Social Capital and Credit Constraints in Informal Finance [1]

by

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Abstract This paper considers problems arising from contract enforcement and the attendant possibility of voluntary default. Loan contracts in the informal sector are rarely explicitly recorded and enforced by formal legal institutions. Repayments may be induced via informal enforcement mechanisms based on social sanctions through linked relations in repeated interactions. Lenders tend to use the strength these (bilateral) relations, called social capital, as a device for rationing heterogeneous borrowers. We apply the existing notion of exogenous social capital and introduce the notion of endogenous social capital. Appropriates level of social capital may promote loans that otherwise would not be granted. For small loans though, the endogenous social capital may become negative. We find that in such cases borrowers may be encouraged to take up excessive loans to increase incentives for repaying. The theoretical analysis is supported by empirical observations, mainly from China.

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JEL Classification Codes: C72, G32, O16, O17.

1. Introduction

Informal finance is an essential feature of credit markets in developing and poor regions of emerging economies as, e.g. in China.[4] However, those engaged in informal finance are unlikely to seek legal enforcement of their activities because they are illegal in the first place.[5] How about legal activities? As an American lawyer observed, 'contracts in China have more of a sense of moral obligation than absolute rights. There is no concept that they are binding'.[6] Social capital in community networks promotes interpersonal trust, provides better

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[4]See Allen, Qian and Qian (2002,[3]).
[5]See McMillan (1997,[41]) and Tsai (2002,[53]).
[6]See McMillan (1997,[41]).

opportunities to punish deviants, and serves as a hedging substitute for institutional and legal deficiencies.[7] Hence, there exist effective informal financing channels and governance mechanisms, such as those based on reputation and relationships, to promote investment and thereby to support economic growth.[8]

Another feature of credit markets in China is that private entrepreneurs or firms, especially small firms, are *credit constrained*. These firms are willing to pay the current interest rate but cannot obtain funds at that rate because lenders are unwilling to lend to them. This normally happens in formal financial institutions. Evidence shown in the sample of the World Bank's survey in China, i.e. IFC (2000,[35]), indicates that private firms may then be forced to limit their investment to retained earnings. In the informal credit market, entrepreneurs with better political and social ties (*guanxi*) will incur lower transaction costs and experience less uncertainty in institutionalising their financing arrangements.[9] [10]

Due to the possibility of default and lack of effective contract enforcement mechanisms, lenders have additional incentives to restrict the supply of credit (*credit rationing*), even if they have more than enough funds to meet a given demand and the borrower is willing to pay a high enough interest rate.[11] [12]

The *credit constraint* is one of the central concepts in this paper. The term *credit rationing* is often used interchangeable with constrained credit, but they express two different concepts, as indicated in Figure 1. Credit rationing occurs because there is a difference between what a lender is *willing* to lend and would be *able* to lend. This difference is at the discretion of the lender.[13] Nevertheless, whether or not a borrower ends up being credit constrained also depends on his optimal demand for credit. We refer to borrowers as *unconstrained* in the

[7] See Bian (2001,[12]), McMillan and Woodruff (1999,[42]) and Xin and Pearce (1996,[58]).

[8] See Allen, Qian and Qian (2002,[3]).

[9] See Tsai (2002,[53], p.161).

[10] Tsai (2002,[53], p.19) points out that local male business owners with strong political ties, for example, are more likely to tap the more highly institutionalized financing mechanisms than are migrant women who operate businesses at a similar scale in the same locality. Different entrepreneurs tap different forms of informal finance because they rely on different interpersonal dynamics to create the level of predictability and 'credible commitment' those formal financial institutions and sophisticated property rights would theoretically require.

[11] See Allen (1983,[2]).

[12] In the context of this analysis, asymmetric information problems as in Stiglitz and Weiss (1981,[50]) are not overly important because contracts are not enforceable by court or other formal institutions in the first place.

[13] This concept of credit rationing includes the case in which identical borrowers are treated differently, putting some at a disadvantage compared to others. This is sometimes used as an alternative definition of credit rationing.

credit market when they either do not wish to obtain external funds or when they were able to obtain a loan of optimal size. Those that apply for a loan and are refused and those that do not apply because they expect to be refused, are considered to be *constrained*.

