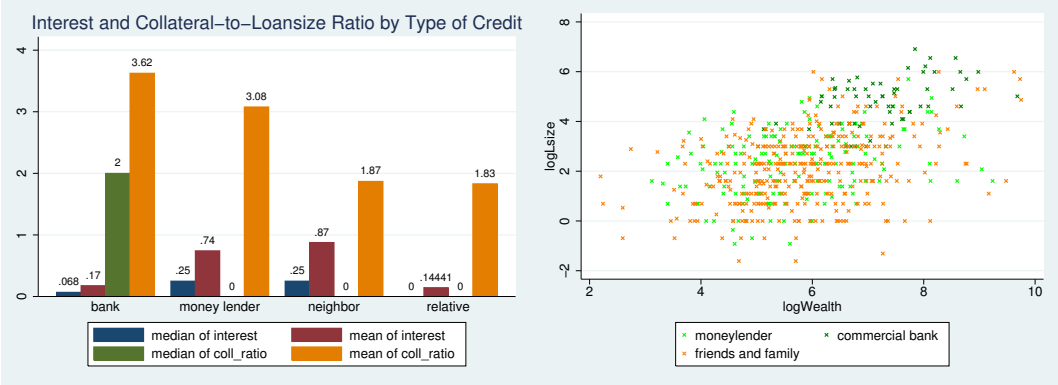

Figure 2: InterestRates and Collateral (a) and Size of Loan and Wealth (b) by type of credit

loan sources we use: commercial banks, moneylenders, neighbours, and relatives. Consistent with our model, we see that informal credit (loans from relatives or neighbors) is significantly cheaper than formal credit (loans from commercial banks or moneylenders): the median interest rate for loans from relatives is zero which is considerably lower than the median commercial bank loan interest rate (7%) or the median moneylender rate (25%). In addition, the majority of neighbours and relatives require no explicit collateral, presumably using in its place the social capital from personal ties.

The fact that informal credit is considerably cheaper than borrowing from a bank or a moneylender does not mean, however, that formal credit is non-existent. Figure 2 b) illustrates that while informal loans can be found over the entire range of observed wealth, moneylender credit is also widespread. At the same time, only relatively wealthy households borrow from commercial banks. A likely explanation is that access to banks is limited in poor remote villages, and that commercial banks require more collateral than moneylenders, which is a serious constraint for poorer households. The question remains, though, why we observe formal credit at all. Certainly, one important reason is that funds available from neighbors/friends and relatives are more limited *a priori* than funds available through a commercial bank. However, we see from Figure 2 b) that there are some very large informal loans obtained by relatively wealthy households.

The relation between the loan source (formal vs. informal) and the main indicator of how secure is the loan, the loan size-to-wealth ratio (LTW), is non-monotone, as Figure 3 shows. For smaller LTW ratios households primarily resort to informal credit. As loan size rises relative to household wealth, formal credit becomes more prominent. For very high LTW ratios, however, the negative relationship between the prevalence of informal credit and the LTW ratio is reversed – more informal credit occurs. Note that the observed U-shaped relationship between the loan source and the LTW ratio is supportive of our theory – see Propositions 3-5. As we show below, the relationship is also preserved once we control for other important observables.

