(Dis)Advantages of Informal Loans – Theory and Evidence*

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Abstract

We study borrowers' choice between formal and informal credit in a setting with imperfect debt enforcement. In contrast to formal loans (e.g., from banks), informal loans (e.g., from friends or relatives) can be enforced by the threat of severing social ties. If the underlying social capital is sufficiently large, we show that informal loans carry lower interest rate and collateral than formal loans, including the possibility of zero interest and collateral. This makes informal credit *a priori* more attractive to borrowers. At the same time, since physical collateral is divisible unlike the social capital pledged in informal credit, default on formal loans is less costly to both parties than default on informal loans. Because of this trade-off, formal and informal credit can co-exist depending on the loan riskiness measured by the ratio of loan size to borrower's wealth (LTW ratio). Borrowers choose formal credit for riskier (larger) loans while informal credit is preferred for (smaller) projects with low default risk. Empirical results using household data from rural Thailand are consistent with the predicted choice pattern and terms of formal and informal credit.

Keywords: informal credit; family loans; social capital; limited enforcement; default risk
JEL Classification: D14, G21, O16, O17

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1 Introduction

Informal loans from family, friends or neighbours are widespread among households and small businesses in developing countries.[1] A common explanation is that informal credit offers information or enforcement advantages that mitigate market imperfections originating from moral hazard, adverse selection or limited commitment. In addition, inability to post collateral and high access costs due to lack of credit history, financial illiteracy, insecure property titles or inefficient courts cause many poor people to be rationed out of formal credit[2] leaving interpersonal loans based on social ties as their only option.[3]

In this paper we use the term *informal credit* to refer to loans that rely on personal relationships or social sanctions as means of enforcement. The examples we have in mind are loans from family, friends or neighbours, although other sources like credit cooperatives or village funds may also fit our definition. In contrast, we use *formal credit* to refer to loans for which social ties between the lender and borrower are absent or not used to enforce repayment. Examples are bank or moneylender loans.

Despite the abundance of informal credit in developing countries, the evidence suggests the presence of a 'shadow' cost associated with it – if borrowers had a choice, they would prefer to use formal credit but are unable to do so because of market imperfections, lack of collateral or formal sector access/transaction costs. Indeed, the fraction of informal loans in total lending is generally lower in countries with larger financial sectors and decreases as the formal sector expands.[4] In our Thai data, Figure 1 illustrates the use of informal credit based on social ties around the 1998 Asian financial crisis for a panel of 872 rural households observed between 1997 and 2001.[5] Prior to the crisis, informal loans from neighbours or relatives make up roughly 21 percent of all loans in the sample. This fraction rises to 31 percent during the crisis and then gradually reverts to its pre-crisis level, consistent with the idea that many households use family or neighbours as "lender of last resort".

This is puzzling. Borrowing from relatives or friends appears preferable in many situations, since informal lenders are often better informed about the personal circumstances of the borrower or have lower monitoring and enforcement costs (Stiglitz, 1990). Furthermore, loans from friends or family typically have very favorable terms. In their survey of financial practises among the poor, Collins et al. (2010) report that most family loans are interest-free. Similarly, in the 2004 Global Entrepreneurship Monitor survey, between 60 and 85 percent of all investors are relatives or friends of the entrepreneur they financed, with the majority willing to accept low or negative return (Bygrave and Quill, 2006). In our Thai data the median interest rate on loans from relatives is zero and 90 percent of all loans from relatives or neighbours

[1] For example, Paulson and Townsend (2004) report that about 30% of Thai household-run businesses have outstanding loans from other households while only 3% have loans from commercial banks. Banerjee and Duflo (2007) document that, among all loans to poor households in Udaipur, India, 27% are from a relative, friend or other villager, 36% from a shopkeeper and only 6% from banks. In Cote d'Ivoire, 94% of the loans are from other villagers and 6% from banks. They report similar numbers for 11 other developing countries.

[2] See Ghosh et al. (2000) for a review.

[3] Group-lending microfinance is another source of credit based on social collateral.

[4] Detailed reliable data on interpersonal loans in developed countries are scarce which may be partly due to tax reasons (e.g., in the USA, personal loans are subject to tax if the interest charged is too low). The US National Association of Realtors (2012) reports that 9% of home buyers received a family loan to help with their downpayments in 2011.

[5] These data are from the Townsend Thai Project, a detailed survey of rural Thai households. See http://cier.uchicago.edu/ for details.

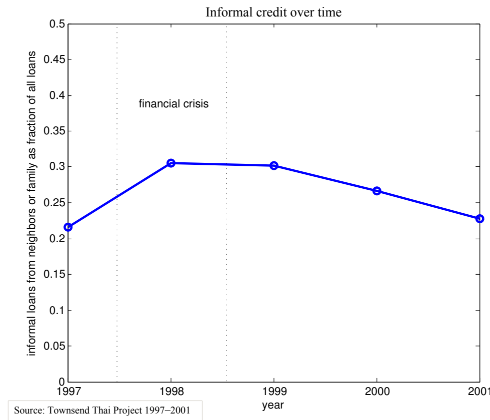


Figure 1: Informal loans in rural Thailand

require no collateral (see Section 2 for more details).

There is little systematic guidance in the literature, however, about why people seem reluctant to borrow from friends or family when alternative credit sources are available.[6] A possible explanation may be that formal lenders have a comparative advantage (expertise, risk diversification, etc.), but this seems implausible for small amounts for which risk aversion or liquidity constraints are also less likely a problem.

In sum, the argument that informal loans based on social capital face fewer contracting problems, together with the evidence that these loans have more favorable terms, leads to the conclusion that borrowers should prefer informal over formal credit unless informal lenders have insufficient funds. But if formal and informal credit are both viable options and informal lenders can do everything a bank can (charge interest, require collateral) and also leverage pre-existing social capital as means of enforcement, why use formal credit at all? Why is formal credit not based on social ties preferred in developed countries, even for small amounts of money?

We answer these questions by highlighting the costs and benefits of informal and formal loans and point out an inherent disadvantage ('shadow cost') of informal credit based on social ties. We do so in the context of a theoretical model that captures and explains the stylized facts in the data: co-existence of formal and informal credit, more favorable loan terms for informal credit, yet preference for formal credit under broad conditions. In addition, our model generates a new testable prediction that we confirm in the data – the preference for formal loans increases in the ratio of loan size to borrower wealth (the LTW ratio); that is, riskier loans are more likely to be formal than informal, all else equal.

We model the trade-off between informal and formal credit as follows. Informal credit uses 'social collateral' measured by the value of social or kinship ties between the borrower and the lender. This social collateral can serve as substitute for physical collateral and the threat of losing it enables informal borrowers to commit not to behave opportunistically (strategic default). Using the social collateral is always feasible and allows favorable loan terms. On first thought, this makes informal credit very attractive. However, using the social collateral comes at a cost. Unlike physical assets, the pledged social capital is

[6]An exception is Lee and Persson (2016) discussed below.

indivisible – if a borrower defaults on an informal loan, the relationship is severed or damaged and the social capital is lost, with possible utility costs for both sides. This social loss is incurred whenever there is positive probability of default and increases in that probability. In our model default is endogenous and more likely for more leveraged borrowers (with higher loan size to wealth ratio). Social capital could be also partially lost if an informal lender refuses a loan when approached by a borrower. In contrast, in formal credit asset-based collateral can be freely adjusted with the loan size and (partially) compensates the lender upon default. Overall, this implies that informal credit can be more 'expensive' in welfare terms than formal credit.

We show that informal lenders use the social capital as means of enforcement, which allows them to offer more favorable financial loan terms (lower interest and collateral) than formal lenders, all else equal. This includes the possibility of charging zero interest and collateral. Intuitively, for large enough social capital at stake, informal borrowers never default strategically and hence informal lenders always find it optimal to lend when asked, knowing that they would not be approached by a borrower if the risk of default (project failure) were too high. In contrast, formal loans always require collateral and, if there is positive probability of default, demand a strictly positive interest rate. Despite the relative disadvantage of formal loans in terms of financial costs, the potential loss of social capital associated with informal lending makes borrowers choose formal over informal credit when the ratio of the loan size to borrower's wealth (the LTW ratio) is relatively high, which corresponds to a higher probability of default. Specifically, when the risk of default is negligible, informal credit is always preferred because of its favorable terms. As the risk of default increases, informal credit becomes costlier because of the expected social capital loss and borrowers prefer formal loans.

Our model has empirically testable implications that we take to the data. First, informal loans based on social ties should have more favorable terms (lower interest and collateral) than formal loans not based on social ties. Second, the model implies a *negative* relationship between the riskiness of a loan, measured by the ratio of loan size to borrower's wealth (LTW ratio) and the likelihood of observing informal credit. Using data from the 1997 Townsend Survey of Thai households we find empirical results consistent with the model predictions. Informal loans from relatives or neighbours do have more favorable terms compared to formal loans from commercial banks or moneylenders and high-LTW ratio (riskier) loans are more likely to be informal. These results remain robust with respect to different empirical specifications, alternative definitions of formal and informal loans, selection bias in borrowing, and endogeneity of loan size.

Related literature

Our paper contributes to a relatively small but growing literature on the coexistence of formal and informal credit. The most closely related work is Lee and Persson (2016), hereafter LP, who propose an alternative and complementary explanation of the 'shadow cost' of informal credit. Like us, LP define informal credit as based on a social relationship, but model it as two-sided altruism – the borrower's utility enters the lender's utility and vice versa. The authors show that altruistic preferences can account for both below market (negative) rates of return in informal finance and borrowers' reluctance toward informal finance. Depending on the altruism specification used, the reluctance to use informal credit stems from either (i) undermining intra-family insurance or (ii) lack of limited liability arising from the relationship acting as collateral. The second specification is closer to ours, although LP rule out involuntary default by allowing the borrowers to compensate lenders with favors. The main difference between our paper and Lee and Persson (2016) is that we incorporate borrower wealth and collateral. This generates an additional testable prediction, regarding the relationship between the LTW ratio and credit source choice, that we explore and find support for in the data. In contrast, LP do not perform empirical analysis.

Gine (2011) assumes limited enforcement and fixed costs to access formal loans to model a trade-off between informal and formal credit. He estimates the model structurally using Thai data and concludes that the limited ability of banks to enforce contracts, as opposed to fixed costs, explains the observed diversity of lenders.[7] This is consistent with our assumption of limited enforcement as the key friction in the credit market. 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 an information advantage that informal lenders possess about their borrowers.[8]

More generally, we draw on and contribute to the literature on cooperation, social capital 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 a 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 (Bond and Townsend, 1996; Bose, 1997; Kochar, 1997; Guirkinger, 2008 among others). Similar insights underlie joint-liability lending in microfinance, by exploiting information sharing or peer enforcement (see Ghatak and Guinnane, 1999 or Morduch, 1999). Udry (1994) models informal loans between risk-averse agents as reciprocal and state-contingent and shows that low interest rates may be observed after a borrower suffers an adverse shock, with higher rates otherwise. In contrast, our explanation for the more favorable terms of informal loans does not rely on risk aversion or information advantages and we additionally model the co-existence of informal and formal credit with different terms. The literature on social capital (see Woolcock and Naryan, 2000 for a survey) identifies a downside of transactions based on social ties, as the lack of such ties to outsiders can stifle the extent to which production can move beyond the kin group. Our focus differs, since we highlight how the possibility of losing social capital in a risky environment makes borrowers substitute informal with formal credit.[9] Finally, since we model informal lending as embedded in a pre-existing social relationship, our paper also relates to the literature on interlinked contracts (e.g., Braverman and Stiglitz, 1982).

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

[8] The empirical work on the choice of formal versus informal finance generally highlights the factors mentioned in the beginning of the introduction. For example, Guirkinger (2008) finds that Peruvian farmers resort to informal loans either when they are excluded from the formal sector or face lower transaction costs. Barslund and Tarp (2008) find that the demand for formal credit in Vietnam is positively associated with household wealth while informal credit is positively associated with bad credit history and the number of dependents. Lisack (2016) documents the significant role of alternative financing, including loans from family and friends, in enabling small new enterprises in China alleviate credit constraints.

[9] Our paper is also related to Anderson and Francois (2008) who point out that social capital destroyed upon default represents a loss not only to the borrower but also to other members of her social group.

We proceed as follows. In Section 2, we describe key empirical regularities regarding formal and informal credit in rural Thailand. Section 3 describes the model and the optimal terms of informal and formal loans. The costs and benefits of informal vs. formal credit and the choice of credit source are analyzed in Section 4. In Section 5 we perform empirical analysis of the model predictions. Section 6 concludes. All proofs are in the Appendix.

2 Household Loans in Rural Thailand

We use data from a detailed survey of rural households in Thailand, conducted in 1997 as part of the Townsend Thai Project.[10]. The sample covers four provinces located in two distinct regions of Thailand – the more developed Central region near Bangkok and the poorer, semi-arid Northeast region (see Figure 2). The data contain socioeconomic and financial variables, including current and retrospective information on assets, savings, income, occupation, household demographics, entrepreneurial activities, and education. Most importantly for our purposes, the 1997 survey provides detailed information on the households' use of a variety of formal and informal credit sources.

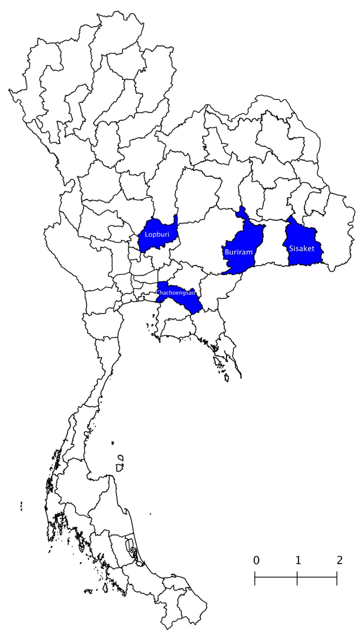


Figure 2: Surveyed Thai Provinces

Households were asked detailed questions about their borrowing and lending activities: 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, from what type of lender it was borrowed. The last question has a range of possible answers including: a neighbour, a relative, the Bank for Agriculture and Agricultural

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

Table 1: Loan Source

Source	Frequency	Percent
neighbour	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

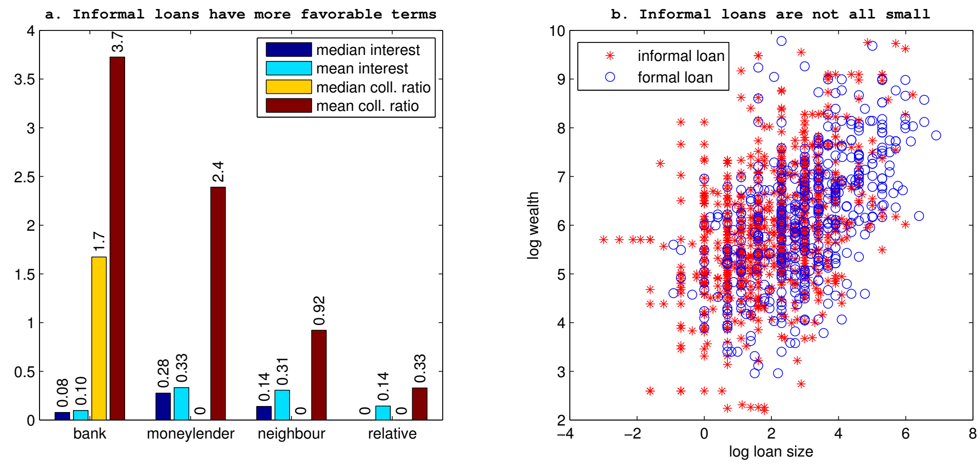
[a] **Note:** The category "other" includes rice bank, landlord, purchaser of output, supplier of input, as well as the answer "other" (344 observations). Some households hold multiple loans.

Cooperatives (BAAC), a commercial bank, an agricultural cooperative, a village fund, a moneylender, etc. Table 1 breaks down the loan sources by type. Borrowing from neighbours and relatives comprises about 24% of all loans in the sample. Borrowing from commercial banks, in contrast, is relatively rare (3% of all loans). Households resort more often to moneylenders or to the Bank for Agriculture and Agricultural Cooperatives (BAAC). The BAAC is a state-owned bank established to provide loans primarily for "agricultural infrastructure" (Ministry of Finance, 2008). While most BAAC loans are given to individuals, borrowers are frequently organized in joint liability groups. The interest rate on BAAC loans is typically 1–2 % lower than that of commercial banks.

Detailed summary statistics of the data are provided in Table A1 in the Appendix. We construct household wealth from self-reported information on the value of household assets which include land, agricultural assets (animals, machinery, etc.), business assets, durable consumption goods, financial assets and savings. As a reference, the average annual income in Thailand in 1996 was 105,125 Baht or roughly \$4,200 (Paulson and Townsend, 2004).

Recall that the key distinction we make between informal and formal credit is whether or not a loan is backed or enforced by social capital. In our baseline specification we therefore define informal credit as loans from relatives or neighbours and formal credit as loans from commercial banks or moneylenders. While moneylenders are often considered informal sources by authors who use an institutional-based definition, the dimension we focus on here, whether or not the lender and borrower have personal or social ties, makes us group moneylenders with commercial banks. The BAAC is a hybrid institution in terms of our definition – it often requires collateral but can also leverage social capital via joint liability clauses in group loans. We initially exclude the loans from the BAAC and village institutions from the analysis, to keep the distinction between formal and informal loans as sharp and close to the model as possible, but in Section 5.2.2 we also perform robustness checks by including these loans in either the formal or informal categories.