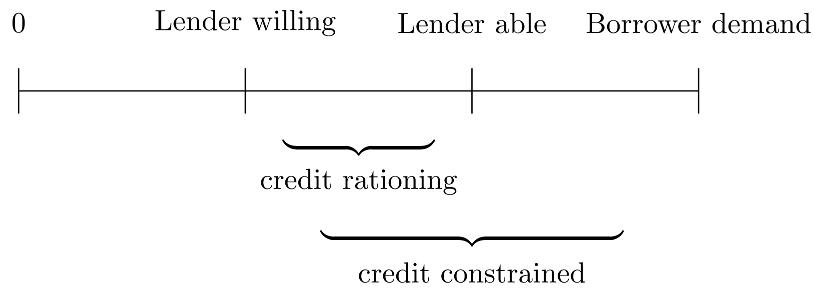

Figure 1: Credit Rationing and Credit Contraint

Developing countries and transitional economies often have weak legal institutions for the enforcement of contractual commitments. Where legal institutions are weak, bilateral relationships, such as social ties and reputation, can substitute for the courts in supporting contracting.[14] Thus, lenders tend to use these bilateral relations, called *social capital*, as a device for rationing heterogeneous borrowers.[15] As discussed in Section 3, our focus on *micro-level* social capital sets this paper apart from Guiso et.al. (2004,[33]), who focus on social capital on the *macro-institutional level*.

In the discussion below, we address the following questions. How exactly does 'social capital' work as an effective enforcing mechanism? How well can an alternative mechanism replace formal systems? What are the effects of social capital on the *credit constraint* problem of the borrowers?

These questions motivate the present paper as it revisits enforcement issues with particular reference to China. The overall argument is that social capital supplements the usual criteria in investment decisions. The relative immobility of the borrower in social interactions, that is required for the use of 'punishment strategies' in infinitely repeated interactions, may be reasonably applicable to the type of environment in which non-market institutions flourish.[16]

[14] See McMillan and Woodruff (2002,[43]).

[15] Another device the lenders could normally choose is loan size.

[16] In this spirit, DiPasquale and Glaeser (1999,[20]) investigate empirically whether homeownership increases

The core idea of the possible *enhancing effects of social capital* is that the presence of particular direct (e.g., prior professional relationship, or interpersonal friendship) and indirect (e.g., third party referral) ties between lenders and borrowers will positively affect investment selection decisions of lenders, and therefore, may tend to solve the credit constraint problem of borrowers.[17]

Our model emphasizes the design of an incentive compatible contract in an infinitely repeated game to ensure borrowers have an incentive to repay their loans. In that sense, this research is related to the literature that studies repeated borrower-lender interactions in which the threat of termination of the relationship by the lender provides incentives for the borrower to repay.[18] We depart from this literature by emphasizing the effects of social capital on constraints in credit markets. In particular, social capital is not clearly modelled in those previous papers. Nevertheless, many studies reveal that the small-firm sector is highly organized and regulated through informal rules shaped by social capital.[19] Empirical evidence shows the important role of social capital not only in China,[20] but also in other developing and transitional economies.[21] For example, De Soto (1989,[18]) documents that membership in social groups is crucial for access to many economic opportunities in the informal sector in Lima, Peru. Consequently, 'It takes a fair amount of time and resources to establish and cultivate a wide network of friends, 'uncles', and 'cousins'... '.[22] Hence, social capital is costly to maintain and needs to be understood in a more rigorous approach.

Social capital and trust are integrated within an economic framework in Spagnolo (1999,[49]). He defines the concept of social capital in the context of an infinitely repeated game and offers

investment in local amenities and social capital and find that indeed it does, especially because it reduces individual mobility. See also Fafchamps (1992,[23]).

[17]The model is related to the literature that analyses the effects of informal finance in developing countries. A growing microeconomic literature, see Morduch (1999,[44]), especially in the area of the micro-finance, assesses the mechanisms (group lending, dynamic incentives, etc.) underlying the advantages of traditional informal credit institutions. See for instance Banerjee, Besley and Guinnane (1994,[7]) for credit cooperatives, McMillan and Woodruff (1999,[42]) for trade credit in Vietnam, and also Ghatak and Guinnane (1999,[30]), Ghatak (2000,[31]), Armendariz de Aghion (1999a,[5], 1999b,[6]) and Laffont and N'Guessan (1999,[39]) for group lending.

[18]See e.g. Allen (1981,[1], 1983,[2]), Dutta and Kapur (2002,[22]) and Bolton and Scharfstein (1990,[13]).

[19]See Jagannathan (1987,[38]).