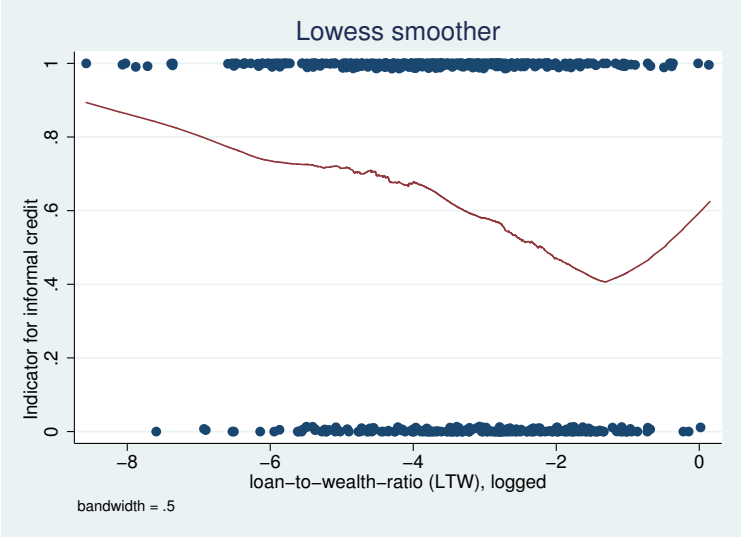

Figure 3: LTW ratio and type of credit

4.2 Results

We now formally investigate the link between the chosen loan source (formal versus informal), loan characteristics, and household characteristics. In doing so, we largely assume that the size of loan is exogenously determined by the needs of the household.[16] In our baseline specification the dependent variable is the choice of loan source, and the main regressors of interest are log loan size, $Lsize$ and the logged loan-to-wealth ratio, LTW

$$y_{kij} = \delta_j + \gamma Lsize_{ki} + \sigma LTW_{ki} + \beta X_i + u_{kij},$$

where i refers to the household, j refers to the region, and k to the loan (one household can have several loans). The dependent variable $y_{kij} \in \{0, 1\}$ equals one if the creditor was 'informal', i.e., a neighbor or a relative, and zero if the creditor was 'formal', i.e., a commercial bank or a moneylender. For reasons explained above, BAAC loans are excluded from both loan source categories.[17] Altogether, formal credit constitutes 36 percent of the sample used in the regressions. The vector X_i is a list of observable household characteristics and δ_j are regional dummies. Estimation is done by probit and the results are reported in Table 3.

[16] This is obviously a strong assumption, but may be justified if most loans are taken for a specific purpose as the data seem to indicate. Another related issue is that some households may borrow from several sources to finance a single investment project (Kaboski and Townsend, 2000). In the data, we observe the calendar dates at which each household took out any given loan, as well as rough categories regarding the reported purpose of the loan. If we count loans that are taken for the same purpose within an year of each other as potentially being part of a larger loan that was split up (e.g., due to cash constraints on the lenders' side or due to the required collateral), we arrive at a fraction of roughly 17% of all informal credit loans and only 0.2 % of all formal credit loans. We deal with the possibility that the loan size is endogenous in the robustness section below.

[17] See Section 4.3 on the robustness of our results with regard to the coding of the dependent variable.

Table 3: Probit Regressions for Loan Source

dependent variable	loan source (informal=1)			
independent variable	(1)	(2)	(3)	(4)
loan size	-0.24***	-0.23***	-0.28***	-0.27***
	(0.071)	(0.066)	(0.053)	(0.057)
LTW ratio	-0.09*	-0.10**	-0.07**	
	(0.052)	(0.045)	(0.031)	
business owner		-0.02	0.01	0.02
		(0.034)	(0.037)	(0.037)
farmer		-0.00	-0.01	-0.01
		(0.058)	(0.062)	(0.061)
tenure		-0.32	-0.31	-0.30
		(0.208)	(0.250)	(0.240)
salary		0.01	-0.00	-0.00
		(0.131)	(0.145)	(0.146)
Bank access			-0.16*	-0.15*
			(0.084)	(0.085)
BAAC member			-0.02	-0.03
			(0.090)	(0.093)
household income			0.15***	0.15***
			(0.041)	(0.041)
LTW ratio 1st quintile				-0.02
				(0.030)
LTW ratio 2nd quintile				-0.03**
				(0.016)
LTW ratio 3rd quintile				-0.00
				(0.029)
LTW ratio 4th quintile				0.01
				(0.036)
LTW ratio 5th quintile				0.12***
				(0.020)
Observations	1,234	1,233	1,232	1,232
pseudo R^2	0.11	0.12	0.12	0.12

[a] **Note:** Dependent variable is Lsource, which equals 1 if the source is a neighbour or relative, and 0 if the source is a commercial bank or moneylender. With the exception of indicator variables, all independent variables are in log form. The regressions include regional fixed effects and control for age, gender, marital status and education of the household head. The standard errors reported in parentheses are heteroskedasticity–robust, and clustered at the regional level. Superscripts ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

Our baseline regression, column (1) in Table 3, is the most parsimonious specification. It only includes basic demographic characteristics of the household head, such as gender, education, marital status,

and age.[18] The estimates reveal that the incidence of informal loans is significantly lower, the larger the loan size, *ceteris paribus*. At the same time, significantly fewer informal loans are also taken out as the loan-to-wealth ratio increases, controlling for loan size. The magnitude of these effects is significant: comparing the smallest loan in our sample with the largest loan, we estimate that the latter is over 70 percent less likely to be from an informal source, evaluating the other regressors at their average values. Similarly, comparing the household loan with the smallest LTW ratio to the one with the largest LTW ratio in our sample, the estimated coefficient suggests that the latter is over 17 percent less likely to originate from a neighbour or relative.