We first compare the loan terms for formal and informal credit in our sample. Although the survey did



Panel (a) excludes observations with interest rate > 200% and collateral ratio > 100.

Figure 3: Variation in (a) loan terms, and (b) size of loan vs. household wealth, by type of credit

not ask about interest rates directly, we were able to manually compute them in most cases using the loan period length, the total required repayment and the initial loan size. Figure 3(a) shows the mean and median loan interest rate and the ratio of collateral to loan size ('collateral ratio') for the four loan sources in our baseline specification: commercial banks, moneylenders, neighbours, and relatives. We see that, in most cases, informal credit (loans from relatives or neighbours) is significantly cheaper in monetary terms (interest and collateral) than formal credit (loans from commercial banks or moneylenders) – the median interest rate on loans from relatives is zero, which is considerably lower than the median commercial bank interest rate (8%) and the median moneylender rate (28%). In addition, the vast majority of neighbours and relatives (over 90%) require no collateral, arguably using in its place social capital. Some neighbours do charge high interest, which explains the large mean, but their median interest rate is only half that of moneylenders (14% vs. 28%). Banks charge lower interest than neighbours and moneylenders but require significantly larger collateral (and possibly additional fees or documentation). Many moneylender loans do not report requiring collateral. For such loans our model can be re-interpreted as the moneylenders having an enforcement advantage that allows them to seize borrower's assets ex-post in case of default.

The fact that informal credit, as defined, is cheaper than borrowing from a bank or a moneylender does not mean that formal credit is rare in the data. Figure 3(b) plots the distribution of formal and informal loans over loan size and household wealth. We see that informal loans from relatives and neighbours exist over the whole range of observed wealth and loan sizes, and similarly for formal credit.[11]

Even though informal loans are smaller on average (see Table A1), loan (project) size is not the sole factor affecting the choice of credit source. Indeed, the availability of different lenders and the borrowers' choice among them is naturally related to the risk of default. Unfortunately, our data do not allow us to directly measure default risk. Instead, we compute the borrowers' loan-size-to-wealth (LTW) ratio as an indicator of the riskiness of a loan, with the interpretation that loans with large size relative to household

[11] Within formal loans, mostly large loans taken by wealthy households originate from commercial banks. Access to banks is limited in rural areas and commercial banks require more collateral than moneylenders which is a serious constraint for poor borrowers.

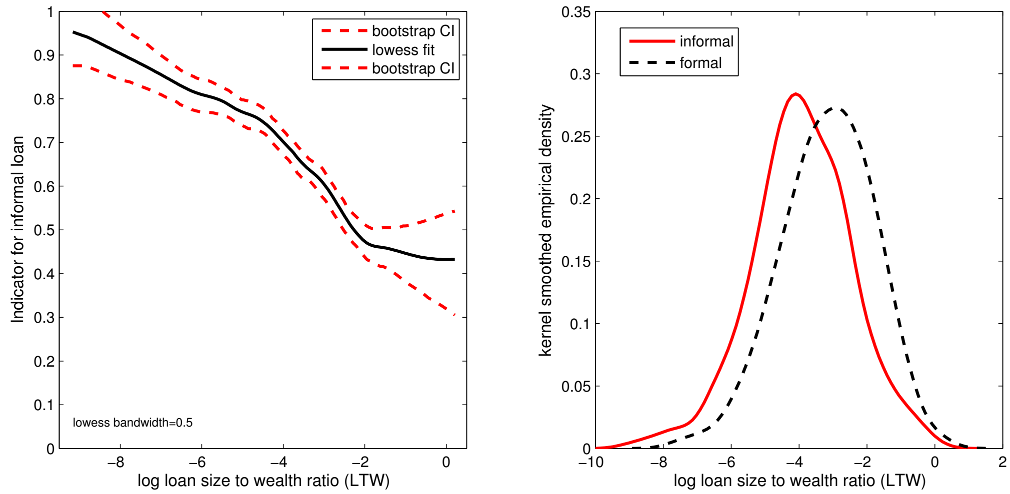


Figure 4: The LTW ratio and type of credit

wealth are riskier than loans that are small relative to household wealth.[12] A direct link between the LTW ratio and the risk of default arises endogenously in our model described in Section 3. The argument from the literature that informal credit has enforcement or informational advantages suggests that riskier loans should be more likely to come from informal sources. This is not confirmed by the data. In fact, the opposite holds, as Figure 4 shows. The relationship between loan informality and the LTW ratio risk proxy is negative – the riskier a loan, the *less likely* it is to originate from a relative or neighbour. The left panel of Figure 4 shows this negative relationship using a lowess regression of loan informality (from neighbour or relative) against log of the LTW ratio. The right panel of Figure 4 plots kernel density estimates of the distributions of formal and informal loans over the LTW ratio, again showing that formal loans tend to be riskier.

3 Model

3.1 Setting

Consider an economy populated by risk-neutral lenders and borrowers. Each borrower has an investment project which is fully financed by a loan taken at time $t = 0$. The projects can vary in size denoted by θ. A project requiring investment (loan) θ generates stochastic return $y(\theta)$ at time $t = 1$. The return $y(\theta)$ can take two possible values: $R\theta$ ('project success'), with probability p, or 0 ('project failure'), with probability $1 - p$, where $R > 1$ and $p \in (0, 1)$.

Each borrower is endowed with illiquid assets, $w > 0$ which can differ across borrowers. The assets are collateralizable but subject to risk. Specifically, at time $t = 1$, only fraction α of the asset value is available to compensate the lender, where α is a random variable with cdf $G(\alpha)$ and support $[\alpha_{\min}, 1]$, with $\alpha_{\min} \in (0, 1)$ and $E(\alpha) \in (\alpha_{\min}, 1)$. The cdf $G(\alpha)$ is assumed continuous on $[\alpha_{\min}, 1)$ but we allow a

[12]Note that the LTW ratio is similar to the loan-to-value (LTV) ratio (the mortgage amount divided by the appraised property value), frequently used by banks to assess borrower risk before approving a mortgage loan.

strictly positive mass at $\alpha = 1$, that is, a drop in the asset value may occur with cumulative probability less than one.[13]

The collateral value parameter α is important since it ties the risk of default to the loan-size-to-wealth (LTW) ratio, $\frac{\theta}{w}$. As we show below, a higher LTW ratio $\frac{\theta}{w}$ increases the probability that the borrower would not pay back the loan. One possible interpretation of α is that it captures ex-ante uncertain expenses incurred by the lender for acquiring or storing the collateral. Alternatively, one can think of α as a random shock to the $t = 1$ asset value; for example, a bad harvest, an accident lowering the resale price of a vehicle, or an unexpected drop in house/land prices. Importantly, the realization of α is unknown to both the borrower and the lender at $t = 0$ when the loan is taken, but the value αw is observable by both at $t = 1$ when repayment is due.[14]

We assume a limited enforcement setting in which the project return $y(\theta)$ is non-verifiable. This gives rise to the possibility of *strategic default* – a borrower may choose to default on a loan despite being able to pay it back. In addition, as in most of the literature, we assume that the borrowers have limited liability. That is, if the project fails, $y(\theta) = 0$ and the borrower has insufficient funds to repay, then the borrower *defaults involuntarily* and cannot be punished by the lender beyond seizing any posted collateral.

Let r_i, $i = I, F$ denote the the required gross repayment (principal plus interest) in an informal (indicated by $i = I$) or formal (indicated by $i = F$) loan. Similarly, denote by c_i, $i = I, F$ the required collateral in terms of borrower's assets transferred to the lender upon default, that is, when a borrower declares that she cannot pay back r_i. The timing is as follows. First, the borrower learns the required investment (loan size), θ. Second, the loan terms (r_i, c_i) are determined, depending on the borrower's wealth, project size, and social capital with the lender (if applicable). Given the loan terms, the borrower chooses formal or informal credit (it is possible that only one type is available to her in equilibrium). Next, nature chooses the value of α and whether the investment project succeeds or fails. The value of α is then observed by both parties. The project outcome is observed only by the borrower. Finally, the borrower decides whether to repay or default, the contract terms are executed, and payoffs are realized.

3.2 Main assumptions

Our focus is on the distinction and choice between informal (I) credit and formal (F) credit. The defining characteristic of informal credit is that the borrower has a personal or social relationship with the lender which gives rise to *social capital.* Part or all of this social capital is lost upon default on an informal loan. In contrast, no social capital is lost when defaulting on a formal loan. For our main results it is only essential that the borrower bears a social capital loss upon default.

Assumption A0. *In informal credit the borrower loses a non-pecuniary social capital value $\gamma > 0$ upon default.*

We can interpret γ as the value of social capital 'pledged' in an informal credit relationship, for example

[13]For simplicity, we set the upper bound of α to 1 but all results easily generalize for upper bound $\alpha_{\max} > 1$ as long as $E(\alpha) < 1$.

[14]We assume that this shock is uninsurable, that is, there do not exist third parties or markets that can be used to hedge against the collateral value risk.

between friends or relatives. In contrast, in formal credit the lender is a stranger to the borrower, that is, no personal relationship exists ($\gamma = 0$). An example is a loan from a commercial bank. To capture the idea that friends or relatives may have limited funds, we also allow the possibility that an informal lender may have a maximum amount, $\bar{\theta} > 0$ available for lending. Such ex-ante limit does not exist in formal credit.

The following analysis is done for any given values of γ, θ, w and $\bar{\theta}$ and in reality people can differ in these values. They could also be correlated. For example, a poor agent (low w) might only have poor friends or relatives to turn to and thus $\bar{\theta}$ may be positively correlated with w.

In line with the literature, assume that there is a (possibly small) transaction cost of using formal credit, $\lambda\theta$ where $\lambda > 0$.[15] This cost may be interpreted to arise from the need to show proof of title, filling out forms, etc. On the technical side, assuming $\lambda > 0$ allows us to break the indifference between using riskless formal vs. informal loan. A reduction in λ can be interpreted as financial sector development (see Lemma 3).

Suppose the lenders' opportunity cost of funds is normalized to 1. The next assumption guarantees that all investments are socially efficient and the borrowers are always willing to take a formal loan.

Assumption A1.

$$pR > 1 + \lambda \tag{A1}$$

Our final main assumption is that the social value loss γ in Assumption A0 is sufficiently large.

Assumption A2. *The social value loss γ in informal credit is sufficiently large so that:*

(i) an informal borrower never defaults strategically. For a required loan size θ, a sufficient condition is:

$$\gamma > \frac{\theta}{p} \quad \textit{(NSD)}$$

(ii) a person would not borrow informally for high-risk loans (with sufficiently high LTW ratio $\frac{\theta}{w}$). A sufficient condition is:

$$\gamma > \frac{(pR-1)\bar{\theta}}{1-p} \quad \textit{(H)}$$

Assumptions A0-A2 are essential for our two main results that: (i) informal loans have more favorable terms than formal loans (lower interest and collateral) and (ii) borrowers would not use informal loans and prefer formal loans for riskier investments (with high LTW ratios, $\frac{\theta}{w}$). Intuitively, the social value loss $\gamma > 0$ (Assumption A0) reduces the borrower's incentives to default strategically in informal credit relative to formal credit. The reduced default incentive enables informal lenders to offer more favorable loan terms. Assumption A2(i) provides a sufficient condition, (NSD) which simplifies the analysis by ruling out strategic default in informal loans for any α.[16] Assumption A2(ii) is important for our results on informal credit use and the choice of loan source. Specifically, we will show that condition (H) implies

[15] Assuming that the cost is proportional to the loan size is not essential but helps with analytical simplicity. If access to formal credit were instead subject to a fixed cost, then only loans above a certain minimum size could be formal but all other results remain qualitatively unchanged.

[16] Alternatively, but more ad-hoc, we could rule out strategic default by referring to superior enforcement by informal lenders, as in some papers in the literature.

that, for a risky investment (with high θ/w), the expected social value loss is so large that a borrower is better off not taking an informal loan. That is, the social disutility from default implies that informal credit has a 'shadow cost' despite its more favorable financial terms compared to formal credit.[17] Finally, Assumption A1 ensures that lending creates gains from trade.

We first present a baseline version of the model that assumes away any social capital costs for informal *lenders*. This simplifies the analysis and keeps the supply sides of formal and informal credit as similar as possible. In Section 3.7 and Appendix B we extend the baseline model by allowing informal lenders to incur a social disutility upon loan default and/or upon refusing to give an informal loan when asked. We show that, under mild conditions, allowing for social costs incurred by informal lenders can affect the terms of informal loans but does not change our main results.

3.3 The repay or default decision

The key difference between formal and informal credit is the absence or presence of social capital; otherwise we treat them symmetrically. Consequently, call

$$\gamma_i \equiv \begin{cases} \gamma > 0 \text{ if } i = I \\ 0 \text{ if } i = F \end{cases}$$

To understand the trade-off faced by borrowers between repaying r_i or defaulting, recall that the decision to default is made after observing the collateral shock, α. Repaying costs r_i to the borrower. Default costs

$$\delta(\alpha, \gamma_i) \equiv \gamma_i + \min\{c_i, \alpha w\},\ i = I, F \tag{1}$$

Since, by Assumption A1, lending is socially efficient, the loan terms are such that repayment is always feasible when the borrower's project succeeds. When the project fails, the borrower has only αw (the assets liquidation value) and repayment is feasible only if $r_i \leq \alpha w$. The lender's payoff if the borrower repays is r_i. The lender's payoff if the borrower defaults is $\min\{c_i, \alpha w\}$.[18]

Lemma 1 (Borrower's repayment decision)

(a) the borrower defaults involuntarily if $r_i > \alpha w$ *and* $y(\theta) = 0$ *(project failure).*

(b) otherwise, if $r_i \leq \alpha w$ *or* $y(\theta) = R\theta$ *(project success) or both, the borrower repays* r_i *if* $r_i \leq \delta(\alpha, \gamma_i)$ *and strategically defaults if* $r_i > \delta(\alpha, \gamma_i)$.

Without loss of generality, we impose a 'no strategic default with probability one' incentive constraint by requiring that the loan terms (r_i, c_i) be such that the borrower does not default strategically for all α. Focusing on this natural scenario with overall default rate less than one helps streamline the exposition without affecting the results.[19]

$$r_i \leq \gamma_i + \min\{c_i, w\} = \delta(1, \gamma_i) \tag{IC}$$

[17] We can ensure that Assumption A2 is satisfied for any feasible informal loan size $\theta \leq \bar{\theta}$ by assuming $\gamma > \max\{\frac{\bar{\theta}}{p}, \frac{p(R-1)\bar{\theta}}{1-p}\}$.

[18] See Appendix B for a model extension allowing for additional social cost of default incurred by informal lenders.

[19] We will show that (IC) is always slack for informal loans given assumptions A0-A2. For formal loans, if (IC) does not hold, there can be loans with $c_F > r_F$ such that the borrower defaults in all states of the world and the lender collects $\min\{\alpha w, c_F\}$. Those loan terms, however, give the same expected payoffs to the lender and borrower as the formal loan terms we characterize (those subject to (IC)) and do not expand the set of parameters for which formal loans are feasible.

3.4 Loan Terms

Suppose the lenders are willing to lend any feasible amount θ as long as their payoff is not lower than their outside option (not lending). In other words, the borrower receives all the trade surplus and so the loan terms maximize the borrower's expected payoff subject to participation and incentive constraints. This assumption helps with the comparability of formal and informal loans, and is satisfied, for example, if the market for credit is competitive (free entry). The opportunity cost of lenders' funds is normalized to 1. The borrowers' outside option, if they do not invest, is normalized to zero.

Given the above, the optimal loan terms, (r_i, c_i) for $i = I$ or F maximize the borrower's expected payoff, U_B^i subject to four constraints.[20]

- the **lender's participation constraint**

$$U_L^i \geq \bar{u}_L^i = \theta, \tag{PC$_L$}$$

  where U_L^i is the lender's expected payoff and $\bar{u}_L^i$ is the lender's outside option. In the baseline model both $\bar{u}_L^I$ and U_L^I are assumed unaffected by social capital, hence $\bar{u}_L^i$ equals the loan size θ. In Section 3.7 we allow the informal lender's payoff, U_L^I and/or outside option, $\bar{u}_L^I$ to include a loss of social value equal or different to the borrower's social value loss γ.

- **non-negativity constraints** on interest and collateral

$$r_i \geq \theta \text{ and } c_i \geq 0. \tag{NN}$$

- the **borrower's participation constraint**,

$$U_B^i \geq 0 \tag{PC$_B$}$$

- the **incentive constraint** (IC) ensuring that strategic default does not occur for all α.

3.5 Formal Credit

We first characterize formal credit since the analysis is easier and the results help the comparison between formal and informal loan terms in Section 4. Formal credit lacks associated social capital, that is $\gamma_F = 0$. Since $\delta_F = \min\{c_F, \alpha w\}$ from (1), Lemma 1 implies that formal credit borrowers have a strict incentive to default unless a sufficiently large strictly positive amount of assets is pledged as collateral. Using (IC), to ensure that borrowers do not always strategically default, formal loans must satisfy

$$r_F \leq \min\{c_F, w\} \tag{2}$$

Therefore, $c_F \geq r_F$. Subject to (2), if $r_F > \alpha w$ (sufficiently low asset value shock) a borrower would still find it optimal to default, strategically if the project succeeds and involuntarily otherwise (see Lemma 1). This holds since, if $\delta(\alpha, 0) = \alpha w < r_F$, then the most the lender can seize is αw, which by (2) is less than the both the required repayment r_F and the collateral c_F. As a result, strategic default cannot be

[20] The exact expressions for the borrower's and lender's expected payoffs are given in Sections 3.5 and 3.6.

avoided in formal credit and can occur with positive probability depending on the realization of α. In the alternative case, $r_F \leq \alpha w$, Lemma 1 implies that the borrower would always repay, either from the project output $R\theta$ or by voluntary liquidating assets. The reason is that $r_F \leq \delta_F = \min\{c_F, \alpha w\}$ always holds when $r_F \leq \alpha w$, using $r_F \leq c_F$ by (2). Overall, these results imply that the lender receives r_F if $\alpha \geq \frac{r_F}{w}$ and αw otherwise.