[20]See Allen, Qian and Qian (2002,[3]), Batjargal and Liu (2002,[9]), Bian (2001,[12]), Ivory (1994,[36]), Lin (2001,[40]), Rauch and Trindade (2002,[48]), Tsai (2002,[53]), Tsui and Farh (1997,[54]), Xin and Pearce (1996,[58]) and Yeung and Tung (1996,[59]).

[21]See Besley and Coate (1995,[11]), De Soto (1989,[18]), Fafchamps (1992,[23]), Ferrara (2003,[25]), Fukuyama (1992a,[26], 1995b,[27]), Greif (1989,[32]), Helliwell (1996,[34]), McMillan and Woodruff (1999,[42], 2002,[43]).

[22]See De Soto (1989,[18], p. 166).

the following mechanism. Each period two players face two stage games: an economic game and a social game. They must choose between cooperating and defecting in both of the games. Spagnolo argues that even if the incentive compatibility constraint in the economic game is violated, the additional payoff from the social game can make up the 'deficit' in the economic game, so that players may choose to cooperate in both games. Enforcement problems in the credit market have not been analysed in his framework, although some scattered pieces of evidence suggests that they are significant.[23] The purpose of this paper is to provide a theoretical analysis to explore how a variable that represents social capital may fit into the formal theory, and what types of questions it may be able to answer. Above all, our model not only explains the existence of constrained credit as consequences of an enforcement problem, but also discusses the possibility that the credit constraint problem is mitigated or even disappears because of the role of social capital. We extend Spagnolo's framework, which relies on exogenously given levels of social capital, by allowing the level of social capital to be determined endogenously, increasing with the loan size. For sufficiently small loans the level of social capital becomes negative, thus reducing the borrower's incentive to repay. As a consequence, small borrowers may be forced to take excessive loans.

Section 2 describes the set-up of the model. It specifies the credit market without reference to social capital. Section 3 conceptualises social capital as a specific form of governance. Following Section 3, Sections 4 and 5 analyse the associated repeated game. In Section 4 a model with *exogenous* social capital is analysed, whereas Section 5 introduces *endogenous* social capital. Finally, we conclude in Section 6 with a summary and a discussion of our results. Proofs of the two main propositions are gathered in the Appendix.

2. The Model

The basic feature of informal finance captured in the following analysis is that the repayment of a loan is not enforceable by law or by a third party. The key problem that we focus on is why, how, and in what contexts, social capital increases the size of loans and thus investments. We also try to shed some light on the mechanism through which social capital generates the trust

[23] See Allen (1981,[1], 1983,[2]).

needed for financial transactions. More specifically, we address the following three questions:

1. What is the role of social capital on the level of investment in the credit-constrained market.

2. How does social capital affect the incentives to repay informal loans.

3. What single variable captures social capital and how may it fit into the formal theory? What insights can be derived from it?

We use a simple model to investigate these questions, in order to focus the results.

Generally speaking, borrowers may fail to repay lenders for three reasons. The first is that the risky project fails and borrowers do not have the financial capacity to repay.[24] The second reason is that the cash flow of the project is not observable by the lender unless the lender undertakes an audit.[25] Finally, as an extreme version of this, repayment of a loan may be impossible to enforce by laws or other formal institutions. Therefore, even if the borrower has the financial capacity, he may fail to have an incentive to repay the lender.[26] Borrowers default if the costs of non-repayment are less than the loan and interest payment combined (i.e. so called *strategic default*). Borrowers repay when incentives are present to do so.

Throughout this paper, we focus solely on strategic default. We ignore the possibility that borrowers have insufficient funds to repay their loan. The model can easily be extended to deal with default of this kind but this additional complication yields little extra insights. Thus, it is assumed that borrowers run riskless projects.

The model that we consider is one of an infinitely repeated game. We adapt Allen (1983,[2]) by making the following assumptions. We assume that the borrower takes the interest rate set by the lender as given. He chooses the size of the informal loan to maximise his profits for the given interest rate, taking into account the relevant constraints. For simplicity, borrowers are taken to have no initial wealth of their own. A borrower makes an investment funded by an informal loan of size I provided by a lender. The size of the loans can differ and is determined

[24] See Stiglitz and Weiss (1981,[50]).

[25] This so called *costly state verification*, was modelled rigorously by Choe (1998,[15]), Diamond (1984,[19]), Gale and Hellwig (1985,[29]), and Townsend (1979,[52]).