Column (2) in Table 3 adds four additional indicator variables, namely whether or not the household head is a business owner, farmer, whether (s)he has lived in the village longer than 6 years, and whether (s)he draws a regular salary. Although those co-variates are potentially important in determining the extent of interpersonal credit, we see that none adds much explanatory value; the coefficient estimates of all other variables remain largely unchanged. In column (3), we include three additional important variables. We add a dummy variable for BAAC access and another indicator on whether or not a member of the household is a customer of a commercial bank (note that having access to the BAAC or a commercial bank, however, does not imply that the household has a loan with any of these institutions). In rural areas, access to commercial banks is often severely restricted and travel times to the nearest bank branch may be prohibitive. The third added variable is household income. Clearly, these factors could affect the selection of type of credit and since they are highly correlated with wealth with loan size and borrower's wealth, could potentially bias the previously estimated coefficients. As before, however, the coefficients on both loan size and loan-to-wealth ratio remain largely unaffected and statistically significant. We also see that direct access to a commercial bank increases the probability of formal loans, as expected. For households with access to a commercial bank, the estimated effect translates into a reduced likelihood of observing informal credit of 5 percentage points. Somewhat less obvious is the observed strong positive relation between household income and informal credit. There are two possible explanations. First, households with higher incomes are likely to socialize with people of similar income groups, implying that the upper bound on the available funds from informal lenders ($\bar{\theta}$ in our model) likely increases in one's income. Alternatively, one could imagine that income may serve as a form of guarantee against default, which is more important for informal loans for the reasons explained in the theory section. In this view, the *desirability* (as opposed to the feasibility) of informal loans increases in a household's income, since the probability of not being able to repay the loan and lose the social collateral decreases. This effect is quantitatively significant: increasing one's income from the smallest to the largest value in the dataset would increase the likelihood of an informal loan by roughly 40 percent, evaluating all other controls at their means.

The last column (4) investigates the possibility of a non-linear effect of the LTW ratio. Specifically, we split the observed LTW ratios into five quintiles and allow for a different slope coefficient for each LTW ratio interval. The results are illuminating, and replicate the pattern in the raw data that we already identified in Figure 3. For small and medium-sized LTW ratios, the incidence of informal loans declines with the loan-to-wealth ratio, although not all estimates are statistically significant. In the highest

[18] With the exception of age, none of these variables has a statically significant effect on formal versus informal loan choice and are therefore suppressed in the reported output for brevity of exposition. Complete details are available from the authors upon request.

LTW ratio quintile, the estimated effect turns positive and highly statistically significant. This finding is consistent with our model's implication that for loans that are very large relative to the household's assets, formal credit may be no longer available (due to insufficient collateral) while informal credit remains available. Indeed, the pattern of coefficients is suggestive of an U-shaped relationship between the LTW ratio and the incidence of informal credit, which is consistent with the results in Propositions 3-5: as loans become *more risky* as proxied by their LTW ratio, households *switch to formal credit* whenever it is available because physical collateral as opposed to social collateral is divisible and can be adjusted to meet the loan requirement. Only for very risky loans, with high LTW ratios, where formal lenders no longer extent loans as they cannot break even, do household revert *back to informal loans*. Note also that the estimated negative relationship between loan source and loan size is not affected when we allow for non-linear effect of the LTW ratio.