Define the function $\pi(x) : \mathbb{R}_+ \to [0,1]$ as

$$\pi(x) \equiv \begin{cases} 0 \text{ if } x \leq \alpha_{\min} \\ G(x) \text{ if } x \in (\alpha_{\min}, 1] \\ 1 \text{ if } x > 1 \end{cases} \tag{3}$$

and note that $\int_0^\infty d\pi(\alpha) = 1$. The value $\pi(\frac{r_F}{w}) \in [0,1]$ equals the probability that $\alpha \leq \frac{r_F}{w}$. The contracting problem between a formal lender and a borrower with assets w and required loan size θ is:

Problem F

$$\max_{r_F,\, c_F} \; U_B^F = pR\theta - \int_0^\infty \min\{\alpha w, r_F\} d\pi(\alpha) - \lambda\theta \tag{OBJ$_B$}$$

$$\text{s.t.} \quad U_L^F = \int_0^\infty \min\{\alpha w, r_F\} d\pi(\alpha) \geq \theta \tag{PC$_L$}$$

$$U_B^F \geq 0 \tag{PC$_B$}$$

$$r_F \leq \min\{c_F, w\} \tag{IC$_F$}$$

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

where $\lambda\theta$ is the transaction/access cost of formal credit.

Proposition 1 (Formal credit)**.** *Suppose Assumption A1 holds and consider a formal borrower with assets w and required loan size θ. Call $\hat{\alpha}_F \equiv E(\alpha) > \alpha_{min}$.*

*(a) If $\frac{\theta}{w} \in (0, \hat{\alpha}_F]$, the formal loan terms (r_F^*, c_F^*) solving **Problem F** are: strictly positive collateral, $c_F^* \geq \theta$ and repayment, $r_F^* \geq \theta$, both strictly increasing in θ. For low LTW ratio (zero default risk), $\frac{\theta}{w} \leq \alpha_{\min}$, the interest rate equals the lender's net opportunity cost of funds, $r_F^* = \theta$.[21] For intermediate LTW ratio (positive default risk), $\frac{\theta}{w} \in (\alpha_{min}, \hat{\alpha}_F)$, the interest is strictly positive, $r_F^* > \theta$ where r_F^* solves $U_L^F = \theta$.*

*(b) if $\frac{\theta}{w} > \hat{\alpha}_F$ (high LTW ratio / high default risk), **Problem F** has no solution – a formal loan is not feasible since the lender's participation constraint is violated.*

Formal loans always require strictly positive collateral, $c_F^* > 0$, since this is the only way to avoid default in all states. This could be also interpreted as the formal lenders (e.g., moneylenders) having the ability to seize borrowers' assets ex-post.[22] Formal loans also carry positive interest, unless there is zero default

[21] The opportunity cost of funds could be positive in general (e.g., $\rho > 0$), in which case $r_F^* = (1+\rho)\theta$. In contrast, for sufficiently large social cost of loan refusal, riskless informal loans could be still offered at zero nominal interest rate, $r_I^* = \theta$ (see Section 3.7).

[22] We abstract from modeling other pecuniary or non-pecuniary costs to the borrower from default on formal loans. Such expected costs could be included in the cost of access to formal credit $\lambda\theta$ or their absence could be justified by the lack of credit registries or efficient bankruptcy laws in developing countries.

risk ($\frac{\theta}{w} \leq \alpha_{\min}$) in which case the interest rate equals the lender's opportunity cost of funds because of the free entry assumption.

Proposition 1 establishes that the loan size to wealth (LTW) ratio, $\frac{\theta}{w}$ plays a key role in whether a formal loan is feasible for a given borrower and, if yes, at what terms. Intuitively, since formal loans are always secured by collateral, the lender faces only one risk, that the ex-post asset value αw falls short of the required repayment r_F^* or the pledged collateral c_F^*. The probability of default increases in the LTW ratio since it becomes more likely that an $\alpha < \frac{r_F^*}{w}$ is realized. Default by itself is otherwise irrelevant to the lender, unlike in informal loans where an additional social cost may be incurred (see Section 3.7). This implies that borrowers with high default risk (high LTW ratio, $\frac{\theta}{w}$) are denied formal loans since the lender cannot break even.

3.6 Informal Credit

Informal credit allows borrowers to 'leverage' their social relationships with informal lenders and use the associated utility loss upon default γ as means of ensuring repayment beyond what can be achieved by physical collateral. Here we treat the social capital value γ as exogenously given but more generally it can be micro-founded as arising from repeated interaction under limited enforcement, for example, as in Coate and Ravallion (1993), Kocherlakota (1996), Fafchamps (1999) or Boot and Thakor (1994).[23]

From Lemma 1, it is clear that if the social value γ which an informal borrower would lose upon default is sufficiently large so that $r_I < \delta(\alpha, \gamma)$ for all α, then the borrower would always choose to repay r_I when feasible, that is, if $r_I \leq \alpha w$ or if $r_I > \alpha w$ and the project succeeds. Since $\delta(\alpha_{\min}, \gamma) > \gamma$ by (1), to obtain this result it is sufficient to ensure that $\gamma > r_I$ holds at the optimal r_I. We will show that $\gamma > r_I$ is guaranteed by Assumption A2(ii). Under the sufficient condition (NSD) there would be *no strategic default in informal loans* because of the large social capital γ at stake. An informal borrower would only default involuntarily, if her project fails *and* $r_I > \alpha w$.

Using that $Prob(r_I > \alpha w) = \pi(\frac{r_I}{w})$ by (3), the probability of involuntary default is $(1-p)\pi(\frac{r_I}{w})$ and so, for any given $\alpha < \frac{r_I}{w}$, the borrower loses $\delta(\alpha, \gamma) = \gamma + \min\{c_I, \alpha w\}$ while the lender receives $\min\{c_I, \alpha w\}$. Otherwise, with probability $1 - (1-p)\pi(\frac{r_I}{w})$, the borrower repays (and the lender receives) r_I. The contracting problem between a lender and an informal borrower with wealth $w > 0$, social capital $\gamma > 0$ and required loan size θ is then,

[23] In Coate and Ravaillion (1993) and Kocherlakota (1996), agents share risk ('cooperate') in equilibrium by making transfers to each other contingent on stochastic income realizations. Cooperation is supported by the threat of punishment with perpetual autarky. Similarly, Fafchamps (1999) shows that contingent credit can arise as an equilibrium in a long-term risk-sharing arrangement. Boot and Thakor (1994) provide conditions under which long-term credit relationships can achieve the first best in a repeated moral hazard problem without a risk sharing motive.

Problem I

$$\max_{r_I,\, c_I} \; U_B^I = pR\theta - [1-(1-p)\pi(\tfrac{r_I}{w})]r_I - (1-p)\pi(\tfrac{r_I}{w})\gamma - \eta(r_I, c_I) \qquad (\text{OBJ}_B)$$

$$\text{s.t. } U_L^I = [1-(1-p)\pi(\tfrac{r_I}{w})]r_I + \eta(r_I, c_I) \geq \theta \qquad (\text{PC}_L)$$

$$U_B^I \geq 0 \qquad (\text{PC}_B)$$

$$r_I \leq \gamma + \min\{c_I, w\} \qquad (\text{IC}_I)$$

$$r_I \geq \theta \text{ and } c_I \geq 0, \qquad (\text{NN})$$

where $\eta(r_I, c_I)$ is the expected cost to the borrower from the collateral requirement,

$$\eta(r_I, c_I) \equiv (1-p) \int_0^{r_I/w} \min\{c_I, \alpha w\} d\pi(\alpha). \qquad (4)$$

Proposition 2 (Informal credit)**.** *Consider an informal borrower with assets w, social capital γ and required loan size $\theta \leq \bar{\theta}$ which satisfy Assumptions A0–A2.*

*a) if $\frac{\theta}{w} \leq \alpha_{\min}$ (low/riskless LTW ratio), the loan terms (r_I^*, c_I^*) solving **Problem I** are $c_I^* = 0$ (no collateral) and $r_I^* = \theta$ (zero interest).*

*b) for any $\frac{\theta}{w} > \alpha_{\min}$, an informal lender is willing to provide a loan with positive collateral, $c_I^* > \theta$ and positive interest, $r_I^* > \theta$, both strictly increasing in θ. These (r_I^*, c_I^*) solve **Problem I** if the borrower's participation constraint (PC_B) is satisfied.*

c) $\exists \hat{\alpha}_I \in (\alpha_{\min}, 1)$ such that, if $\frac{\theta}{w} > \hat{\alpha}_I$ (high LTW ratio), the borrower chooses not to use informal credit since (PC_B) is not satisfied.

We use Propositions 1 and 2 to compare the terms of formal vs. informal loans for the same borrower.

Proposition 3 (Informal credit has more favorable terms)**.** *Consider a borrower with assets w, social capital γ and required loan size $\theta \leq \bar{\theta}$, which satisfy Assumptions A0–A2 and $\frac{\theta}{w} \leq \hat{\alpha}_F$.*[24] *If (r_i^*, c_i^*) for $i = I, F$ are the loan terms from Propositions 1 and 2, then,*

a) an informal loan requires no collateral (if $\frac{\theta}{w} \leq \alpha_{\min}$) or strictly lower positive collateral (if $\frac{\theta}{w} > \alpha_{\min}$) than a formal loan; that is, $0 \leq c_I^* < c_F^*$.

b) an informal loan has a lower interest rate than a formal loan; that is, $r_I^* \leq r_F^*$, with strict inequality if $\frac{\theta}{w} > \alpha_{\min}$.

Intuitively, for low LTW ratios, $\frac{\theta}{w} \leq \alpha_{\min}$ an informal loan is riskless – the borrower is always able and willing to repay. In contrast to Proposition 1 where formal loans always require positive collateral ($c_F^* \geq \theta > 0$), the sufficiently large social capital γ at stake in an informal loan (Assumption A2) precludes strategic default and hence no collateral is needed, that is, $0 = c_I^* < c_F^*$ (Proposition 2(a)).

For LTW ratios, $\frac{\theta}{w} > \alpha_{\min}$ there is risk of involuntary default for low realizations of α and hence informal loans require positive interest and collateral (Proposition 2(b)). The positive collateral allows charging the

[24] If $\hat{\alpha}_I < \hat{\alpha}_F$ then informal loans with high LTW ratios, $\frac{\theta}{w} > \hat{\alpha}_I$ would not be used by the borrower despite their strictly lower interest and collateral.

lowest feasible repayment (interest) $r_I^* > \theta$. Doing so minimizes both the borrower's payment upon success and the borrower's expected social capital loss, since the probability of default $(1-p)\pi(\frac{r_I^*}{w})$ increases in r_I^*. As Proposition 3 shows, the interest rate and collateral of an informal loan are, however, strictly lower than those of a formal loan for an identical borrower. Intuitively, the lack of strategic default allows the lender to offer more favorable terms, which in turn reduces the probability of involuntary default. Finally, when the LTW ratio is high, $\frac{\theta}{w} > \hat{\alpha}_I$ (Proposition 2(c)), the risk of default and expected loss of social capital to the borrower is so large that it outweighs the expected gain from borrowing and undertaking the project, that is, $U_B^I < 0$. While informal credit is still available if $\theta \leq \bar{\theta}$, the borrower prefers not to use it.

Proposition 2(b) also shows that, under our assumptions, an informal lender would never refuse a loan when asked. When strategic default is ruled out by the large social capital at stake (Assumption A2(i)), there always exist loan terms (r_I^*, c_I^*) at which an informal lender can break even. This is easiest to see by using (PC_L) to note that $U_L^I \geq pr_I$ always holds since $\pi(\frac{r_I}{w}) \leq 1$ and $c_I \geq 0$ for any r_I, c_I. Hence, $r_I = \frac{\theta}{p}$ and $c_I = 0$ always satisfy constraints (PC_L), (NN) and (IC_I) (the latter by Assumption A2(i)) – these loan terms are always feasible for the lender but not optimal. Unlike in formal loans, for which no break-even terms exist for $\frac{\theta}{w} > E(\alpha)$ (see Proposition 1), in informal credit it is the borrowers and not the lenders who avoid risky loans with high LTW ratios.

The zero interest and no collateral result for riskless loans in Proposition 2(a) hinges on our assumptions that social capital is sufficiently large to rule out strategic default (condition NSD) and that lenders break even (free entry). The result in Proposition 2(b) that informal loans require strictly positive interest and collateral when there is risk of involuntary default depends on assuming away any social costs incurred by informal lenders upon loan refusal. In Appendix B we extend the model to allow costly loan refusal and social cost of default to the lender.

3.7 Discussion and extensions

3.7.1 The role of social capital γ

In the baseline model presented above social capital γ plays two roles in informal credit. First, γ appears in the borrower's payoff, U_B^I. Call this instance γ_1. It can be interpreted as the "shame", "loss of face", or expected loss of future access to informal credit to the borrower when unable to repay the informal loan after project failure. As shown in the proof, a sufficient condition for Proposition 2(c) is

$$\gamma_1 > \frac{pR-1}{1-p}\bar{\theta} \quad \text{(C0)}$$

which is guaranteed by Assumption A2(ii). If, instead, the social cost γ_1 were zero or sufficiently low, then, all else equal, the borrower would be willing to take and the lender would be willing to supply informal credit for any LTW ratio θ/w with $\theta \leq \bar{\theta}$. Hence, the result of Proposition 2(c) that high-risk informal loans are avoided by borrowers depends on Assumption A2(ii) applied to the social cost γ_1. Note, however, that nothing changes if we assumed that in case of involuntary default the borrower transfers all her assets αw to the lender but loses a reduced amount, $\gamma - \alpha w$ of social capital.

Second, the social capital γ appears in constraint (IC_I) – call this instance γ_2. It can be interpreted as the shame, expected loss of future informal credit, or other similar cost to the borrower from *strategically* defaulting on an informal loan. As shown in the proof of Proposition 2, a sufficient condition for its results is $\gamma_2 > r_I^*$ which, since r_I^* is bounded from above by $\frac{\theta}{p}$, is guaranteed by condition (NSD), $\gamma_2 > \frac{\theta}{p}$ in Assumption A2(i). Compared to condition (C0), it is clear that we can allow the social losses γ_1 and γ_2 from involuntary vs. strategic default to be different, while keeping all results unchanged. If the social cost from strategic default did not exist (that is, $\gamma_2 = 0$), then positive collateral ($c_I^* > 0$) would be needed to support informal loans, like in formal credit (see Proposition 1).

3.7.2 Social capital and informal lenders

So far we have assumed that only the borrowers incur loss of social value in informal credit (Assumption A0). However, there can plausibly exist social capital costs incurred by the lenders too, either affecting their expected payoff U_L^I or their outside option $\bar{u}_L^I$. First, informal lenders could incur a *social capital loss from refusing to lend* to a friend or relative.[25] We can incorporate this possibility by modifying the lender's outside option to $\bar{u}_L^I = \theta - \kappa\gamma$ where $\kappa \geq 0$ measures the relative magnitude of social capital lost by the lender when an informal loan is refused.[26] Our baseline model assumes $\kappa = 0$, which can be interpreted as the informal lender having no qualms about refusing a loan. If $\kappa > 0$ instead, then surplus is being destroyed by not lending and, as we show in Appendix B, this leads to even more favorable terms for informal loans, all else equal (the lender's participation constraint is relaxed).

Second, like the borrowers, informal lenders could incur a *social capital loss upon default*, $\phi\gamma$, with $\phi \geq 0$. An interpretation is the lender being upset or angry with the borrower that the loan is not repaid, leading to a (partial) loss of their social relationship. If $\phi = 1$, then the lender's social loss is equal to that of the borrower (e.g., terminating a friendship). Our baseline model assumes $\phi = 0$, which can be interpreted as the lender 'forgiving' involuntary default. Allowing $\phi > 0$ tightens the lender's participation constraint, all else equal, and has the opposite effect on the loan terms compared to the loan refusal cost $\kappa\gamma$.

In Appendix B we analyze an extended version of the model which allows for social capital loss by the lender upon default and/or loan refusal. We provide a sufficient condition on the parameters κ and ϕ under which our results from Propositions 2 and 3 continue to hold (see Appendix B, Proposition 5). One difference with Proposition 2 is that allowing for a utility loss of loan refusal enables even more favorable informal credit terms, including the possibility of charging zero interest and zero collateral for loans with positive default risk if the social cost of loan refusal is high. In the extended model it is also possible to have informal loans with zero interest and strictly positive collateral. The result of Proposition 3, that informal credit has more favorable terms than formal credit for the same borrower, continues to hold as long as the social loss from loan refusal, $\kappa\gamma$ is sufficiently large relative to the lender's social cost of default, $\phi\gamma$.

[25] The field experiment results of Jakiela and Ozier (2015) offer evidence in support that refusing financial help to a relative when asked is costly. The authors document that a large number of rural Kenyan women were willing to forgo a significant amount of money to be allowed to hide their experiment payout from relatives.