[26] Jaffee and Russell (1976,[37]).

by the interaction between the lender and the borrower. The lender has an opportunity cost for her funds of zero (a *real* interest rate of zero is exogenously given by a financial authority). She charges a real interest rate r on her loans in the informal credit market.

Each period, the borrower has a riskless project that requires investing capital and lasts for the whole period. As the borrower has no capital of his own, he depends on a loan from one of many competing lenders to finance the project at the prevailing interest rate. The timing of the events in each period is as follows.

At beginning of each period, the borrower and the lender agree on a loan contract. At $t = 0$, the borrower applies for a loan of size I to start his project. If the lender provides a loan to the borrower, then she will charge the exogenously given real interest rate $r > 0$ independent of its size. If the lender does not grant the loan, she obtains zero profit.

At $t = 1$, the output $Y = f(I)$ is realised by the borrower. The production function $f(I)$ has the usual properties: $f'(I) > 0$; $f''(I) < 0$; $f'(0) = \infty$ and $f'(\infty) = 0$. The borrower has access to this production technology but the lender has not. Since the project of the borrower is riskless, we may focus on the case that the output $f(I)$ is sufficient to repay the loan with interest $(1 + r)I$. Each period the borrower withdraws his profits and can not continue the project if the lender denies him a new loan.

Since the loan is informal, the lender cannot rely on courts to enforce the contract, even if she can verify the level of output. The borrower knows this and decides whether to repay in full. He is able to repudiate his debt, but in this case he cannot obtain any further loans. We disregard issues related to renegotiation of the debt.[27] The borrower's repayment decision will hinge on comparing the gain from having the additional income of $(1 + r)I$ (the consequence of default), with the gain from continuing the project. Time is discrete and the interaction between the lender and the borrower is infinitely repeated.

The timing of the interaction is represented in the following table.

Table 1: Timing of the Interaction.

[27] For this issue, see e.g. Fender and Sinclair (2000,[24]).

Time	Revenue	Repayment	New Loan
$t = 0$	0	0	I_0
$t = 1$	$f(I_0)$	$(1 + r_0)I_0$	I_1
$t = 2$	$f(I_1)$	$(1 + r_1)I_1$	I_2
etc.			

For now we focus on the economic interaction between the borrower and the lender, disregarding their social interaction and its payoffs.[28] Given the set-up of the model, the profit of the borrower at time t is defined as

$$\pi_t(I_{t-1}; r_{t-1}) := f_t(I_{t-1}) - (1 + r_{t-1})I_{t-1}$$

where $f_t(I_{t-1})$ is total output and $(1 + r_{t-1})I_{t-1}$ indicates the total repayment. In order to simplify the analysis, we assume that the exogenous variables (including the wealth of the borrower) remain constant over time, i.e. that the associated game is stationary. This allows us to drop the subscript t in our notation.

The borrower's demand for capital I_D when he repays the loan is obtained by solving the following maximisation problem for the given interest rate r:

$$\max_{I} \pi(I; r)$$

The corresponding first order condition is

$$\frac{\partial \pi(I; r)}{\partial I} = f'(I) - (1 + r) = 0.$$

Therefore, the borrower's optimal loan size is obtained from:

$$f'(I_D) = (1 + r).$$

From our assumptions it follows that $\pi(I_D; r) \geq 0$, i.e. the borrower is capable of repayment of a loan of optimal size.

The borrower knows that when he defaults he will not be able to gain access to the credit market (and therefore to produce) in the future. When the informal loan is repaid, the lender is willing to grant another informal loan.[29] At the moment of repayment, the discounted

[28] We will discuss later what happens when the lender and the borrower interact in both an 'economic' and a 'social' relationship.

[29] The implicit assumption is that the information about the borrower's credit history is reliable and free, and circulates in the market without friction. In the context of informal loans, the reliability of information may at times be compromised.

stream of present and future income for the borrower in the infinitely repeated interaction is defined by:

$$E(I) = \sum_{t=1}^{\infty} \delta^{t-1} [f(I) - (1+r)I] = \frac{1}{1-\delta} [f(I) - (1+r)I] \tag{1}$$

where future payoffs are discounted by the factor $0 < \delta < 1$.