4.3 Robustness

4.3.1 Selection issues

One important issue in our identification strategy that we have neglected so far is that we may not observe the loan choice related characteristics of households in our sample who decide not to take out a loan. It is easy to imagine that households who have an outstanding loan have higher credit needs or may be more trustworthy than those who do not have a loan. If the propensity to take out a loan is correlated with unobserved characteristics that are also important in determining the type of credit selected, the estimated coefficients will tend to be biased since selection into our sample could be correlated with the error term. To correct for this potential bias, we use a Heckman sample selection correction for probit models. Heckman's (1979) insight was that sample selection can be viewed as a form of omitted-variables bias, that can be corrected for using a two-stage procedure.[19] In the first stage, we estimate a 'selection equation' as probit regression of the form

$$s_{ij} = \delta_j + \alpha Z_i + e_{ij}, D_{ij} = 1 \Leftrightarrow s_{ij} \geq \bar{s}$$

where s^*_{ij} is the propensity to be included in the sample, $D_{ij} = 1$ if the household took out a loan and zero otherwise, Z_i is a vector of observable household characteristics, and e_{ij} is the error term. In the second stage, we can then correct for self-selection by incorporating a transformation of the predicted individual probabilities as an additional explanatory variable in the equation The estimated model is

$$Pr\left\{y_{kij} = 1 | D_{ij} = 1\right\} = \delta_j + \gamma Lsize_{ki} + \sigma LTW_{ki} + \beta X_i + \beta_\lambda \lambda(\alpha Z_i + \delta_j) + u_{kij}.$$

where $\lambda(\cdot)$ is the inverse Mills ratio, evaluated at $\alpha Z_i + \delta_j$.

The results, reported in Table 4, are encouraging. The estimated coefficients on the main variables of interest remain similar in magnitude and significance to those reported in Table 3. In addition, the estimate of ρ, the correlation between the error terms in the regression equation and the selection equation, suggests a relatively weak relationship, and the corresponding Wald test is not statistically

[19] We use a special application of Heckman's sample selection model in which the second stage equation is also probit. The corresponding STATA command is 'heckprob'.

Table 4: Heckman Correction Probit Regressions for Loan Source

dependent variable independent variable	loan source (1)	selection (1')	loan source (2)	selection (2')	loan source (3)	selection (3')
loan size	-0.24***		-0.29***		-0.28***	
	(0.067)		(0.056)		(0.057)	
LTW ratio	-0.10***		-0.06***			
	(0.045)		(0.020)			
bank access		0.11	-0.17*	0.11	-0.17*	0.11
		(0.127)	(0.100)	(0.135)	(0.100)	(0.136)
BAAC member		0.65***	0.11	0.65***	0.12	0.65***
		(0.135)	(0.128)	(0.136)	(0.139)	(0.136)
HH income		0.20***	0.17***	0.20***	0.16***	0.20***
		(0.043)	(0.041)	(0.041)	(0.042)	(0.040)
LTW ratio 1st quintile					-0.01	
					(0.024)	
LTW ratio 2nd quintile					-0.02**	
					(0.009)	
LTW ratio 3rd quintile					0.02	
					(0.032)	
LTW ratio 4th quintile					0.02	
					(0.033)	
LTW ratio 5th quintile					0.14***	
					(0.024)	
savings		-0.20***		-0.20***		-0.20***
		(0.030)		(0.031)		(0.031)
credit constr.		0.26***		0.26**		0.25**
		(0.098)		(0.104)		(0.106)
Observations	1229	866	1229	866	1229	866
correlation of error terms ρ		-0.30		0.30		0.31
		(0.306)		(0.306)		(0.322)
Wald test p -value		0.352		0.354		0.337

[a] **Note:** Dependent variable is Lsource, which equals 1 if the source is informal and 0 otherwise. With the exception of the indicator variables, all independent variables are in log form. Both the loan source and the selection regressions include regional fixed effects and control for age, gender, marital status and education of the household head. The co-variates business owner, tenure, and salary have been dropped as they were statistically insignificant, as before. The standard errors reported in parentheses are clustered at the regional level. Superscripts ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

significant, suggesting that sample selection bias does not pose a significant problem for the validity of our estimates. Moreover, the estimates of the coefficients in the selection equation (Table 4, columns 1', 2' and 3') have the expected sign. Namely, controlling for other household characteristics, the propensity to take out a loan increases in income and decreases in the amount of accumulated savings. The indicator variable 'credit constrained' equals 1 if the respondent answered "yes" to the question

whether additional funds would be useful to increase the profitability of the family business or farm. As one would expect, the corresponding coefficient is positive, i.e., households who state that expanding the economic basis of their livelihood would be profitable are more likely to borrow funds than those who do not.