[26] Alternatively, instead of losing social value when refusing to make a loan, one can think of the lender *receiving* social value when an informal loan is made (pleasure of helping out). In this case nothing changes since $\kappa\gamma$ is added to the l.h.s. of (PC_L) while the r.h.s. equals the opportunity cost θ.

3.7.3 The threshold $\hat{\alpha}_I$

Lemma 2. *Suppose the threshold $\frac{\theta}{w}$ value $\hat{\alpha}_I$ in Proposition 2 at which $U_B^I = 0$ is unique.*[27] *Then, $\hat{\alpha}_I$ is decreasing in the social capital γ and increasing in the project success probability p and the return R.*

Intuitively, for larger γ informal loans are more costly when there is risk of default. This reduces the range of LTW ratios, $(0, \hat{\alpha}_I]$ for which an informal loan is desirable. One implication is that, as long as Assumption A2 holds, more closely related people (with higher γ) are less likely to lend to each other, all else equal. On the other hand, borrower-lender pairs with too low γ may not satisfy Assumption A2, hence reducing the advantage of informal credit. In contrast, larger p and R support a wider range of LTW ratios for which informal loans are desirable for a borrower, since either the risk of default is lower or borrowing is more profitable in expectation.

4 The Choice between Formal and Informal Credit

Using Propositions 1 and 2, we now compare and contrast formal vs. informal credit. The advantage of informal credit is two-fold. First, provided the social capital at stake is large, informal loans have more favorable financial terms than formal loans. The reason is that informal lenders do not need to be compensated for the risk of strategic default – they know that the borrower has an incentive to pay back whenever possible in order to avoid the social capital loss. When the risk of social loss is too high, the borrower prefers not to ask for an informal loan. Second, because of the pledged social capital, informal credit can be extended to borrowers with low assets, although such borrowers may not necessarily wish to borrow. In contrast, formal lenders always require physical collateral to secure repayment.

Informal credit comes with a cost, however. First, unlike physical collateral that can be freely adjusted, the relationship value γ which acts as social collateral securing an informal loan is lumpy or indivisible – a fixed value γ is pledged, even though for small θ only a fraction may suffice. This has broader implications (not modelled here) regarding which person from one's set of friends or relatives one would approach depending on the required loan amount. Another possible disadvantage of informal credit is the upper limit $\bar{\theta}$ – friends or relatives normally do not have unlimited loanable funds. In addition, the friends or relatives or a poor person may be poor themselves ($\bar{\theta}$ can be correlated with w). Note, however, that the upper limit $\bar{\theta}$, or its possible correlation with w, do not affect the results in Propositions 2 and 3 beyond possibly restricting the applicable cases.

We also saw that, when using informal credit, both the lender and the borrower can share a common interest to avoid default since each of them may stand to lose social capital (Appendix B). Hence they avoid risky (high LTW ratio) loans, and therefore such loans would not be taken from informal sources. In contrast, in formal credit, the lender's and borrower's incentives regarding the risk of default are not aligned. The borrower does not mind riskier loans since her maximum loss is capped at αw. The lender, however, cannot break even for high-LTW ratio loans. This is why the LTW ratio threshold $\hat{\alpha}_F$ in Proposition 1 above which formal loans are not given is determined by the lender's participation constraint, while the corresponding threshold $\hat{\alpha}_I$ in Proposition 2 is determined by the borrower's participation constraint.

[27] A sufficient condition is provided in Lemma A1 in the proof of Proposition 2.

We proceed to characterize the choice between formal and informal credit for any given borrower with characteristics w, γ and $\theta \leq \bar{\theta}$ for whom *both formal and informal loans are feasible.*

Proposition 4 (Choice of loan source)**.** *Consider a borrower with assets w, social capital γ and required loan size θ, for whom both formal and informal credit are feasible (Problems F and I have solutions) and suppose Assumptions A0-A2 hold:*

(a) if $\frac{\theta}{w} \leq \alpha_{\min}$ (low/riskless LTW ratio), the borrower prefers informal credit.

(b) if $\frac{\theta}{w} > \alpha_{\min}$, the borrower prefers informal credit for relatively low LTW ratios and prefers formal credit for relatively high LTW ratios.

Intuitively, when the LTW ratio, and hence the risk of social value loss, is zero (Proposition 4a), the borrower prefers informal credit, since it offers more favorable loan terms and has no access cost. By continuity, this preference extends to θ and w for which the default risk is small (Proposition 4b). In contrast, for higher LTW ratio (riskier loans), the borrower prefers formal loans despite their less favorable financial terms. The reason is that the expected cost of losing the social capital is smaller than the larger required repayments under project success or failure.

It is also possible that a given borrower may not have a choice of credit source. For example, if $\frac{\theta}{w} > \hat{\alpha}_F$, the borrower may only be able to use informal credit since formal credit is unavailable. If $\frac{\theta}{w} > \max\{\hat{\alpha}_I, \hat{\alpha}_F\}$, the borrower would not or cannot borrow from any source – either the risk of losing the social capital is too high or the lender cannot break even.

We also characterize how the choice of loan source depends on the formal credit access cost λ.

Lemma 3. *Call $\hat{\alpha} \in (\alpha_{\min}, \hat{\alpha}_I)$ the threshold LTW ratio $\frac{\theta}{w}$ at which $U_B^I(r_I^*, c_I^*) = U_B^F(r_F^*, c_F^*)$ and suppose $\hat{\alpha}$ is unique.*[28] *Then, a decrease in the formal credit cost λ lowers $\hat{\alpha}$ and narrows the range of LTW ratios $(0, \hat{\alpha})$ for which a borrower prefers informal loan over formal loan, all else equal. If the cost is negligible ($\lambda \to 0$), borrowers weakly prefer formal credit for all $\frac{\theta}{w} \leq \hat{\alpha}_F$ and strictly so for $\frac{\theta}{w} > \alpha_{\min}$.*

Lemma 3 shows that as the formal credit transaction/access costs decrease, which could be interpreted as financial development, informal credit is preferred for a smaller range of LTW ratios $\frac{\theta}{w}$ (going to zero in the limit as $\lambda \to 0$). This model implication is consistent with the discussion in the introduction on how informal credit based on social ties appears to be less used in developed countries despite its more favorable financial terms.

Numerical example

To illustrate the results, we provide a numerical example of the baseline model solution (Propositions 1-4). Let $p = 2/3$, $R = 3$, $\lambda = .2$, $\bar{\theta} = 1$, $\alpha_{\min} = .2$, $\gamma = 5$ and let α be uniformly distributed on $[\alpha_{\min}, 1]$. Normalize borrower's wealth to $w = 1$ so that loan size θ and the LTW ratio coincide. It is easy to verify that Assumptions A0–A2 are satisfied for these parameter values. In the left panel of Figure 5 we plot the loan terms solving Problems F and I. The net interest rate for formal loans, $\frac{r_F^*}{\theta} - 1$ increases in the LTW ratio (loan size) up to 67% at $\frac{\theta}{w} = \hat{\alpha}_F = .6$. The collateral requirement, c_F^* increases strictly in

[28] As shown in the proof of Lemma A1 in Appendix A, a sufficient condition is $G''(\alpha) \geq 0$.

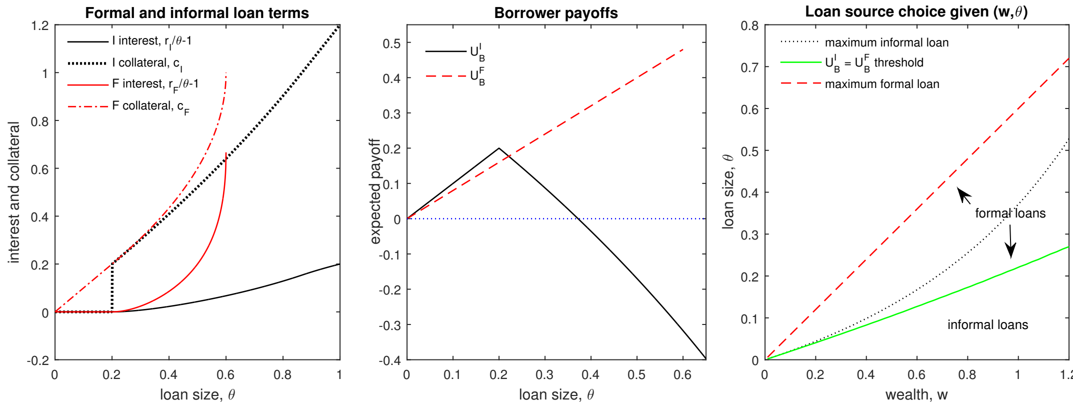


Figure 5: Loan terms, payoffs, and choice of loan source

the LTW ratio. The net interest, $\frac{r_I^*}{\theta} - 1$ and collateral c_I^* for informal loans also increase in the LTW ratio but at a much slower rate and, for any $\frac{\theta}{w} > \alpha_{\min}$, are strictly lower than the formal loan terms (for example, the net interest of an informal loan at $\frac{\theta}{w} = .6$ is 6.7% or 10 times lower than the formal rate).

The middle panel of Figure 5 plots the borrower's expected payoffs, U_B^F and U_B^I. For the chosen parameters, $U_B^I = 0$ at $\frac{\theta}{w} = \hat{\alpha}_I = .37$; that is, informal loans with size exceeding 37 percent of the borrower's wealth are undesirable. Borrowers with LTW ratio above 60 percent do not have access to formal loans, since $\hat{\alpha}_F = .6$. Comparing U_B^I and U_B^F, informal loans are preferred for LTW ratios $\frac{\theta}{w} \in (0, .22]$, while formal loans are preferred for riskier loans, with LTW ratios $\frac{\theta}{w} \in (.22, .6]$. Loans with LTW ratios above .6 are not provided or taken.

The right panel of Figure 5 illustrates the choice of credit source in the loan size / wealth plane (w is now allowed to vary). Considering borrowers who differ in some unobserved dimension such as γ, we see that, for given wealth w, borrowers with higher LTW ratios (larger θ) are less likely to borrow informally than borrowers with lower LTW ratios. Similarly, for given loan size θ, borrowers with higher LTW ratio (lower wealth) are less likely to borrow informally.

5 Empirical Analysis

In Section 2 we showed two main patterns in the rural Thai data. First, informal loans based on social ties have more favorable terms – lower interest rate and collateral. Second, the loan size to wealth (LTW) ratio, viewed as proxy for default risk, is an important predictor of whether a loan is formal vs. informal, beyond the direct effect of loan size.

In this section, we show that the assumptions and results of our theoretical model are consistent with and able to explain those data patterns. We go beyond the data summaries and bivariate correlations explored in Section 2 and test the model predictions by taking advantage of additional household characteristics for which we can control. We view households as heterogeneous in two key observables: loan size, θ and household wealth, w. Since in practise households generally also differ in unobservables which can be captured by $\alpha_{\min}$, $G(\alpha)$, p and γ, the model predictions can be thought of as being about average differences in the terms of formal and informal loans and the likelihood that we observe an informal versus a formal loan as function of the loan-to-wealth (LTW) ratio and loan size.

Specifically, Propositions 1-3 imply that, all else equal, the interest rate and collateral in informal loans based on social capital are lower on average than those in formal loans. Proposition 4 implies further that households with lower LTW ratios would choose informal loans while households with higher LTW ratios would choose formal loans. Importantly, the loan choice pattern is not simply determined by the loan size. That is, holding loan size fixed, we should still observe formal credit for borrowers with larger wealth (lower LTW ratio) and informal credit for borrowers with less wealth (higher LTW ratio).

The same reasoning implies also that, holding borrower's wealth fixed, larger loans are less likely to be informal. We should therefore expect that loan informality, on average, decrease in the loan size θ. Of course, there could be other reasons why borrowers with larger credit requirements are more likely to use formal credit. One such reason may be that informal lenders (especially those approached by poorer borrowers) are more constrained in their available funds than formal lenders. To accommodate this possibility, we allow informal loans to be capped at $\bar{\theta}$, so all loans $\theta > \bar{\theta}$ are necessarily formal.[29] We explore this issue further in Section 5.2.4.

5.1 Results

5.1.1 Loan Terms

We first explore the model implications about the loan terms. Table 2 reports results from a tobit regression of the loan interest rate and collateral requirement on the loan source, controlling for household characteristics including income, age, gender, marital status, time lived in the village, education, location fixed effects, the loan's intended use and the total number of loans. In all specifications we find that loan informality (a loan from relative or neighbour, as opposed to from a commercial bank or moneylender) is associated with statistically significantly lower interest rate and collateral. Specifications (1) and (5) use only household controls and fixed effects while columns (2)-(4) and (6)-(8) also include log household wealth, log loan size or log LTW ratio. Larger wealth, larger loan size and larger LTW ratio are associated with larger collateral size. These findings are consistent with our model. The loan terms and loan size may be jointly determined in practice but despite this potential simultaneity problem, the negative relationship between them is preserved. We address the potential endogeneity of loan size in Section 5.2.

5.1.2 The loan-size-to-wealth (LTW) ratio

We next explore the relationship between the observed choice of loan source (formal versus informal), loan characteristics and household characteristics. In doing so, we initially assume that the loan size is exogenously given by the needs of the household.[30] In our baseline empirical specification the dependent

[29] While one could imagine borrowers tapping multiple informal sources if their investment needs exceed $\bar{\theta}$, taking multiple loans could increase the risk of loss of social capital.

[30] This is obviously a strong assumption, but could be justified if most loans are taken for a specific purpose, as our data indicate. A related issue is that some households may borrow from several sources to finance a single investment project (Kaboski and Townsend, 1999). In the Thai data, we observe the calendar dates at which households took each loan as well as rough categories regarding the reported purpose of the loan. If we count loans taken for the same purpose within

Table 2: Tobit Regressions for Loan Terms

dependent variable	interest				collateral size			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
loan source (informal=1)	-0.41***	-0.42***	-0.42***	-0.4***	-690***	-647***	-514***	-639***
	(0.10)	(0.10)	(0.09)	(0.09)	(94.0)	(86.7)	(76.7)	(94.9)
household wealth		-0.07	-0.07			148***	92.0**	
		(0.05)	(0.05)			(31.8)	(28.8)	
loan size			-0.00				173***	
			(0.03)				(25.7)	
LTW ratio				0.03				78.2***
				(0.03)				(18.9)
Observations	900	896	896	896	1,235	1,231	1,231	1,231
pseudo R^2	0.03	0.03	0.03	0.03	0.08	0.09	0.11	0.09

[a] **Note:** All specifications include fixed effects for location (tambon) and the intended loan use (consumption, real estate, investment, other). We also control for age, gender, marital status, tenure and education of the household head, as well as household income and total number of loans. The standard errors reported in parentheses are clustered at the household level. Superscripts ***, **, and * indicate significance at 0.1%, 1% and 5%, respectively.

variable is the loan source, *Lsource*, which equals 1 if the loan is informal, that is, originates from a neighbour or a relative, and 0 if the loan is formal, that is, originates from a commercial bank or a moneylender. As explained in Section 2, our baseline regressions exclude BAAC loans from both categories.[31] Altogether, formal credit constitutes 35 percent of the baseline sample.

The main dependent variable of interest is the LTW ratio while controlling for various household characteristics. We also run specifications including loan size. The LTW ratio and loan size in the data are very skewed and thus are log-transformed. Specifically, we run the following two regressions:

$$Lsource_{kij} = \delta_j + \gamma_0 LTW_{ki} + \beta X_{ik} + u_{kij} \quad \text{(A)}$$

$$Lsource_{kij} = \delta_j + \gamma_1 Lsize_{ki} + \gamma_2 LTW_{ki} + \beta X_i + u_{kij} \quad \text{(B)}$$

where i refers to the household, j refers to the tambon (a local administrative unit at a subdistrict level), and k to the loan (a household may have several loans). In specification (B), we additionally control for loan size because there may be other reasons why smaller loans are more likely informal that are logically distinct from the loan-size-to-wealth ratio (default risk) effect we highlight. If that were the case, finding a negative relationship between the incidence of informal credit and the LTW ratio in specification (A) (as we do) may be purely an artifact of loan size, instead of indicating that larger LTW ratios imply higher default risk thereby disadvantaging informal credit, which is the primary channel we model and seek to identify. Controlling for loan size means that residual variations in the LTW ratio correspond to variations in household wealth and a negative coefficient γ_2 would therefore suggest that, for given loan size, wealthier (less risky in the model) households are more likely to seek informal credit that poorer households. Estimation is done by probit and the results are reported in Table 3. In the Appendix we also display an alternative table using wealth instead of the LTW ratio (Table 8). The regressions with

a year of each other as potentially being part of a larger loan that has been split up (e.g., due to cash constraints on the lenders' side), we arrive at a fraction of roughly 17% of all informal loans and only 0.2 % of all formal loans. We address the possibility that loan size is endogenous in Section 5.2.

[31] In Section 5.2 we explore alternative definitions of formal and informal credit, including BAAC loans.

log loan size and log wealth in columns (2) and (4) of Table 8 are mathematically equivalent to the regressions with log loan size and log LTW ratio in Table 3.