As the informal loan contract cannot be enforced, the borrower must have incentives to repay. Repayment is supported if:

$$E(I) \geq f(I), \tag{2}$$

i.e. the incentive compatibility constraint (IC) for the borrower is satisfied.[30] That is, the discounted present value of the earnings stream that can be realized from future transactions exceeds the one-time wealth increase obtained from breaching the current agreement. The left hand side (LHS) of (2) denotes the discounted income stream for the borrower if he repays now and in each future period. The right hand side (RHS) of (2) is his income when he defaults. Thus, inequality (2) is the general expression of the incentive compatibility constraint for the borrower to repay.

Combined, equation (1) and inequality (2) lead to the following optimal repayment decision of the borrower:

$$\textit{Repay whenever } f(I) \geq \frac{1+r}{\delta} I.$$

The resulting decision problem of the borrower is depicted in Figure 2.

The intersection of the straight line $\ell_0(I) := \frac{1+r}{\delta} I$ and the concave production function $f(I)$ defines the maximal informal loan $\hat{I}$ that satisfies the incentive compatibility constraint expressed in inequality (2). The lender will only grant loans within the interval $[0, \hat{I}(\delta, r)]$. The cut-off point $\hat{I}$ is the maximum that the lender is willing to lend. If the borrower's unconstrained demand I_D exceeds $\hat{I}(\delta, r)$, then his credit is constrained. We now state under which condition the optimal demand I_D is higher than the cut-off point $\hat{I}$.

Proposition 1. *For each $r \geq 0$ there exists a unique discount factor $0 < \hat{\delta}(r) < 1$ such that for any $\delta < \hat{\delta}(r)$ the borrower faces a binding credit constraint.*

[30] This assumes that the strategy of the lender in the repeated game is to provide a new loan if the borrower honoured his past obligations and the new loan satisfies the incentive compatibility constraint.

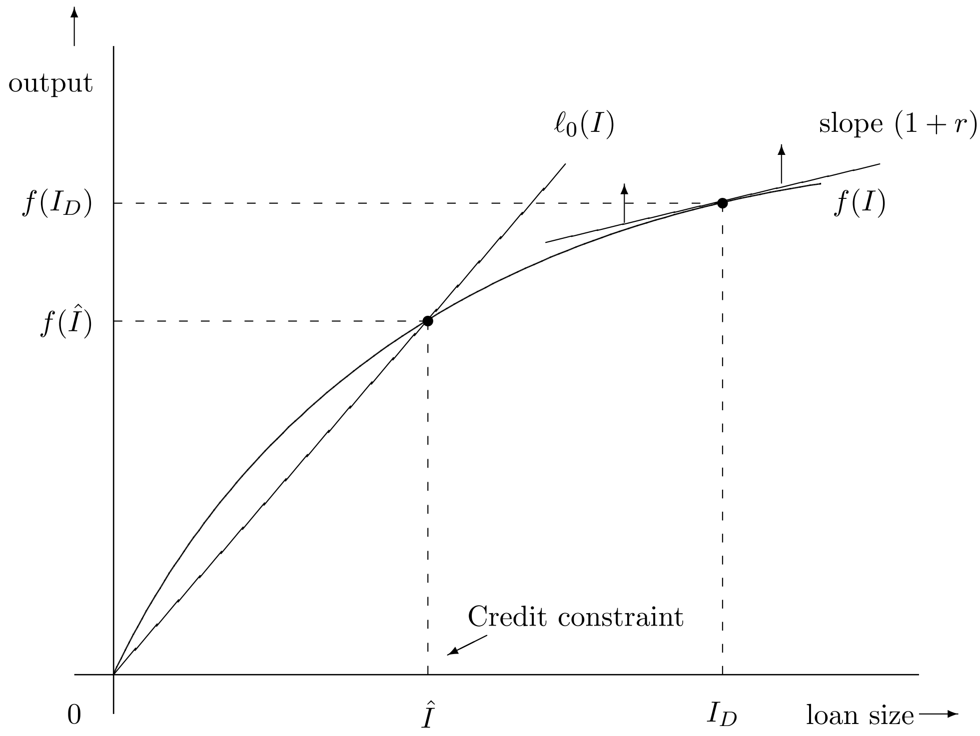

Figure 2: Credit Contraint without Social Capital

Proof: See Appendix.

Proposition 2. *If the discount factor δ approaches zero, then the maximum the lender is willing to lend approaches zero as well.*

Proposition 2 is illustrated by Figure 2. As can be seen, the intersection $\hat{I}$ of the line $\ell_0(I)$ and the concave production function $f(I)$ will approach the origin when δ approaches zero and, as a consequence, the slope of $\ell_0(I)$ approaches infinity.