4.3.2 Alternative definitions of formal and informal credit

We next examine the sensitivity of our results to alternative definitions of formal versus informal loans. As explained above, we have so far excluded all village-level organizations such as production credit groups (PCGs), rice or buffalo banks, village poor and elderly funds, as well as prominent agricultural lending institutions such as the Bank for Agriculture and Agricultural Cooperatives (BAAC) and agricultural cooperatives. The latter two in particular are very common and make up for almost 45 percent of all observed loans. At the outset, one could think of those institutions as formal; indeed, roughly 85 percent of BAAC loans and almost 95 percent of Agricultural cooperative loans require collateral and virtually all carry a positive interest rate. For the village-based organizations these numbers are somewhat lower. While PCG loans require collateral in roughly 60% of all cases, the corresponding number of village fund and rice bank loans is only 30%. At the same time, however, loans from all these institutions often rely on group-liability or community monitoring for enforcement and thus could be viewed as being secured by social (rather than physical) capital. About 50 percent of BAAC loans, for example, are reported to be collateralized by multiple guarantors. As such, they bear more resemblance to informal loans, as we defined them in the theory section.

To investigate how sensitive our results are to changes in the definitions of formal vs. informal loans, we re-ran our main specification using alternative categorizations of informal and formal credit. Table 5 reports the corresponding estimates. All regressions are identical in specification to our final regression in Section 4.2 which includes all co-variates [column (3) in Table 3]. The first column (1) in Table 5 replicates the estimated coefficients of that original regression. For brevity we only report the estimates of the main coefficients of interest, namely loan size and the LTW ratio. In the second column (2), we augment our original measure of formal credit by also classifying all loans from agricultural organizations (the BAAC and agricultural co-operatives) or from village-level institutions as formal. This is the broadest definition of formal credit we consider. In the column (3), we take the opposite view and instead classify all such loans as informal; which dramatically broadens our definition of informal credit.

The results in Table 5 are instructive and show that the coding of formal versus informal credit matters. Although the signs of all coefficients remain unchanged relative to the original specification, the estimated coefficient on the LTW ratio in Table 5, column (2), with formal credit the most broadly defined, is significantly reduced in magnitude and no longer significant. The reverse is true for the specification in column (3), with informal credit the most broadly defined, where the estimated LTW ratio influence increases relative to the original specification and is highly significant. We see that the measured effect of loan size remain similar to the baseline value (-0.28) for specification (2) but drops to -0.09 in column (3). Taking our theoretical model at face value, these estimates suggest that village-level and agricultural lending organizations are more akin to informal than to formal credit

sources. As explained above, although those loans frequently require collateral, the borrower is *not* required to collateralize the loan with his or her own physical capital in the majority of cases. As a result, borrowers behave *as if* those loans were informal: as the loan-to-wealth ratio increases and the possibility of default on the loan becomes more likely from the borrower's point of view, the borrower is *less likely* to rely on those institutions and *more likely* to resort to formal sources that do not rely on social capital holding loan size constant. Our theory also provides an explanation for why the estimated effect of loan size is less prominent if village-level and agricultural institutions are classified as informal credit rather than formal credit (compare columns (2) and (3) in Table 5). Those institutions presumably have more available loanable funds than neighbours and relatives. In the terminology of the model, the upper bound on the lender's resources $\bar{\theta}$ should thus be binding less often once those organizations are included among the informal loan sources.

Table 5: Alternative classification of formal and informal credit

dependent variable	loan source	alt. loan source 1	alt. loan source 2	alt loan source 3
independent variable	(1)	(2)	(3)	(4)
loan size	-0.28***	-0.34**	-0.09**	-0.95***
	0.053	(0.034)	(0.041)	(0.124)
LTW ratio	-0.07**	-0.01	-0.09***	0.08
	(0.031)	(0.013)	(0.010)	(0.133)
Observations	1232	2,479	2,818	906
pseudo R^2	0.11	.25	.10	.59

[a] **Note:** Dependent variable is the source of the loan which equals 1 if the source is informal, and 0 otherwise (see the main text for the categorization in different samples). All regressions include regional fixed effects, household demographics, and the co-variates specified in the main regression (3) in Section 4.2. The standard errors reported in parentheses are clustered at the regional level. Superscripts ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

The final column (4) in Table 5 reports results when we define formal credit very narrowly as only loans extended by commercial banks. We see that the coefficient estimate on loan size more than triples compared to our baseline in column (1). The effect of the loan-to-wealth ratio, however, is no longer negative and not statistically significant. As before, the underlying relationship between loan source choice and the LTW ratio appears to be non-linear but one problem with this last specification is that if formal credit is defined so narrowly, the number of observations for that category drops dramatically.[20] From the 906 observations used in column (4), only 104 are instances of formal credit which reduces the precision of the estimates.