Table 3: Probit Regressions for Loan Source

dependent variable	loan source (informal=1)			
independent variable	(1)	(2)	(3)	(4)
LTW ratio	-0.23***	-0.10*	-0.24***	-0.11*
	(0.03)	(0.04)	(0.03)	(0.05)
loan size		-0.22***		-0.22***
		(0.04)		(0.05)
tenure			-0.42	-0.38
			(0.22)	(0.21)
bank access			-0.31**	-0.20
			(0.11)	(0.11)
BAAC member			-0.23*	-0.13
			(0.10)	(0.10)
income			-0.01	0.09
			(0.04)	(0.05)
Observations	1232	1232	1231	1231
pseudo R^2	0.13	0.15	0.15	0.16

[a] **Note:** The regressions include fixed effects that account for location (tambon) and intended loan usage. We also control for the following household characteristics: age, gender, marital status, education of the head, and total number of outstanding loans. The standard errors reported in parentheses are clustered at the household level. Superscripts ***, ** and * indicate significance at 0.1%,1% and 5%, respectively.

Columns (1) and (2) in Table 3 are the most parsimonious specifications and include as controls only demographic characteristics of the household head, such as gender, education, marital status, and age, as well as fixed effects for location (tambon) and intended use of the loan.[32] The estimates show that the incidence of informal loans is significantly lower the larger is the LTW ratio, ceteris paribus. This holds both with and without controlling for loan size. These findings are in line with the model prediction that riskier loans, as measured by their LTW ratio, are less likely to be informal. The magnitude of the effects is relatively large; for example, in column (1) one standard deviation increase from the mean log LTW ratio decreases the probability of a loan being informal by 13 percentage points. Controlling for loan size, in column (2), the estimated effect of one standard deviation increase in the LTW ratio lowers the likelihood of informal credit by 5 percentage points (equivalently, a 5 percentage point increase in the likelihood of informal credit for one standard deviation increase in household wealth).

Columns (3) and (4) in Table 3 add additional control variables, namely whether or not the household head has lived in the village longer than 6 years ('tenure'), whether (s)he has bank access, whether (s)he is a BAAC member, and household income.[33] In rural areas, access to commercial banks is often restricted and travel times to the nearest branch may be prohibitive while the government-funded BAAC may act

[32] We distinguish between four broad loan use categories: investment, real estate, consumption, and other. The coefficients on age, education and the total number of outstanding loans are statically significant and have the expected signs. They are suppressed in the reported output for brevity of exposition. Full details are available from the authors.

[33] Having access to the BAAC or a commercial bank does not mean that the household has an outstanding loan with these institutions.

as a backup credit source. Clearly, these factors may affect the choice of loan source and, since they are also likely to be correlated with the loan size and borrower wealth, omitting them might bias the estimates. We see, however, that the negative coefficients on the LTW ratio and loan size are essentially unaffected and remain statistically significant (compare columns 3 and 4 to columns 1 and 2).

Looking at the estimated coefficients on the controls, column (3) indicates that access to a commercial bank increases the probability of a formal loan holding the LTW ratio constant, which is expected but the significance of this effect disappears when loan size is also controlled for. A similar result holds for BAAC access. Household income is not correlated with the loan source choice when controlling for the LTW ratio, loan size and other household characteristics.

5.2 Robustness

5.2.1 Selection

A potentially important issue that we have neglected so far is that households who decided not to take a loan are not present in our sample. This could cause our estimates to be biased if sample selection is based on unobserved characteristics that are also correlated with the choice of loan source. For example, it is possible that households who borrow have larger credit needs or are more trustworthy than households who decide not to borrow. To correct for this potential selection bias, we use Heckman's (1979) correction method for probit models.[34] In the first stage, we estimate a selection equation as the probit regression,

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

where s_{ij} is the propensity to be included in the sample ($D_{ij} = 1$) if the household took a loan and zero otherwise, Z_i is a vector of observable household characteristics and e_{ij} is an error term. The second stage incorporates a transformation of the predicted choice probabilities as an additional explanatory variable to correct for selection,

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

where $\lambda(\cdot)$ is the inverse Mills ratio, evaluated at $\alpha Z_i + \delta_j$ and M_{ki} is either $Lsize_{ki}$ or ($Lsize_{ki}$, LTW_{ki}) corresponding to specifications (A) and (B) in Section 5.1. To help separately identify the borrowing decision from the choice of loan source, we include two additional variables in the selection equation: household savings and the binary variable "credit constrained" which equals 1 if the respondent answered "yes" to the survey question whether "additional funds would be useful to increase the profitability of the family business or farm".[35] As we show below, both these variables are important predictors of the decision to borrow while at the same time relatively unimportant in explaining loan source choice. This makes intuitive sense – the need to borrow is lower for households who already have liquid funds set aside and higher for households who perceive that their business is held back by insufficient capital. On the other hand, there is no strong conceivable link between the "savings" and "credit constrained" variables and the decision from whom to borrow, accounting for other observable household characteristics.[36]

[34] We use a version of the method in which the second stage equation is also probit ('heckprob' in Stata).

[35] We also ran a specification using the same covariates in the selection and main equations in which identification comes from the joint normality assumption; the results are unaffected.

[36] The raw correlation with our dependent variable Lfriend (which equals 1 for loans from friends and relatives) is -0.04 for household savings and -0.02 for "credit constrained". Note that savings are part of household wealth which enters

Table 4: Heckman Correction Probit Regressions for Loan Source

dependent variable	loan source (1=informal)			
	(1)	(1')	(2)	(2')
LTW ratio	-0.24***		-0.10*	
	(0.04)		(0.05)	
loan size			-0.22***	
			(0.05)	
tenure	-0.40	0.13	-0.35	0.13
	(0.21)	(0.15)	(0.21)	(0.15)
bank access	-0.33**	0.00	-0.22*	0.00
	(0.10)	(0.09)	(0.11)	(0.09)
BAAC member	-0.14	0.74***	-0.02	0.74***
	(0.14)	(0.09)	(0.14)	(0.09)
income	-0.00	0.09**	0.10*	0.09**
	(0.04)	(0.03)	(0.05)	(0.03)
savings		-0.15***		-0.15***
		(0.02)		(0.02)
credit constrained		0.35***		0.35***
		(0.07)		(0.08)
Observations	1228	866	1228	866
corr. of error terms		0.26		0.34
		(0.29)		(0.28)
Wald test p-value		0.39		0.26

[a] **Note:** The columns with primes are the selection equations. All specifications control for household characteristics (age, gender, marital status, tenure, and education of the head) and include tambon fixed effects. The loan source regressions also include intended loan usage and total number of outstanding loans. The standard errors reported in parentheses are clustered at the household level. Superscripts ***, ** and * indicate significance at 0.1%,1% and 5%, respectively.

The results in Table 4 provide support for the robustness of our previous findings. The estimated coefficients of the main variables (the LTW ratio and loan size) remain similar in magnitude and significance to those in the baseline, Table 3, columns (3) and (4). Furthermore, the estimates of the correlation between the error terms in the main and selection equations show a relatively weak relationship, with the corresponding Wald test not statistically significant. Assuming that the selection model is correctly specified, these results suggest that sample selection bias does not pose a significant problem for the validity of our estimates.[37]

The coefficient estimates in the selection equation (columns 1' and 2' in Table 4) have the expected signs. Controlling for other household characteristics, the propensity to take a loan increases in income and decreases in household savings. Also, the estimated effect of whether a household reports to be credit constrained is positive and strongly significant, that is, households who state that expanding their business or farm would be profitable are more likely to borrow than those who do not.

the LTW ratio and so the LTW ratio and savings are correlated. However, savings are typically only a tiny fraction of household wealth. Among the households without loans, the median ratio of savings to total wealth is roughly 0.2% and rises to 0.3% for the households with loans.

[37] Of course, an alternative interpretation could be that we have failed to fully capture the selection effect in which case we would not be able to rule out that our estimates might be biased.

5.2.2 Alternative definitions of formal and informal credit

We next examine the sensitivity of our results to alternative definitions of formal and informal credit. As explained in Section 2, so far we have excluded from the analysis loans from the BAAC and village organizations (agricultural cooperatives, production credit groups, village funds, etc). In particular, BAAC loans are very common in rural Thailand and make up for almost 35% of all loans in our data.

It seems natural to consider the BAAC (a government bank) a formal lender. Indeed, roughly 85 percent of BAAC loans require collateral and virtually all carry positive interest rate. At the same time, many BAAC loans are group loans and rely on joint liability, thus drawing on pre-existing social ties (about 50 percent of BAAC loans are backed by multiple guarantors). Similarly, loans from village organizations often rely on community monitoring or enforcement and so can be thought of as backed by social capital.

We check the robustness of our baseline results by first considering a wider definition of formal credit which includes all loans from commercial banks, moneylenders and the BAAC (columns 2 and 2' in Table 5). We also consider a wider definition of informal credit by adding BAAC loans and loans from village organizations (production credit groups, agricultural cooperatives, village funds and rice banks) to the baseline set of informal loans from relatives and neighbours (columns 3 and 3'). Another definition of informal credit adds only the loans from village organizations to the baseline informal loan categories (see columns 4 and 4'). Columns 1 and 1' in Table 5 repeat the baseline results from Table 3, columns (3)-(4) for convenience. For brevity we only report the main coefficients of interest.

Table 5: Alternative definitions of formal and informal credit

	baseline		wide formal		wide informal 1		wide informal 2	
loan source	(1)	(1')	(2)	(2')	(3)	(3')	(4)	(4')
LTW ratio	-0.24***	-0.11*	-0.28***	-0.11**	-0.15***	-0.09*	-0.23***	-0.15**
	(0.03)	(0.05)	(0.03)	(0.04)	(0.03)	(0.04)	(0.03)	(0.04)
loan size		-0.22***		-0.30***		-0.11*		-0.14**
		(0.05)		(0.05)		(0.04)		(0.05)
N	1231	1231	2389	2389	2818	2818	1660	1660
pseudo R^2	0.15	0.16	0.34	0.36	0.13	0.13	0.12	0.13

[a] **Note:** The dependent variable is the loan source which equals 1 if the source is informal, and 0 otherwise (see the text for the categorization in different samples). All regressions control for location and intended loan usage, household demographics, and the co-variates specified in columns (3) and (4) in Table 3. The standard errors reported in parentheses are clustered at the household level. Superscripts ***, ** and * indicate significance at 0.1%,1% and 5%, respectively.

The results in Table 5 show that the definition of formal vs. informal loans matters for the coefficient magnitudes but overall the results remain consistent with our model. In all specifications with the LTW ratio alone (columns 2, 3 and 4) the corresponding estimates are statistically significantly negative at the 0.1% level, indicating a strong negative relationship between loan informality and the LTW ratio that is robust to the different considered definitions of formal and informal credit. Controlling for loan size (the columns with primes), the coefficient on the LTW ratio also remains statistically significantly negative in all specifications.[38] We also find that loan size is always significantly negatively associated with loan

[38] Re-defining informal credit to include only loans from relatives, neighbours and the BAAC also yields a negative coefficient on the LTW ratio but with p-value larger than 0.1.

informality at the 5% confidence level or better, with coefficient estimates varying between -0.11 and -0.30 depending on the definition of formal vs. informal credit used.

5.2.3 Loan size endogeneity

We now address the potential issue of loan size endogeneity. In the model and the empirical analysis thus far we have treated loan size as exogenously given, for instance as determined by the borrower's investment needs. In practice, however, loan size, the loan source and the loan terms can be jointly determined; for example a risky borrower could receive a smaller loan than requested. Alternatively, if informal lenders have limited funds, instead of taking a more expensive formal loan, a borrower could split the needed amount into smaller loans from multiple informal sources. This possibility does not invalidate our theory *a priori* – allowing households to split up large loans in the model would not alter our conclusions qualitatively, except for increasing the range for which informal credit is feasible (the upper limit $\bar{\theta}$). However, if such issues were widespread, the causal link implied by our model, from the LTW ratio and loan size to the chosen credit source, could be reversed or the dependent and independent variables be co-determined, potentially biasing the estimates.

Table 6: Exogenous Loan Size Regressions

dependent variable	hypothetical loan source (informal =1)				
estimation method	fixed effects	random effects GLS		random effects logit	
	(1)	(2)	(3)	(4)	(5)
LTW ratio		-0.05***	-0.02*	-0.46***	-0.21*
		(0.01)	(0.01)	(0.06)	(0.09)
loan size	-0.01***		-0.01***		-0.05**
	(0.00)		(0.00)		(0.01)
Observations	2830	2,764	2,764	2,764	2,764
number of HHs	1,987	1,940	1,940	1,940	1,940

[a] **Note:** In specification (1) all households whose answers did not vary with the size of the loan were dropped. The random effects regressions include fixed effects for location (tambon) and intended loan usage, and control for household characteristics. The LTW ratio, loan size and income are logged. Superscripts ***, ** and * indicate significance at 0.1%,1% and 5%, respectively.

The survey contains a question which allows us to address the loan size endogeneity concern by using an exogenous proxy. Households were asked to imagine a hypothetical situation in which they need funds for an emergency and had to answer how they would get the needed amount. The possible answers included "selling assets" (land, equipment, livestock, car, etc.), "using savings"or "taking a loan". In the latter case the source had to be specified. Since all households were asked about the same two hypothetical loan amounts, 2,000 and 20,000 Baht, the latter are clearly exogenous to the observed and unobserved household characteristics. Assuming that households responded to the hypothetical question in a way corresponding to their actual behaviour, we can use an indicator variable for the two hypothetical loan sizes as the regressor and the corresponding answer about the chosen loan source as the outcome variable. The results are reported in Table 6. We only report the estimates for the main variables of interest. The fixed effects specification in column (1) uses only loan size since all other variables are at the household level. The other specifications include the same covariates as Table 3.

The results in Table 6 remain consistent with the model predictions: in the model with household fixed effects, column (1), an exogenous increase in the hypothetical loan size has a statistically significantly negative effect on the reported choice of informal credit. Similarly, in the random effect models, columns (2)–(5), the probability that a household reports relatives or neighbours as their preferred loan source decreases in the LTW ratio, with and without controlling for loan size.

5.2.4 Alternative mechanism

So far we have interpreted the results on loan source choice in Tables 3-6 in line with our theoretical model, that is, higher LTW ratio implies higher risk of default which makes a borrower more likely to choose formal credit, all else equal. However, an alternative hypothesis consistent with these results could be that the friends and relatives of poor households are also likely to be poor on average.[39] Hence, a poor household has to go to a formal lender whenever it needs a large loan, since an informal loan is unavailable from its peers. In other words, conditional on being poor, the determinants of credit source choice might be the loan size and the wealth of one's potential informal lenders, and not the LTW ratio and default risk.

Unfortunately, our data does not allow us to directly test or otherwise address this alternative mechanism. First, we do not observe the borrowers' network of possible informal lenders and their wealth. Second, we do not observe whether both formal and informal loans are feasible for a household. Given these data limitations, we can only investigate this alternative hypothesis indirectly.

We first focus on small loans, either below the median loan size (10,000 Baht) or in the bottom quartile of the loan size distribution (below 3,000 Baht). Both these loan sizes are very small relative to the households' wealth and incomes in our sample. The bottom 1% of the wealth distribution is 15,000 Baht, the bottom 1% of the income distribution is 4,000 Baht, and only 6% of all households have incomes below 10,000 Baht. Therefore, it is very plausible that, even if a household were poor and only had poor friends or relatives, the latter would still be able to afford such small loans. In columns (1) and (2) of Table 7 we re-run the loan source choice regressions from Table 3 but restricting the sample to only loans with size below the median (10,000 Baht) or in the bottom quartile (below 3,000 Baht), respectively. We see that for these small loan amounts, for which informal credit is likely to be feasible for all households, the LTW ratio remains statistically significant and negatively associated with informal credit. In contrast, the coefficient on loan size is not statistically different from zero suggesting that for these households loan size on its own is not associated with the choice of loan source. A possible issue with specifications (1) and (2), however, is that they feature a mix of poorer households (with higher LTW ratios) and richer households (with lower LTW ratios). Thus, if informal credit is differentially more available for the richer households, this would affect the LTW ratio estimate. In Table 7, column (3) we address this potential composition effect by restricting the sample further, to only poorer households (wealth below the median) with loans below the median loan size.[40] The results remain robust.

[39] We thank a helpful referee for this observation. In the model this possibility can be captured by positive correlation between wealth, w and $\bar{\theta}$.

[40] We cannot do the same for column (2) or for households with wealth above the median as the sample size becomes too

Second, while we do not observe the households' actual network of potential informal lenders, we attempt to imperfectly proxy for this network by including village-level fixed effects in the loan choice regressions, see Table 7, columns (4) and (5). Unfortunately, our data are such that including village fixed effects leads to a significant reduction in the sample size and data from 55 out of the 192 villages are dropped due to collinearity. Nevertheless, we cautiously interpret the estimates in specifications (4) and (5) of Table 7 as remaining in line with our baseline results.

Overall, while the results in Table 7 suffer from data limitations and cannot rule out the possibility that some poor households may indeed be constrained in their ability to borrow informally, they offer further supportive evidence for the role of the LTW ratio in explaining the choice between formal and informal credit.

Table 7: Additional Regressions for Loan Source

dependent variable	loan source (informal=1)				
independent variable	(1)	(2)	(3)	(4)	(5)
LTW ratio	-0.21**	-0.33*	-0.27*	-0.26***	-0.08†
	(0.08)	(0.14)	(0.12)	(0.04)	(0.05)
loan size	0.02	-0.02	0.05		-0.28***
	(0.14)	(0.27)	(0.16)		(0.05)
Observations	508	209	418	1,073	1,073
pseudo R^2	0.16	0.21	0.19	0.20	0.23

[a] **Note:** Specification (1) uses only loans below the median loan size (10,000 Baht). Specification (2) uses only loans with size in the bottom quartile (below 3,000 Baht). Specification (3) uses only loans of households with wealth below the median and not larger than the median loan size. Specifications (4) and (5) use village fixed effects and the controls from columns (1) and (2) in Table 3. Standard errors reported in parentheses are clustered at the household level. ***, **, * and † indicate significance at 0.1%,1%, 5% and 10% respectively.