Example 1: Consider the production function $f(I) := A\sqrt{I}$. For this production function the cut-off point is obtained by

$$A\sqrt{\hat{I}} = \frac{1+r}{\delta}\hat{I},$$

so $\hat{I}(\delta; r) := \frac{A^2\delta^2}{(1+r)^2}$. The unconstrained optimal loan size I_D follows from the first order condition $f'(I) = 1 + r$, which gives

$$I_D = \frac{A^2}{4(1+r)^2}.$$

For $\hat{\delta} = \frac{1}{2}$, the maximal incentive compatible loan size equals the unconstrained optimal loan size, i.e. $\hat{I} = I_D$. Thus, if the borrower is sufficiently impatient, i.e. $\delta \in (0, \frac{1}{2})$, then his credit is constrained.

As $\frac{\partial \hat{I}(\delta;r)}{\partial \delta} > 0$ and $\frac{\partial \hat{I}(\delta;r)}{\partial r} < 0$, our example indicates that the two factors that affect the maximal loan size $\hat{I}$, viz. the interest rate r and the discount factor δ, work in different directions. In particular, an increase in the interest rate decreases the cut-off value $\hat{I}$ of informal loans and, consequently, the credit constraint becomes stricter. Hence, our example illustrates the possible *negative* effects of increases in the real interest on the *supply* of informal credit.

3. An Economic Approach to Social Capital

What is social capital?[31] The debate on social capital has brought together sociologists, anthropologists, political scientists and economists. While differences remain, there is agreement that, in contrast to all other concepts of capital central to the development debate, social capital is unique in that it is *relational*.

> 'Whereas economic capital is in people's bank accounts and human capital is inside their heads, social capital inheres in the structure of their relationships. To possess social capital, a person must be related to others, and it is these others, not himself or herself, who are the actual source of his or her advantage'. [32]

The broad definition of social capital from Turner (1999,[55], p. 95) refers to

> 'those forces that increase the potential for economic development in a society by creating and sustaining social relations and patterns of social organization'.

These forces operate at macro- and micro-levels of analysis. That is, social capital is formed

[31] Coleman (1999,[17]) defines social capital by its function. It is not a single entity but a variety of different entities, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors – whether persons or corporate actors – within the structure of *relations* between actors and among actors. For alternative definitions of social capital see, e.g. Bowles and Gintis (2002,[14]), Fukuyama (2000,[28]), Ostrom (1999,[45]), and Putnam (1993,[47]). The World Bank has an excellent web site with an entire electronic library on the subject, see social capital home page, http://www.worldbank.org/poverty/scapital/index.htm.

[32] See Portes (1998,[46], p. 7).

(a) as a population becomes organised to meet basic and fundamental needs for production, reproduction, regulation and coordination (the *macro-institutional level*); and

(b) as social encounters in the form of face-to-face interaction unfold within corporate and categorical units (the *micro-level*).

Whereas the paper by Guiso et.al. (2004,[33]) on social capital and financial development in Italy focuses on the macro-institutional level, we follow the micro-level approach. People's interaction with each other will normally be embedded in two environments: multiplex relations and simplex relations. In a *multiplex relation*, persons are linked in more than one context (neighbour, fellow worker, fellow parent, co-religionist, etc.), while in a *simplex relation*, persons are linked through only one of these relations. The central feature of multiplex relations is that it allows the resources of one relationship to be appropriated for use in others. Sometimes, the resource is merely information, as when two parents who see each other as neighbours exchange information about their teenagers' activities; sometimes, it is the obligations that one person owes the second in one relationship, which the second person can use to constrain the actions of the first in the other relationship. Often, it is resources in the form of other persons who have obligations in one context that can be called on to aid when one has problems in another context.

In order to formulate these ideas in a formal approach, Spagnolo (1999,[49]) defines a concept of social capital by distinguishing between economic and social interaction. The essential idea is that two persons face each other in two contexts: economic interaction and social interaction. In modern societies, the two interactions are not necessarily linked: business is business and family is family. However, in developing countries, where business and family often cannot be separated, linked interactions are crucial to help us understand the credit market. A deviation in one context could lead to subsequent punishment in *both* contexts. For example, if a borrower does not repay, he could be punished by the lender not only by termination of future loans, but also by the lender as his uncle, neighbour, close friend, and so on. We follow the definition of social capital from Spagnolo, but extend it to include negative social capital:

Definition 1. ***Social capital*** *is the (possibly negative) surplus of enforcing power present in the social relation, i.e. the amount of social punishment power available as a threat in excess of that required to maintain cooperation in the social interaction.*

In order to capture the mechanism on which this definition of social capital is based, Spagnolo (1999,[49]) provides the following description of the general case.