4.3.3 Endogenous loan size

Finally, we address the potential issue of endogeneity in the loan size. If informal lenders have limited available funds (as we hypothesize) and if the credit needs of a household exceed those funds, then one

[20] Allowing for the slope of the LTW ratio effect to vary as in column (4) of Table 3 results in a pattern that shows a negative coefficient for smaller values of the ratio. Adding a quadratic term also results in a negative estimate. However, these estimates are noisy and we therefore do not report them here. They are available upon request.

alternative to taking out a more expensive formal sector loan is to split up the needed amount into several smaller loans using multiple loan sources and personal relations to arrive at the desired sum. If this is a widespread practice, then the causality from loan size to the choice of credit source would be reversed: rather than choosing to rely less often on informal sources for larger loans, households would endogenously choose smaller loans once they have decided not to enter the formal credit market. Note that this possibility does not a priori invalidate our theory – allowing households to split up larger loans in the model would not alter our conclusions qualitatively, other than increasing the range for which informal credit is feasible (the upper limit $\bar{\theta}$). For the empirical analysis, however, the assumed exogeneity of loan size is important, since otherwise the estimated coefficients on both explanatory variables of interest, loan size and the loan-to-wealth ratio will be biased.

Fortunately, the survey contained a question which allows us to address the above concern by using an exogenous proxy for loan size. Households were told to imagine a hypothetical situation in which they needed funds for an emergency situation. Among the questions asked was how they would get the needed amount. The possible answers included selling assets (land, equipment, livestock, car, etc.); using savings; or taking out a loan, where the source of the loan had to be specified. The same questions were posed for two different hypothetical loan amounts, 2,000 Baht and 20,000 Baht. Neither amount is particularly high (both are below the median loan size in the data) but, since everyone was confronted with the same figures, the hypothetical loan amount is clearly exogenous and orthogonal to any observed and unobserved household characteristics. If we reasonably assume that households answered the hypothetical question in a way that corresponds to their behaviour had they actually faced the same situation in real life, we can employ an indicator variable for the two hypothetical loan sizes as a regressor and the corresponding answer as the outcome variable. The results are reported in Table 6. For brevity of exposition, the table only reports the estimated coefficients for our main explanatory variable of interests, loan size and the LTW ratio. All regressions include the full set of covariates as well as regional fixed effects (for the random effects model).

We see that our baseline findings continue to hold: even in a model with household fixed effects, an exogenous increase in the loan size has a statistically significantly negative effect on the likelihood that the household would turn to a neighbor or relative for credit. Similarly, in the random effects model, the probability that a household reports relatives or neighbours as the preferred loan source decreases in the loan-to-wealth ratio as in the baseline results in Table 3. Holding loan size constant, households with less wealth are thus *less likely* (not more likely, as one may think at first), to report that they would ask neighbours and family members for a loan, rather than go to a bank or a moneylender. Our theory provides a possible answer: low-wealth households prefer formal to informal credit because they cannot eliminate the relatively high risk of not being able to pay back the loan. Default in informal loans is (more) costly because the social capital is indivisible.

5 Conclusion

We model borrowers' optimal choice between formal (collateral-based) and informal (relationship-based) credit in a setting with imperfect enforcement, risk, and strategic default. Our model delivers

Table 6: Exogenous Loan Size Regressions

dependent variable	loan source (informal =1)			
estimation method	fixed effects	fixed effects logit	random effects GLS	random effects logit
independent variable	(1)	(2)	(3)	(4)
loan size	-0.007***	-0.069***	-0.01***	-0.05***
	(0.0008)	(0.011)	(0.009)	(0.013)
LTW ratio			-0.017**	-0.018**
			(0.009)	(0.087)
Observations	2,830	388	2,764	2,764
Number of HH's	1,987	194	1,940	1,940
R-squared (within)	0.071		0.088	

[a] **Note:** Dependent variable is Lsource, which equals 1 if the household answered that it would obtain the loan from a friend or relative, and 0 if the answer was a commercial bank or a moneylender. Independent variables are in log scale. In specification (2), 1793 households were dropped because their answers did not vary with the size of the loan. The standard errors reported in parentheses are heteroskedasticity–robust, and clustered at the regional level. Superscripts ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

several testable predictions which we show are consistent with data from rural Thai households. First, informal lenders charge zero interest rate and do not require physical collateral. Second, the likelihood of observing informal loans decreases with the loan size. Third, the prevalence of informal loans either monotonically decreases or has a U-shaped relationship with the ratio of loan size to borrower's wealth which in our model also proxies for the risk of default.