6 Conclusions

We model borrowers' choice between formal (collateral based) credit and informal (social capital based) credit in a setting with asymmetric information, risk, and strategic default. Our model delivers testable predictions that are consistent with data from rural Thailand. First, informal lenders charge lower interest rate and require less collateral than formal lenders. Second, the likelihood of observing informal loans decreases with the loan size to household wealth ratio (the LTW ratio) which proxies for risk of default in the model.

We focus on informal loans between agents in a kinship or other social relationship characterized by a sufficiently large social capital value that is lost to the borrower or to both parties in case of default. The presence of this social capital is essential for supporting repayment and ruling out strategic default in informal loans even when they require no physical collateral. The assumption that the social capital value is sufficiently large (Assumption A2) makes our model better suited to traditional settings, such as rural or immigrant-group communities in which the value of maintaining interpersonal links is high. It is also consistent with the observed prevalence of informal credit in such settings.

small.

Reducing the social capital loss upon default makes informal loans look more like formal (they carry interest to compensate for default risk and require collateral). The informal loan terms, however, are still more favorable than those of formal loans for the same borrower. In addition, informal loans would still be chosen for less risky investments, as long as some social capital can be pledged.

In the model, agents choose either an informal or formal loan, depending on their wealth and the needed amount to invest in their project. Nothing in the analysis prevents agents from having two projects requiring different loan sizes and hence possibly borrowing from both an informal and formal source, backing the informal loan with social capital and the formal loan with assets. The analysis would change, however, if formal lenders could observe repayment on an informal loan as a signal of project success or ability to repay.

We have deliberately abstracted from risk aversion and the role of (informal) credit as a risk-sharing mechanism, in order to highlight as clearly as possible the main trade-off between the pecuniary and non-pecuniary costs and benefits of informal credit based on social ties vs. formal credit based on collateral. Extending the model to allow for risk sharing or explicitly modeling repeated interactions between the borrowers and lenders remain topics for future research.

In addition to the choice between formal and informal credit for a project of given size by a borrower of given wealth, our model has indirect implications for the type of investments that are likely to be financed using formal vs. informal loans. For example, if formal credit were unavailable (e.g., for lack of collateral), and the model were extended to allow project choice, the social disutility from default would imply that projects financed by informal credit would involve less risk taking compared to in a setting without financial constraints. As a result, households or regions primarily relying on informal credit based on social ties could experience slower or limited business growth.

References

[1] Anderson, S. and P. Francois, 2008. "Formalizing Informal Institutions: Theory and Evidence from a Kenyan Slum", in *Institutions and Economic Performance*, E. Helpman (ed.), Harvard University Press.

[2] Banerjee, A. and E. Duflo, 2007. "The Economic Lives of the Poor", Journal of Economic Perspectives 21(1), p.141-67.

[3] Barslund, M., Tarp, F., 2008. "Formal and informal rural credit in four provinces of Vietnam", Journal of Development Studies 44(4), p.485-503.

[4] Besley, T. and S. Coate, 1995. "Group lending, repayment incentives and social collateral", Journal of Development Economics 46(1), p.1-18.

[5] Bond, P. and R. Townsend, 1997. "Formal and informal financing in a Chicago ethnic neighbourhood", Economic Perspectives 20(4), p.3-27.

[6] Boot, A. and A. Thakor, 1994. "Moral hazard and secured lending in an infinitely repeated credit market game", International Economic Review 35(4), p.899-20.

[7] Bose, P., 1998. "Formal-Informal Interaction in Rural Credit Markets", Journal of Development Economics 56, p.265-80.

[8] Braverman, A. and J. Stiglitz, 1982. "Sharecropping and the Interlinking of Agrarian Markets", American Economic Review 72(4), p.695-715.

[9] Coate, S. and M. Ravallion, 1993. "Reciprocity without commitment: Characterization and performance of informal insurance arrangements", Journal of Development Economics 40(1), p.1-24.

[10] Fafchamps, M., 1999. "Risk Sharing and Quasi-Credit", Journal of International Trade and Economic Development 8(3), p.257-78.

[11] Ghatak, M. and T. Guinnane, 1999. "The economics of lending with joint liability: theory and practice", Journal of Development Economics, 60(1), p.195-228.

[12] Ghosh, P., D. Mookherjee and D. Ray, 2000. "Credit Rationing in Developing Countries: An Overview of the Theory", ch. 11 in *Readings in the Theory of Economic Development.*

[13] Gine, X., 2011. "Access to Capital in Rural Thailand: An Estimated Model of Formal vs. Informal Credit", Journal of Development Economics 96, p.16-29.

[14] Guirkinger, C., 2008. "Understanding the coexistence of formal and informal credit markets in Piura, Peru", World Development 36(8), p.1436-52.

[15] Heckman J., 1979. "Sample selection bias as a specification error", Econometrica 47, p.153-61.

[16] Hoff, K., and J. Stiglitz, 1994. "Some Surprising Analytics of Rural Credit Subsidies", mimeo., Department of Economics, University of Maryland.

[17] Jain, S., 1999, "Symbiosis vs. Crowding-Out: the Interaction of Formal vs. Informal Credit Markets in Developing Countries.", Journal of Development Economics 59, p.419-44.

[18] Jakiela, P. and O. Ozier, 2015. "Does Africa Need a Rotten Kid Theorem? Experimental Evidence from Village Economies.", Review of Economic Studies (forthcoming).

[19] Kaboski, J. and R. Townsend, 1999, "Lending Services of Local Financial Institutions in Semi-Urban and Rural Thailand ", manuscript.

[20] Kochar, A., 1997. "An Empirical Investigation of Rationing Constraints in Rural Credit Markets in India.", Journal of Development Economics 53, p.339-71.

[21] Kocherlakota, N., 1996. "Implications of Efficient Risk Sharing without Commitment", Review of Economic Studies 63(4), p.595-09.

[22] Lee, S. and P. Persson, 2016. "Financing from Family and Friends", Review of Financial Studies 29(9), p.2341-86.

[23] Lisack, N., 2016. "Alternative Finance and Credit Sector Reforms: the Case of China", manuscript, European University Institute.

[24] Madestam, A., 2014. "Informal Finance: A Theory of Moneylenders", Journal of Development Economics 107, p.157-74.

[25] National Association of Realtors, 2012. *Profile of Home Buyers and Sellers*, www.realtor.org.

[26] Paulson, A. and R. Townsend, 2004. "Entrepreneurship and Financial Constraints in Thailand", Journal of Corporate Finance 10, p.229-62.

[27] Stiglitz, J., 1990. "Peer Monitoring and Credit Markets", World Bank Economic Review 4, p.351-66.

[28] Turvey, C. and R. Kong, 2010. "Informal lending amongst friends and relatives: can microcredit compete in rural China?", China Economic Review 21, p.544-56.

[29] Udry, C., 1994. "Risk and Insurance in a Rural Credit Market: An Empirical Investigation in Northern Nigeria", Review of Economic Studies 61(3), p.495-526.

7 Appendix A – Proofs

Proof of Proposition 1 (formal credit)

Since $c_F \geq \min\{c_F, w\}$, constraint (IC$_F$) implies $c_F \geq r_F$. Together with (NN), this implies that formal loans *always require positive collateral* since $c_F \geq r_F \geq \theta > 0$. Note that the lender's payoff U_L^F is increasing in r_F and the borrower's payoff U_B^F is decreasing in r_F since $\int_0^\infty \min\{r_F, \alpha w\} d\pi(\alpha)$ is increasing in r_F.[41] This implies that the solution to **Problem F** is the *smallest* possible repayment, $r_F^* \geq \theta$ at which the lender's participation constraint $U_L^F \geq \theta$ is satisfied. Without loss of generality we can set $c_F^* = r_F^*$ since a larger collateral does not affect the lender's and borrower's payoffs and since constraint (IC$_F$) requires $c_F \geq r_F$. There are three possible cases depending on the LTW ratio $\frac{\theta}{w}$.

Case F1 (low LTW ratio): $\frac{\theta}{w} \leq \alpha_{\min}$. In this case, $\theta \leq \alpha w$ for *all* $\alpha \in [\alpha_{\min}, 1]$ and so, evaluated at $r_F = \theta$, $U_L^F = \int_0^\infty \min\{\theta, \alpha w\} d\pi(\alpha) = \theta$. That is, (PC$_L$) is satisfied at equality. Since, by (NN), $r_F = \theta$ is the lowest possible repayment and since the borrower's participation constraint is satisfied, $U_B^F = (pR - 1 - \lambda)\theta > 0$ (by Assumption A1), the loan terms solving **Problem F** for $\frac{\theta}{w} \leq \alpha_{\min}$ are $c_F^* = r_F^* = \theta$. The borrower always has sufficient funds and incentive to repay the loan and there is no default in equilibrium.

Case F2 (high LTW ratio): $\frac{\theta}{w} > E(\alpha)$. This implies,

$$\theta > wE(\alpha) \geq \int_0^\infty \min\{r_F, \alpha w\} d\pi(\alpha)$$

[41] To prove this, call $x = \frac{r_F}{w}$ and write $U_L^F = w(\int_0^x \alpha d\pi(\alpha) + (1 - \pi(x))x)$. The derivative $\frac{\partial U_L^F}{\partial r_F}$ equals $x\pi'(x) + 1 - \pi'(x)x - \pi(x) \geq 0$, with strict inequality for $r_F \in (\theta, w)$. The second derivative of U_L^F has the same sign as $-\pi'(x)$. Hence U_L^F is strictly increasing and strictly concave in r_F on (θ, w).

The second inequality holds since $\alpha w \geq \min\{r_F, \alpha w\}$ for all α and hence $wE(\alpha) = \int_0^\infty \alpha w d\pi(\alpha) \geq \int_0^\infty \min\{r_F, \alpha w\} d\pi(\alpha)$. Thus, if $\frac{\theta}{w} > E(\alpha)$ the lender's break-even constraint (PC$_L$) cannot be satisfied. No feasible r_F, c_F exist because of strategic default and limited liability and **Problem F** has no solution.

Case F3 (intermediate LTW ratio): $\alpha_{\min} < \frac{\theta}{w} \leq E(\alpha)$. For $\frac{\theta}{w} > \alpha_{\min}$, is easy to see that evaluating U_L^F at $r_F = \theta$ and any $c_F \geq \theta$ yields

$$\int_0^\infty \min\{\theta, \alpha w\} d\pi(\alpha) < \int_0^\infty \theta d\pi(\alpha) = \theta.$$

Since U_L^F is increasing in r_F, this implies that a strictly positive interest, $r_F^* > \theta$ is needed for the lender to break even when $\frac{\theta}{w} > \alpha_{\min}$. Therefore, since U_B^F is decreasing in r_F, the optimal repayment r_F^* solving **Problem F** is the $r_F > \theta$ at which the lender's participation constraint (PC$_L$) holds with equality (otherwise a reduction in r_F would increase the objective U_B^F). That is, r_F^* solves,

$$U_L^F = \int_0^\infty \min\{\alpha w, r_F\} d\pi(\alpha) = \theta \tag{5}$$

We saw that $U_L^F < \theta$ when evaluated at $r_F = \theta$. Evaluating U_L^F at $r_F = w$ yields $wE(\alpha)$ which is strictly larger than θ for any $\frac{\theta}{w} < E(\alpha)$. Therefore, by continuity, for any $\frac{\theta}{w} \in (\alpha_{\min}, E(\alpha))$, there exists $r_F^* \in (\theta, w)$ which solves (5). Moreover, the solution r_F^* is unique and *strictly increasing and strictly convex* in θ because U_L^F is strictly increasing and strictly concave in r_F (see footnote 42). As in *Case F2*, it is directly verified that $r_F^* = w$ solves (5) for $\frac{\theta}{w} = E(\alpha)$.

Note that the borrower's participation constraint (PC$_B$) is satisfied at the r_F^* solving (5) and $c_F^* = r_F^*$ for any $\frac{\theta}{w} \in (\alpha_{\min}, \hat{\alpha}_F]$ since, after substituting the integral from (5) into the borrower's payoff, we have $U_B^F(r_F^*, c_F^*) = (pR-1-\lambda)\theta > 0$. This implies that the loan terms solving **Problem F** for $\frac{\theta}{w} \in (\alpha_{\min}, E(\alpha)]$ are the $r_F^* > \theta$ solving (5) and $c_F^* = r_F^*$. Finally, these results imply that the threshold LTW ratio $\hat{\alpha}_F$, such that formal loans are feasible for $\frac{\theta}{w} \in (0, \hat{\alpha}_F]$ and not feasible otherwise, is $\hat{\alpha}_F = E(\alpha)$.

Proof of Proposition 2 (informal credit)

The proof proceeds in several steps labeled in italics. Suppose that $\gamma > r_I$ holds, that is, by Lemma 1, there is no strategic default since $\delta(\alpha, \gamma) \geq \gamma > r_I$ for all α. Below we prove that condition (NSD) in Assumption A2(i) guarantees that $\gamma > r_I^*$ where r_I^* is the loan repayment solving **Problem I**.

Step 1. The borrower's payoff U_B^I is decreasing in r_I and c_I

We first show that the borrower's expected payoff U_B^I is decreasing in r_I and c_I when $\gamma > r_I$. Write U_B^I as function of r_I and c_I as

$$U_B^I(r_I, c_I) = pR\theta - (1-p) \int_0^{r_I/w} \min\{c_I, \alpha w\} d\pi(\alpha) - (1-p)\pi(\tfrac{r_I}{w})\gamma - (1-(1-p)\pi(\tfrac{r_I}{w}))r_I.$$

Clearly, holding c_I fixed, the second term is decreasing in r_I (strictly if $r_I \in (\alpha_{\min} w, w)$). Calling M the sum of the third and fourth terms and differentiating with respect to r_I,

$$\frac{\partial M}{\partial r_I} = -[1-(1-p)\pi(\tfrac{r_I}{w}) + (1-p)\tfrac{1}{w}\pi'(\tfrac{r_I}{w})(\gamma - r_I)] \leq 0$$

since we assumed $\gamma > r_I$ and since $\pi(\frac{r_I}{w}) \in [0,1]$ and $\pi'(\frac{r_I}{w}) \geq 0$. This implies that U_B^I is decreasing in r_I. Holding r_I fixed, U_B^I is also decreasing in c_I (strictly if $c_I \in (\alpha_{\min} w, r_I)$).

Step 2. Informal loan terms as function of the LTW ratio $\frac{\theta}{w}$

(a) Suppose $\frac{\theta}{w} \leq \alpha_{\min}$. This implies $\pi(\frac{\theta}{w}) = 0$ and it is easy to see that the lender's participation constraint (PC_L) holds with equality at $r_I = \theta$ and $c_I = 0$. Step 1 implies that if $\gamma > r_I$ the objective U_B^I is maximized for the smallest r_I and c_I which satisfy all constraints in **Problem I**. Clearly, $r_I = \theta$ and $c_I = 0$ are the smallest interest and collateral satisfying non-negativity (NN). The incentive constraint (IC_I) is satisfied by Assumption A2(i), $\gamma > \frac{\theta}{p} > \theta = r_I$ and hence there is no strategic default. The borrower's participation constraint (PC_B) is also satisfied since $U_B^I = (pR-1)\theta \geq 0$ by Assumption A1. Hence, the loan terms $r_I^* = \theta$ (zero interest) and $c_I^* = 0$ (no collateral) solve **Problem I** for any $\frac{\theta}{w} \leq \alpha_{\min}$.

(b) Suppose now $\frac{\theta}{w} > \alpha_{\min}$. Since $r_I \leq \alpha w$ for $\alpha \geq \frac{r_I}{w}$, we can write the lender's payoff as the following function of r_I and c_I,

$$U_L^I(r_I, c_I) = pr_I + (1-p)\int_0^{r_I/w} \min\{c_I, \alpha w\} d\pi(\alpha) + (1-p)\int_{r_I/w}^{\infty} \min\{r_I, \alpha w\} d\pi(\alpha)$$

Evaluating $U_L^I(r_I, c_I)$ at $r_I = \theta$ and using that $\int_0^{\theta/w} \min\{c_I, \alpha w\} d\pi(\alpha) \leq \int_0^{\theta/w} \alpha w d\pi(\alpha)$, with equality only if $c_I \geq \theta$,

$$U_L^I(\theta, c_I) \leq p\theta + (1-p)\int_0^{\infty} \min\{\theta, \alpha w\} d\pi(\alpha) < p\theta + (1-p)\theta = \theta,$$

where the second inequality follows since $\alpha_{\min} w < \theta$. This implies that $r_I^* > \theta$ (positive interest), otherwise informal loans are not feasible as (PC_L) is not satisfied.

Suppose (PC_L), that is, $U_L^I(r_I, c_I) \geq \theta$, is satisfied at some $r_I > \theta$ and $c_I \geq 0$. Then,

$$U_B^I(r_I, c_I) \leq pR\theta - \theta - (1-p)\pi(\tfrac{r_I}{w})\gamma$$

with equality when (PC_L) binds. Since the right hand side is decreasing in r_I, the borrower's payoff U_B^I is maximized for the *smallest* $r_I > \theta$ at which (PC_L) binds.