Consider the strategic form of each of the symmetric two-player games in Table 2, which are infinitely repeated. There are two players i and j in each stage game. Each player selects two actions: to cooperate C_e or to defect D_e in the economic stage game, and to cooperate C_s or to defect D_s in the social stage game.

The payoffs of the two games are described in following payoff matrices:

Table 2: General Case: Two Separated Games

Economic	Cooperate C_e	Defect D_e
Cooperate C_e	c_e, c_e	b_e, a_e
Defect D_e	a_e, b_e	d_e, d_e

Social	Cooperate C_s	Defect D_s
Cooperate C_s	c_s, c_s	b_s, a_s
Defect D_s	a_s, b_s	d_s, d_s

In Spagnolo (1999,[49]) the two games are typical prisoner's dilemma games with symmetric payoffs where the payoff structure of the two games is assumed to satisfy $a_k > c_k > d_k > b_k$ and $2c_k \geq a_k + b_k$, where $k = e, s$. In our application, it suffices to assume that $c_k > d_k$, $a_k > d_k > b_k$ and $2c_k \geq a_k + b_k$, where $k = e, s$. That is, the outcome when both players cooperate dominates the outcome if both players defect. Furthermore, if one player defects, this reduces the other player's payoff to at most d_k. We refer to the resulting class of games as *generalized prisoners' dilemmas.*

If the two games are independent, then the two players in the economic game do not interact in the social game. The actions in one game are independent of those in another game. But if the two stage games are combined, players' strategies become more complex. In the combined stage game each player has four strategies:

$$\{C_eC_s, C_eD_s, D_eC_s, D_eD_s\}.$$

There can be many types of equilibrium strategies in the infinitely repeated version of the combined game. In one particular type of equilibrium each player chooses the same actions in both games. We focus our attention on such equilibria. In a static context such strategies make sense. For example, the best a player can achieve through defection is obtained by defecting simultaneously in both games. The optimal punishment against any deviation from a cooperative equilibrium is a simultaneous interruption in both relations. Similar arguments apply for cooperation. Hence, our analysis is only looking at the strategies $\{C_eC_s, D_eD_s\}$ in the combined stage game which have the same actions in both the economic and the social game.

Nevertheless, in the infinitely repeated game there may be many types of equilibrium strategies that can lead to some degree of cooperation. Some of these equilibria may involve strategies switching back and forth between cooperation and defection. For each player, the strategy may, (essentially) state: cooperate in even periods and defect in odd periods. Some other equilibria may have as the strategy of each player: never cooperate. We do not consider such equilibria. To solve our problem, we look for an equilibrium in which each player cooperates in every period, unless a player can gain by defecting, given the specified reaction of the other to defection. Thus, the equilibrium that we focus on is one of the many possible equilibria of this repeated game. We want to show that at least this particular equilibrium supports uninterrupted cooperation.

Definition 2. *Social and economic relations are* ***(strictly) linked*** *if the same two players face each other in both the social game and the economic game, and only such strategies are considered in which the players choose the same actions in both games.*

Table 3: The (Strictly) Linked Stage Game

	C_eC_s	D_eD_s
C_eC_s	$(c_e, c_s), (c_e, c_s)$	$(b_e, a_s), (b_e, a_s)$
D_eD_s	$(a_e, b_s), (a_e, b_s)$	$(d_e, d_s), (d_e, d_s)$

The first pair in the payoffs refers to the row player's payoffs in the economic and the social game respectively, the second pair to the corresponding payoffs of the column player etc.