We study informal loans between agents who are in a relationship with a sufficiently high and indivisible utility value which is lost to both parties in case of default. This is key for supporting repayment and the absence of strategic default at zero collateral and interest rate in informal loans. Relaxing the indivisibility in losing the friendship value (e.g., allowing for 'forgiveness') or relaxing the reciprocity in the loss would make informal contracts look more like formal ones. In contrast, formal loans can only be supported by posting (divisible) physical collateral which does not eliminate the possibility of strategic default and hence results in a positive interest rate. The assumptions on the social collateral make our model better applicable in more traditional, rural, or immigrant-group settings where the value of maintaining interpersonal links is high. This is consistent with the prevalence of informal credit in such settings observed in the data as reviewed in the introduction.

In addition to the optimal choice between formal and informal credit for a project of given size and return, our model has indirect implications for the type of project that is likely to be financed via formal or informal loan. Importantly, if formal credit is not available, the utility loss from default may have negative consequences for the type of projects that are financed: although we do not model the entrepreneurs' choice of investment project explicitly, it is possible to extend the model and show that projects based on informal credit involve less risk taking than they would be in the absence of credit market imperfections. As a result, households or regions primarily relying on informal credit may experiences limited business growth.

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6 Appendix

Proof of Lemma 1:

Call $g \equiv G(\frac{r_I}{w})$ and $d \equiv \lambda \int_{\alpha_{\min}}^{r_I/w} \min\{c_F, \alpha w\} dG(\alpha)$. Then ($\text{PC}_L$) can be written as:

$$[p + (1-p)(1-g)]r_I + (1-p)d - \theta \geq \gamma[(1-p)g - 1] \tag{5}$$

Given (NN) we have $r_I \geq \theta$ and $d \geq 0$ and thus the left hand side of (5) is larger or equal to $\theta[p+(1-p)(1-g)-1] = -g(1-p)\theta$. The latter is larger or equal to $\theta[(1-p)g-1]$ as long as $1 \geq 2g(1-p)$ which holds by Assumption A1(ii) and since $g \leq 1$. We also have that $\theta[(1-p)g-1] > \gamma[(1-p)g-1]$, which is the right hand side of (5), since $(1-p)g < 1$ and since $\gamma \geq \theta$ for all $\theta \leq \bar{\theta}$ by Assumption A2. This implies that under our assumptions the lender's participation constraint (PC_L) is always satisfied for any r_I, c_I that satisfy (NN).■

Lemma A1: *$G'' \leq 0$ is a sufficient condition for uniqueness of the threshold $\hat{\alpha}_I(w)$ in Proposition 1.*

Proof: The first derivative of the left hand side of (1) (multiplied by w) with respect to θ is,

$$pR - 1 + (1-p)G(\theta/w) + (1-p)G'(\theta/w)\frac{1}{w}(\theta - \gamma)$$

which cannot be signed in general. The second derivative has the same sign as

$$2G' + G''\frac{1}{w}(\theta - \gamma)$$

If $G'' \leq 0$ (the cdf G is weakly concave) the above expression is positive since $\gamma > \theta$ for all $\theta \in [0, \bar{\theta}]$ by Assumption A2. That is, the left hand side of (1), call it $\Phi(\theta)$, is a strictly convex function of θ over the interval $[\alpha_{\min} w, w]$. This implies that $\Phi(\theta)$ can cross the horizontal axis exactly once since it is continuous and since $\Phi(\alpha_{\min} w) > 0$ while $\Phi(w) < 0$ (draw a graph to see that). So if $G'' \leq 0$ the threshold $\hat{\alpha}_I(w)$, defined as the $\alpha = \hat{\theta}/w \in (\alpha_{\min}, 1)$ such that $\Phi(\hat{\theta}) = 0$, is unique.■