We show that such r_I always exists. Note that $U_L^I(r_I, c_I) = U_L^I(r_I, r_I)$ for any $c_I \geq r_I$. Call $\tilde{r}_I(\theta)$ the solution to $U_L^I(r_I, r_I) = \theta$, that is, the solution to

$$h(r_I) \equiv pr_I + (1-p)\int_0^{\infty} \min\{r_I, \alpha w\} d\pi(\alpha) = \theta. \tag{6}$$

Above we showed that $h(\theta) < \theta$. Then, since $h(r_I)$ is a strictly increasing[42] and continuous function unbounded from above, a unique solution $\tilde{r}_I(\theta) > \theta$ to (6) always exists, with $\tilde{r}_I(\theta)$ strictly increasing in

[42]This follows the same way as in Proposition 1, see footnote 42.

θ. Finally, note that the integral in the second term of (6) is bounded from above by $wE(\alpha)$ and hence, for sufficiently large θ (for which $\tilde{r}_I(\theta) \geq w$), the solution to (6) is $\tilde{r}_I(\theta) = \frac{\theta-(1-p)wE(\alpha)}{p}$. It is easy to verify that the latter holds if $\frac{\theta}{w} \geq p + (1-p)E(\alpha)$.

What we still need to show is that, for any given $\theta > \alpha_{\min} w$, the value $\tilde{r} = \tilde{r}_I(\theta)$ solving (6) is the *smallest* repayment r_I at which (PC$_L$) binds. Suppose not, that is, suppose there exist some (r', c') with $r' \in (\theta, \tilde{r})$ and $U_L^I(r', c') = \theta$. If $c' \geq r'$, we obtain a contradiction since $U_L^I(r', c') = U_L^I(r', r') < U_L^I(\tilde{r}, \tilde{r}) = \theta$ using that $h(r) = U_L^I(r, r)$ is strictly increasing. Suppose instead $c' < r'$ and note that in such case $\int_0^{r'/w} \min\{c', \alpha w\} d\pi(\alpha) < \int_0^{r'/w} \min\{r', \alpha w\} d\pi(\alpha)$. Therefore,

$$\theta = U_L^I(r', c') < U_L^I(r', r') < U_L(\tilde{r}, \tilde{r}) = \theta$$

which is a contradiction.

The above results imply that, for any $\frac{\theta}{w} > \alpha_{\min}$, there always exist loan terms (r_I^*, c_I^*) with $r_I^* = \tilde{r}_I(\theta) > \theta$ solving (6) and $c_I^* \geq \tilde{r}_I(\theta)$ which satisfy the non-negativity constraint (NN), the incentive constraint (IC$_I$), and the lender's participation constraint (PC$_L$). Without loss of generality we can set $c_I^* = \tilde{r}_I(\theta)$ since any larger collateral does not affect the borrower's and lender's payoff. Clearly then, as long as (PC$_B$) is satisfied (to be determined below), the loan terms (r_I^*, c_I^*) solve **Problem I**.

3. *Condition (NSD), $\gamma > \frac{\theta}{p}$ is sufficient to ensure $\gamma > r_I^*$ and rule out strategic default*

From Step 2, the solution to **Problem I** for $\frac{\theta}{w} \leq \alpha_{\min}$ is $r_I^* = \theta$ and $c_I^* = 0$. Also, for $\frac{\theta}{w} > \alpha_{\min}$ the optimal repayment is $r_I^* = \tilde{r}_I(\theta) > \theta$ which solves $h(r_I) = \theta$. Since $h(r)$ is strictly increasing, holding w fixed, r_I^* is strictly increasing in θ and reaches $\frac{\theta-(1-p)wE(\alpha)}{p}$ for $\frac{\theta}{w} \geq p + (1-p)E(\alpha)$. Clearly, $\frac{\theta-(1-p)wE(\alpha)}{p} \leq \frac{\theta}{p}$ for any $w \geq 0$. Therefore, condition (NSD) implies $\gamma > r_I^*$ for any $\frac{\theta}{w}$ and hence rules out strategic default (see Lemma 1).

4. *There exists a threshold LTW ratio $\hat{\alpha}_I \in (\alpha_{\min}, 1)$ such that the borrower prefers not to borrow informally for $\frac{\theta}{w} > \hat{\alpha}_I$*

(c) So far we have solved for the loan terms that maximize the borrower's payoff subject to (PC$_L$), (IC$_I$) and (NN) ignoring the borrower's participation constraint (PC$_B$), $U_B^I \geq 0$. We show next that (PC$_B$) is only satisfied for sufficiently low LTW ratios $\frac{\theta}{w}$. As we showed in Step 2, (PC$_L$) always binds at the optimal loan terms, (r_I^*, c_I^*). Hence, after substituting from (PC$_L$),

$$U_B^I(r_I^*, c_I^*) = (pR-1)\theta - (1-p)\pi(\tfrac{r_I^*}{w})\gamma$$

Consider the following three cases for the LTW ratio, $\frac{\theta}{w}$.

Case I1 (low LTW ratio), $\frac{\theta}{w} \leq \alpha_{\min}$. We already showed that the borrower's participation constraint is satisfied for such $\frac{\theta}{w}$ in Step 2.

Case I2 (high LTW ratio), $\frac{\theta}{w} \geq p + (1-p)E(\alpha)$. The results in Step 2 imply $r_I^* \geq w$ and so $\pi(\frac{r_I^*}{w}) = 1$. Hence (PC$_B$) is violated,

$$U_B^I(r_I^*, c_I^*) = (pR-1)\theta - (1-p)\gamma < 0,$$

since $\gamma > \frac{(pR-1)\bar{\theta}}{1-p}$ by condition (H) in Assumption A2(ii). Therefore, no informal loans are taken for such $\frac{\theta}{w}$. Note also that $p + (1-p)E(\alpha) \in (E(\alpha), 1)$ since $E(\alpha) < 1$.

Case I3 (intermediate LTW ratio), $\alpha_{\min} < \frac{\theta}{w} < p + (1-p)E(\alpha)$. From Cases *I1* and *I2*, constraint (PC_B) is satisfied, $U_B^I(r_I^*, c_I^*) > 0$, when the LTW ratio is sufficiently small, $\frac{\theta}{w} \leq \alpha_{\min}$ and violated, $U_B^I(r_I^*, c_I^*) < 0$, when the LTW ratio is sufficiently large, $\frac{\theta}{w} \geq p + (1-p)E(\alpha)$. By continuity, there exists a threshold LTW ratio $\hat{\alpha}_I \in (\alpha_{\min}, p + (1-p)E(\alpha)) \subset (\alpha_{\min}, 1)$ such that informal loans do not satisfy (PC_B) for $\frac{\theta}{w} > \hat{\alpha}_I$.

We next provide a sufficient condition for which the LTW ratio threshold $\hat{\alpha}_I$ at which $U_B^I(r_I^*, c_I^*) = 0$ is unique, and hence informal loans are taken for $\frac{\theta}{w} \leq \hat{\alpha}_I$ and not taken for $\frac{\theta}{w} > \hat{\alpha}_I$.

Lemma A1: $G'' \geq 0$ *is a sufficient condition for the uniqueness of the threshold LTW value* $\hat{\alpha}_I$ *at which* $U_B^I(r_I^*, c_I^*) = 0$.

Proof of Lemma A1: For any $\frac{\theta}{w} \in (\alpha_{\min}, p + (1-p)E(\alpha))$, we have $\pi(\frac{r_I^*}{w}) = G(\frac{r_I^*}{w})$ where $r_I^* = \tilde{r}_I(\theta)$ solving (6). As in the proof of Proposition 1 (see footnote 42) it can be shown that $\tilde{r}_I(\theta)$ is *strictly increasing and strictly convex* in θ. The first partial derivative of $U_B^I(r_I^*, c_I^*)$ with respect to θ is

$$pR - 1 - \tfrac{(1-p)}{w}\gamma G'(\tfrac{\tilde{r}_I(\theta)}{w})\tilde{r}_I'(\theta)$$

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

$$-G'(\tfrac{\tilde{r}_I(\theta)}{w})\tilde{r}_I''(\theta) - G''(\tfrac{\tilde{r}_I(\theta)}{w})(\tilde{r}_I'(\theta))^2$$

Since $\tilde{r}_I''(\theta) > 0$ by the convexity of $\tilde{r}_I(\theta)$ and since $G' > 0$, we obtain that if $G'' \geq 0$ (the cdf G is weakly convex, e.g., satisfied for α uniform), the above second derivative is negative. Therefore, holding borrower's assets w fixed, $U_B^I(r_I^*, c_I^*)$ is a *strictly concave* function of θ, call it $\Phi(\theta)$ for $\frac{\theta}{w} \in (\alpha_{\min}, p + (1-p)E(\alpha))$. This implies that Φ crosses the horizontal axis exactly once since Φ is continuous and satisfies $\Phi(\alpha_{\min} w) > 0$ and $\Phi((p + (1-p)E(\alpha))w) < 0$, as shown earlier. Therefore, if $G'' > 0$, the threshold $\hat{\alpha}_I$ defined as the LTW ratio θ/w at which $\Phi(\theta) = 0$, is unique.■

Proof of Proposition 3 (Informal credit has more favorable terms)

Suppose first $\frac{\theta}{w} \leq \alpha_{\min}$. Then, by Propositions 1 and 2, $r_I^* = r_F^* = \theta$ and $0 = c_I^* < c_F^*$, so an informal loan has the same interest but strictly lower collateral than a formal loan, for the same borrower.

Suppose now $\frac{\theta}{w} > \alpha_{\min}$. From the proof of Proposition 1, $c_F^* = r_F^* > \theta$ where r_F^* solves:

$$\int_0^\infty \min\{\alpha w, r_F\} d\pi(\alpha) = \theta \tag{7}$$

while, from the proof of Proposition 2, $c_I^* = r_I^* > \theta$ where r_I^* solves:

$$h(r_I) \equiv p r_I + (1-p)\int_0^\infty \min\{\alpha w, r_I\} d\pi(\alpha) = \theta \tag{8}$$

Evaluate the l.h.s. of (8) at the formal loan terms r_F^*, c_F^* and use (7) and $r_F^* > \theta$. We obtain,

$$h(r_F^*) = pr_F^* + (1-p)\int_0^\infty \min\{\alpha w, r_F^*\} d\pi(\alpha) = pr_F^* + (1-p)\theta > \theta.$$

That is, the informal lender's participation constraint is *slack* at the formal loan repayment r_F^*. Since $h(r)$ is strictly increasing and using (8), this implies $r_I^* < r_F^*$ (and so $c_I^* < c_F^*$ since setting $c_i^* = r_i^*$ is optimal without loss of generality). Therefore, for $\frac{\theta}{w} > \alpha_{\min}$ an informal loan has strictly lower interest rate and collateral than a formal loan, for the same borrower.■

Proof of Lemma 2:

Calling $t = \frac{\theta}{w}$, the equation $U_B^I(r_I^*, c_I^*) = 0$ for $\frac{\theta}{w} > \alpha_{\min}$ can be written as

$$\pi(\tfrac{\tilde{r}_I(tw)}{w}) = \tfrac{(pR-1)t}{(1-p)\frac{\gamma}{w}} \tag{9}$$

where $\tilde{r}_I$ was defined in the proof of Proposition 2. Holding borrower's assets w fixed, the left and right hand sides of (9) can be viewed as functions of t on the interval $[\alpha_{\min}, 1]$, taking equal value at $\hat{\alpha}_I$. Both sides are strictly increasing in t. The l.h.s. equals 0 at $t \to \alpha_{\min}$ and 1 at $t = 1$. The r.h.s. is positive at $t \to \alpha_{\min}$ and strictly less than 1 at $t = 1$ (by Assumption A2). Hence, assuming the solution $\hat{\alpha}_I$ to (9) is unique (see Lemma A1 for a sufficient condition), the r.h.s. of (9) as function of t crosses the l.h.s. from above at $\hat{\alpha}_I$. We therefore obtain the following comparative statics: (i) an increase in the social capital γ shifts the r.h.s. of (9) down, hence $\hat{\alpha}_I$ decreases in γ, ceteris paribus and (ii) an increase in the project's return R or the project's probability of success p shifts the r.h.s. of (9) up hence $\hat{\alpha}_I$ increases, ceteris paribus.

Proof of Proposition 4 (Loan source choice)

(a) Suppose $\frac{\theta}{w} \leq \alpha_{\min}$. Since $\alpha_{\min} < \hat{\alpha}_F = E(\alpha)$ then formal loans are feasible on the entire interval $\frac{\theta}{w} \in (0, \alpha_{\min}]$. Propositions 1 and 2 imply $r_F^* = r_I^* = \theta$ and $\pi(\frac{\theta}{w}) = 0$ since the risk of non-repayment is zero for both formal and informal lenders. The borrower's expected payoff from taking an informal loan loan is $U_B^I = (pR-1)\theta > 0$ while the borrower's expected payoff from a formal loan is $U_B^F = (pR-1-\lambda)\theta$. Clearly, $U_B^F < U_B^I$ – informal loans are strictly preferred because they avoid the transaction cost λ.

(b) From the proofs of Propositions 1 and 2 we have: (i) the borrower's expected payoff from using formal credit is $U_B^F = (pR-1-\lambda)\theta > 0$ for any $\frac{\theta}{w} \leq \hat{\alpha}_F$; (ii) the borrower's expected payoff from using informal credit is $U_B^I = (pR-1)\theta > 0$ for $\frac{\theta}{w} \leq \alpha_{\min}$; and (iii) $U_B^I < 0$ for $\frac{\theta}{w} > \hat{\alpha}_I$. Results (i)–(iii) imply that, as $\frac{\theta}{w}$ increases starting from $\alpha_{\min}$, the borrower's informal loan payoff, U_B^I is initially larger than the formal loan payoff, U_B^F but eventually falls below U_B^F. By continuity, U_B^I must cross U_B^F. There is a technical issue about potential multiple crossings (multiple solutions to $U_B^I = U_B^F$) since, as shown in Lemma A1, U_B^I may be non-monotonic depending on the properties of the cdf G. In any case, results (i)–(iii) imply the existence of $\hat{\alpha}_1 \in (\alpha_{\min}, \hat{\alpha}_I)$ and $\hat{\alpha}_2 \in (\alpha_{\min}, \hat{\alpha}_I)$ with $\hat{\alpha}_2 \geq \hat{\alpha}_1$ and such that $U_B^I > U_B^F$ for $\frac{\theta}{w} < \hat{\alpha}_1$ and $U_B^F > U_B^I$ for $\frac{\theta}{w} > \hat{\alpha}_2$. In words, informal loans are preferred for relatively small LTW ratios, while formal loans are preferred for larger LTW ratios.[43]

If we assume $G'' \geq 0$, then, as in Lemma A1, U_B^I is a strictly concave function of $\frac{\theta}{w}$ on $(\alpha_{\min}, \hat{\alpha}_I)$ and since $U_B^I > U_B^F > 0$ at $\frac{\theta}{w} = \alpha_{\min}$ while $U_B^F > U_B^I = 0$ at $\frac{\theta}{w} = \hat{\alpha}_I$, we obtain that the LTW ratio at which $U_B^I = U_B^F$ is unique; that is $\hat{\alpha}_1 = \hat{\alpha}_2 = \hat{\alpha}$. Informal loans are then preferred for any $\frac{\theta}{w} \leq \hat{\alpha}$ (low LTW ratios) while formal loans are preferred and available for higher LTW ratios, $\frac{\theta}{w} \in (\hat{\alpha}, \hat{\alpha}_F]$ as long as this interval is non-empty.■

Proof of Lemma 3

As in Lemma A1 and the proof of Proposition 4, $G'' \geq 0$ is a sufficient condition for uniqueness of the LTW ratio $t = \frac{\theta}{w}$ threshold $\hat{\alpha} \in (\alpha_{\min}, \hat{\alpha}_I)$ at which $U_B^I = U_B^F$, or equivalently,

$$\lambda t = (1-p)\pi(\tfrac{\tilde{r}_I(tw)}{w})\tfrac{\gamma}{w} \tag{10}$$

Holding borrower's assets w fixed, both sides of (10) are increasing functions of the LTW ratio t. From the proof of Proposition 4, $U_B^I > U_B^F$ for $t < \hat{\alpha}$ and $U_B^F > U_B^I$ for $t > \hat{\alpha}$. That is, the r.h.s. of (10) crosses the l.h.s. from below at $t = \hat{\alpha}$. When λ decreases, the l.h.s. shifts down while the r.h.s. is unchanged. Hence, $\hat{\alpha}$ goes down. In the limit with zero transaction costs, $\lambda \to 0$, we obtain

$$U_B^I = (pR-1)\theta - (1-p)\pi(\tfrac{r_I^*}{w})\gamma \leq (pR-1)\theta = U_B^F$$

for all $\frac{\theta}{w}$ and hence formal loans are weakly preferred for any θ and w, whenever available.

8 Appendix B – Lender's loss of social capital

8.1 Extended model

Call **Problem $\tilde{\mathbf{I}}$** the extended informal credit problem, that is, **Problem I** with the lender's participation constraint (PC_L) modified to include lender's social costs:

$$\tilde{U}_L^I = [1-(1-p)\pi(\tfrac{r_I}{w})]r_I + \eta(r_I, c_I) - (1-p)\pi(\tfrac{r_I}{w})\phi\gamma \geq \theta - \kappa\gamma \tag{$\mathrm{PC}_L^{\tilde{}}$}$$

Proposition 5 (Informal credit with lender's loss of social capital).
Consider an informal borrower with assets w, social capital γ and required loan size $\theta \leq \bar{\theta}$, which satisfy Assumptions A0-A2.

*a) if $\frac{\theta}{w} \leq \alpha_{\min}$ (low/riskless LTW ratio), the loan terms (r_I^*, c_I^*) solving **Problem $\tilde{\mathbf{I}}$** are $c_I^* = 0$ (no collateral) and $r_I^* = \theta$ (zero interest).*

b) for any $\frac{\theta}{w} > \alpha_{\min}$, an informal lender is willing to provide a loan with the following terms depending on the parameter values:[44]

- *if κ is sufficiently large relative to ϕ, the informal loan solving **Problem $\tilde{\mathbf{I}}$** has zero interest and zero collateral, $r_I^* = \theta$ and $c_I^* = 0$.*

[43]Note that, if $\frac{\theta}{w} > p + (1-p)E(\alpha)$, then $\pi(\frac{r_I^*}{w}) = 1$, as shown in the proof of Prop. 2 and so $U_B^I < U_B^F$ (formal loans are preferred) if $\gamma > \frac{\lambda\theta}{1-p}$. By Assumption A1 this is a weaker condition on γ than condition (H) in Assumption A2(ii).

[44]The exact conditions for each case are shown in the proof.

– *otherwise, the informal loan has either: (i) positive collateral, $c_I^* \in (0, \theta]$ and zero interest, $r_I^* = \theta$; or (ii) positive collateral and positive interest, $c_I^* = r_I^* > \theta$.*

c) *suppose $\gamma > \frac{p(R-1)\bar{\theta}}{1-p}$. Then, $\exists \tilde{\alpha}_I \in (\alpha_{\min}, 1)$ such that if $\frac{\theta}{w} > \tilde{\alpha}_I$ (high LTW ratio) the borrower chooses not to use informal credit since (PC_B) is violated.*

d) *suppose the following sufficient condition is satisfied,*

$$\kappa > (1-p)\phi \quad (C1)$$

Then Proposition 3 holds – for the same borrower, an informal loan has more favorable terms than a formal loan.

Proof: (see Section 8.2)

Proposition 5 shows that, under mild additional assumptions, the results of Propositions 2 and 3 extend to the case when informal lenders can incur social capital loss from loan refusal, default or both. One difference with Proposition 2 exists in Proposition 5(b) – the utility loss from loan refusal allows even more favorable informal credit terms. In particular, it is possible that informal loans carry zero interest and do not require collateral for all LTW ratios $\frac{\theta}{w}$ – this happens for loan refusal cost $\kappa\gamma$ large relative to the social cost of default $\phi\gamma$. Intuitively, when the lender's social cost from loan refusal is sufficiently large, the lender would not refuse an informal loan when asked, knowing that the borrower has an incentive to repay whenever feasible. In this case the informal lender may even incur a monetary loss on a loan (when $\frac{\theta}{w} > \alpha_{\min}$) but the desire to preserve the relationship makes it worthwhile to lend to a friend or relative even at negative financial return.

Unlike in Proposition 2(b), in the extended model characterized in Proposition 5 it is also possible to have informal loans with zero interest, $r_I^* = \theta$ but positive collateral, $c_I^* \in (0, \theta)$. This case occurs for intermediate values of κ relative to ϕ. Intuitively, the repayment r_I^* is kept as low as possible since it reduces the borrower's payoff in all states of the world, while positive collateral is required for the lender to break even because of the risk of involuntary default for low α.

In Proposition 5(c), we use a stronger sufficient condition on γ compared to condition (H) in Assumption A2(ii). The reason is technical, since when $\kappa > 0$ the lender's participation constraint could be slack. Finally, Proposition 5(d) shows that our previous result that informal credit has more favorable terms than formal credit (Proposition 3) carries over, as long as the informal lender's social disutility from loan refusal, $\kappa\gamma$ is sufficiently large relative to the lender's social cost from default, $\phi\gamma$. This is plausible in many realistic scenarios. For example, consider a child taking a loan from a parent. The parent may not be upset ($\phi = 0$) if the child cannot repay for exogenous reasons, but may have a high utility cost (large κ) from refusing a loan if asked. Technically, condition (C1) ensures that the lender's participation constraint is relaxed relative to the baseline model with $\kappa = \phi = 0$ in Proposition 2.

8.2 Proof of Proposition 5

(a) Suppose $\frac{\theta}{w} \leq \alpha_{\min}$. Denote the lender's payoff as function of r_I and c_I by $\tilde{U}_L^I(r_I, c_I)$. Proceed as in the proof of Proposition 2(a). The only difference is in the lender's participation constraint ($\tilde{PC_L}$).

Evaluating the lender's payoff at $r_I = \theta$ and $c_I = 0$ yields $\tilde{U}_L^I(\theta, 0) = \theta$ which is weakly larger than the outside option of not lending, $\theta - \kappa\gamma$. Therefore, $r_I^* = \theta$ and $c_I^* = 0$ solve **Problem $\tilde{\mathbf{I}}$**.

(b) Suppose $\frac{\theta}{w} \geq \alpha_{\min}$. Define

$$\mu(\tfrac{r_I}{w}) \equiv \kappa\gamma - (1-p)\pi(\tfrac{r_I}{w})\phi\gamma \tag{11}$$

and write the lender's participation constraint $\tilde{U}_L^I(r_I, c_I) \geq \theta - \kappa\gamma$ in **Problem $\tilde{\mathbf{I}}$** as

$$U_L^I(r_I, c_I) \geq \theta - \mu(\tfrac{r_I}{w}), \tag{12}$$

where $U_L^I(r_I, c_I)$ is the lender's payoff from **Problem I** and Proposition 2 (with $\kappa = \phi = 0$). Consider the following three cases depending on the relative magnitudes of κ and ϕ.

Case I. Suppose that $\kappa\gamma$ (the informal lender's social cost from loan refusal) is sufficiently large relative to the lender's social cost from default ($\phi\gamma$), so that $U_L^I(\theta, 0) \geq \theta - \mu(\frac{\theta}{w})$ and so (12) is satisfied. In this case, the loan terms solving **Problem $\tilde{\mathbf{I}}$** are $r_I^* = \theta$ and $c_I^* = 0$ (zero interest and collateral) for all $\frac{\theta}{w}$ satisfying (PC_B) and $\theta \leq \bar{\theta}$. This is true since all constraints are satisfied and since r_I, c_I are as small as possible given non-negativity (the borrower's payoff is decreasing in r_I and c_I as shown in the proof of Proposition 2). Since $U_L^I(\theta, 0) = (1 - (1-p)\pi(\frac{\theta}{w}))\theta$, the required parametric condition for Case I is:

$$\kappa \geq (1-p)\pi(\tfrac{\theta}{w})(\phi + \tfrac{\theta}{\gamma}) \quad \text{(C-i)}$$

Case II. Now suppose condition (C-i) does not hold and the lender's participation constraint is not satisfied at $(r_I, c_I) = (\theta, 0)$. That is, $U_L^I(\theta, 0) < \theta - \mu(\frac{\theta}{w})$. This implies that the lender's participation constraint (12) must bind. If not, then r_I and/or c_I can be reduced which increases the objective U_B^I. For fixed κ, ϕ, γ note that condition (C-i) may be violated for larger $\frac{\theta}{w}$ (it is always satisfied if $\frac{\theta}{w} \leq \alpha_{\min}$ since $\kappa \geq 0$).

As in the proof of Proposition 2, use that $U_L^I(\theta, c) < U_L^I(\theta, \theta)$ for any $c \in (0, \theta)$ and suppose

$$U_L^I(\theta, \theta) = (1 - (1-p)\pi(\tfrac{\theta}{w}))\theta + \rho(\tfrac{\theta}{w}) \geq \theta - \mu(\tfrac{\theta}{w}) > U_L^I(\theta, 0) \quad \text{(C-ii)}$$

where $\rho(\frac{\theta}{w}) \equiv \eta(\theta, \theta) = (1-p)\int_0^{\theta/w} \alpha w \, d\pi(\alpha)$.[45] For given θ, w, condition (C-ii) holds when κ is relatively smaller or when ϕ is relatively larger than in Case I.

If (C-ii) holds, we show that the loan terms solving **Problem $\tilde{\mathbf{I}}$** keep the interest as low as possible, $r_I^* = \theta$ and set the collateral c_I to the positive value $\tilde{c} \in (0, \theta]$ solving

$$U_L^I(\theta, \tilde{c}) = \theta - \mu(\tfrac{\theta}{w}). \tag{13}$$

Note that such $\tilde{c}$ always exists given (C-ii) and since $\eta(\theta, c_I) = (1-p)\int_0^{\theta/w} \min\{c_I, \alpha w\} d\pi(\alpha)$ is strictly increasing in c_I for $c_I \in (0, \theta]$. That is, the terms $(r_I, c_I) = (\theta, \tilde{c})$ are feasible for **Problem $\tilde{\mathbf{I}}$**. We prove that $r_I^* = \theta$ and $c_I^* = \tilde{c}$ is optimal for **Problem $\tilde{\mathbf{I}}$** in Case II by contradiction. Suppose not. Since, as shown in Proposition 2, the objective U_B^I decreases in r_I and c_I, it is not optimal to choose any $r_I \geq \theta$ and $c_I > \tilde{c}$. Also, by (C-ii), choosing $r_I = \theta$ and any lower collateral $c_I < \tilde{c}$ violates the lender's participation

[45] Condition (C-ii) is equivalent to $(1-p)\pi(\frac{\theta}{w})(\phi + \frac{\theta}{\gamma}) > \kappa \geq (1-p)\pi(\frac{\theta}{w})(\phi + \frac{\theta}{\gamma}) - \rho(\frac{\theta}{w})$.

constraint (12). Finally, suppose the lender chose some $r_I > \theta$ and $c_I < \tilde{c} \leq \theta$ (higher interest but lower collateral). But then, since (12) must bind at optimum, $U_B^I(r_I, c_I) = (pR-1)\theta - (1-p)\pi(\frac{r_I}{w})\gamma + \mu(\frac{r_I}{w})$ which is decreasing in r_I and hence, for any $r_I > \theta$ and $c_I < \tilde{c} \leq \theta$, we would have $U_B^I(r_I, c_I) < U_B^I(\theta, \tilde{c})$ – a contradiction. Therefore, the optimal loan terms in Case II are indeed $r_I^* = \theta$ and $c_I^* = \tilde{c}$ where $\tilde{c}$ solves (13).

Case III. Suppose that, even at $\tilde{c} = \theta$ (any larger c_I does not increase the lender's payoff) keeping $r_I^* = \theta$ is not feasible (the lender cannot break even). That is, suppose,

$$U_L^I(\theta, \theta) = (1-(1-p)\pi(\tfrac{\theta}{w}))\theta + \rho(\tfrac{\theta}{w}) < \theta - \mu(\tfrac{\theta}{w}) \quad \text{(C-iii)}$$

For given θ, w, condition (C-iii) is likely to hold for κ relatively smaller and/or ϕ relatively larger than in Case II. We show that, as in Proposition 2(b), the optimal loan terms in Case III are $c_I^* = r_I^* > \theta$, where r_I^* is the smallest repayment at which the lender breaks even. Clearly, choosing $r_I = \theta$ and any $c_I \geq 0$ (no matter how large) is infeasible under (C-iii), since $U_L^I(\theta, \theta) \geq U_L^I(\theta, c_I)$ for any c_I, with equality if $c_I \geq \theta$, as shown in the proof of Proposition 2. Suppose the lender instead chose some $r_I^1 > \theta$ and $c_I^1 < r_I$ at which (12) binds. Then $U_L^I(r_I^1, c_I^1) < U_L^I(r_I^1, r_I^1)$, as shown in the proof of Proposition 2. Hence, the lender's participation constraint is slack at r_I^1 and $c_I = r_I^1$. But then, since $U_B^I(r_I, c_I)$ is decreasing in r_I, the lender can reduce r_I down from r_I^1 and set $c_I = r_I$, which would raise the objective U_B^I. Consequently, under (C-iii), the solution to **Problem $\tilde{\mathbf{I}}$** is $c_I^* = r_I^* = \bar{r}(\theta) > \theta$ where $\bar{r}(\theta)$ solves:

$$U_L^I(r, r) = pr + (1-p)\int_0^\infty \min\{\alpha w, r\} d\pi(\alpha) = \theta - \mu(\tfrac{r}{w}) \tag{14}$$

(c) We already showed in part (a) that $U_B^I(r_I^*, c_I^*) = (pR-1)\theta > 0$ for $\frac{\theta}{w} \leq \alpha_{\min}$. In addition, $U_B^I(r_I^*, c_I^*) \leq U_B^I(\theta, 0)$ for any $\frac{\theta}{w}$ since $r_I^* \geq \theta$ and $c_I^* \geq 0$ and since the borrower's payoff is decreasing in the loan terms. Take some $\frac{\theta}{w} \geq 1$, for which $\pi(\frac{\theta}{w}) = 1$, and hence

$$U_B^I(\theta, 0) = (pR-1)\theta - (1-p)(\gamma - \theta)$$

Clearly, $\gamma > \frac{(pR-p)\bar{\theta}}{1-p}$ is a sufficient condition ensuring $U_B^I(\theta, 0) < 0$ for any $\frac{\theta}{w} \geq 1$. As in Proposition 2(c), this implies the existence of a threshold LTW ratio $\tilde{\alpha}_I \in (\alpha_{\min}, 1)$ such that the borrower chooses not to take an informal loan if $\frac{\theta}{w} > \tilde{\alpha}_I$.

(d) The lender's participation constraint in **Problem $\tilde{\mathbf{I}}$** is

$$U_L^I(r_I, c_I) \geq \theta - \kappa\gamma + (1-p)\pi(\tfrac{r_I}{w})\phi\gamma = \theta - \mu(\tfrac{r_I}{w}).$$

Condition (C1) in the proposition statement is a sufficient condition to ensure $\mu(\frac{r_I}{w}) > 0$ for any $r_I \geq \theta$, see (11). Hence, under (C1), the lender's participation constraint ($\tilde{PC}_L$) is *relaxed* compared to constraint (PC_L) in **Problem I**. Since all other constraints are the same and since U_B^I is decreasing in r_I, c_I, this implies that the loan terms r_I^* and c_I^* solving **Problem $\tilde{\mathbf{I}}$** are more favorable to the borrower (weakly lower r_I^*, c_I^*) than the loan terms solving **Problem I** in which $\kappa = \phi = 0$. Therefore, Proposition 3 holds.■

Table 8: Additional Probit Regressions for Loan Source

dependent variable	loan source (informal=1)			
	(1)	(2)	(3)	(4)
wealth		0.10*		0.11*
		(0.04)		(0.05)
loan size	-0.28***	-0.32***	-0.31***	-0.33***
	(0.03)	(0.04)	(0.04)	(0.04)
tenure			-0.34	-0.38
			(0.21)	(0.21)
bank access			-0.15	-0.20
			(0.11)	(0.11)
BAAC member			-0.09	-0.13
			(0.10)	(0.10)
income			0.13**	0.09
			(0.05)	(0.05)
Observations	1236	1232	1235	1231
pseudo R^2	0.15	0.15	0.16	0.16

[a] **Note:** The regressions include fixed effects that account for location (tambon) and intended loan usage. We also control for the following household characteristics: age, gender, marital status, education of the head, and total number of outstanding loans. The standard errors reported in parentheses are clustered at the household level. Superscripts ***, ** and * indicate significance at 0.1%,1% and 5%, respectively.

Table A1: Summary Statistics

Variable	obs.	median	mean	std.	min	max	units
Household-level data							
wealth	1915	515	1145	2072	9	21342	1000s Baht
income	1910	65.3	164	519	0.4	15710	1000s Baht
number of outstanding loans	1915	1	1.78	1.03	1	6	integer
age	1892	48	49.3	12.8	23	101	years
education	1892	3	3.47	1.86	1	11	years
gender (1=female)	1892	0	0.19	0.39	0	1	binary
marital status (1=married)	1915	1	0.83	0.37	0	1	binary
tenure	1911	1	0.95	0.22	0	1	binary
bank access (1 = yes)	1914	0	0.28	0.45	0	1	binary
BAAC access (1 = yes)	1914	1	0.52	0.5	0	1	binary
Loan-level data - all loans							
loan size	3406	20	39.6	78.9	0.05	1000	1000s Baht
loan size to wealth (LTW) ratio[a]	3406	0.03	0.07	0.15	0.00	3.54	n.a.
interest rate[b]	2917	9.8	15.7	23.4	0	199	percent
collateral	3406	0	71.3	231	0	2800	1000s Baht
Loan-level data - informal only (relative or neighbor)							
loan size	822	7.5	20	43.8	0.05	500	1000s Baht
loan size to wealth (LTW) ratio	822	0.02	0.05	0.11	0.00	1.16	n.a.
interest rate	552	4.6	19.9	30.1	0	186	percent
collateral	822	0	9.3	69.8	0	1500	1000s Baht
Loan-level data - formal only (commercial bank or moneylender)							
loan size	439	20	58.2	105	0.4	1000	1000s Baht
loan size to wealth (LTW) ratio	439	0.05	0.09	0.14	0.00	1.23	n.a.
interest rate	337	15.8	27.7	32.2	0	199	percent
collateral	439	0	127.3	320	0	2400	1000s Baht

Notes: The household level data include all observations with positive and non-missing wealth and loan size. In the loan-level data: a. the LTW ratio is computed using household wealth, including when a household has multiple loans, b. the interest rate summary statistics exclude observations with missing data and 44 outliers with interest above 200%. 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 access' equals one if the household was a customer of a commercial bank. All other variables are self-explanatory.