When both players treat each game separately, cooperation in game $k = e, s$, i.e. the pair of strategies (C_k, C_k), is self-enforcing if the following inequality is satisfied:

$$\frac{c_k}{1-\delta} \geq a_k + \frac{\delta}{1-\delta} d_k.$$

The LHS of the inequality above is the discounted payoff from the strategy: 'always co-operate in the infinitely repeated game'. As this strategy will not cause the other player to defect, the LHS is the discounted value of the payoffs when both player choose C_k in each stage game. The RHS of the inequality denotes the discounted payoff from the strategy: 'always defect in the infinite repeated game'. As the first defection causes the other player to defect in all future stages of the game, it is obtained by discounting the payoffs of the strategy pair (D_k, C_k) for the first stage game and (D_k, D_k) for all subsequent stage games. Game k yields a positive enforcing power S_k if the difference of the LHS and the RHS of the inequality is positive. More generally, we denote

$$S_k := \frac{(c_k - a_k) + \delta(a_k - d_k)}{1-\delta}.$$

In the generalized prisoner's dilemma with $\delta \in (0, 1)$, S_k is an increasing function of δ and c_k, and a decreasing function of a_k and d_k.

When the players face each other in the linked game, they consider the consequences of their actions in both games, so cooperation in the linked game is self-enforcing if and only if $S_e + S_s \geq 0$. Notice that when this condition holds, cooperation in the linked game may occur even if cooperation in one of the separate games is not self-enforcing. For instance because $S_e < 0$ in the economic game. According to Spagnolo (1999,[49]), social capital is then defined as the positive enforcing power S_s in the social game which is transferable to the economic game when the games are linked. In Section 5, in the context of endogenous social capital, we also consider the case in which social capital may become negative, i.e. $S_s < 0$.

We now proceed to use the concept of social capital in the narrower context of financial transactions. In our model 'cooperation' for the lender means that she provides the appropriate loan to the borrower. For the borrower 'cooperation' means that he repays his debt. Similarly, 'defection' for lender means not providing the appropriate loan and for the borrower it means not to repay. To simplify the notation, we use S to denote the enforcing power in the social game and call it social capital. Therefore

$$S := S_s = \frac{(c_s - a_s) + \delta(a_s - d_s)}{1 - \delta}.$$

The social capital S could also be interpreted as the long-run net payoff from the social game if both players choose to cooperate in each stage game rather than to defect unilaterally. For the time being, we assume social capital is exogenous.

4. CREDIT MARKET WITH EXOGENOUS SOCIAL CAPITAL

The lender and the borrower not only face economic interaction but also interact in a social game which may alter their payoffs in the overall game. For simplicity, we assume the objective functions are linearly separable in the payoffs from the two relations.[33] Table 4 shows the payoff matrix of the economic stage game for given loan size I.

Table 4: Economic Game with Asymmetric Payoff

Economic		Lender j	
		Loan granted Y	Loan refused N
Borrower i	Repay R	$[f(I) - (1+r)I], (1+r)I$	$0, I$
	Default D	$f(I), 0$	$0, I$

Borrower i and lender j are the two players in this game. The lender chooses to grant a loan of size I or to refuse it. If she chooses N and refuses to lend, then no informal loan is made. The borrower obtains the payoff of zero and the lender obtains the safe return I. The discounted return of the lender if she always refuses to lend in the infinitely repeated game is $\frac{1}{1-\delta}I$. After she grants the loan, the borrower can either repay or default. When the borrower is always granted a loan and always repays, he obtains the discounted payoff $E(I)$. If, however, he defaults today, all lenders refuse to lend to him in the future. Hence, the borrower obtains payoff $f(I)$ in the present stage game and zero thereafter. In each period, the two players

[33]This model is based on two linked infinitely repeated games in the spirit of the model of multimarket contact developed by Bernheim and Whinston, (1990,[10]). The underlying idea of multimarket contact is that '(firms which compete against each other in many markets) may hesitate to fight local wars vigorously because the prospects of local gain are not worth the risk of general warfare.' Bernheim and Whinston, (1990,[10], p.3). The linkage of the two games serves to pool the incentive constraints in the two games.

move simultaneously, choosing either to cooperate or to defect. Each seeks to maximise the discounted sum of his or her payoffs over the infinite repetitions of the stage game.

In this context, the borrower always chooses R if and only if

$$E(I) \geq f(I). \tag{3}$$

Similarly, given that the borrower always repays, the lender always chooses Y if and only if

$$\frac{(1+r)I}{1-\delta} \geq \frac{I}{1-\delta} \tag{4}$$

is satisfied.

According to the analysis in Section 2, there exists a feasibility interval $[0, \hat{I}(\delta, r)]$ such that for every loan size within this interval constraint (3) is satisfied and the borrower will repay in each period, given the strategy of the lender.

Following the discussion from the last section, there is a social game to consider as well. It is assumed that the borrower is willing to embed his social behaviour while he borrows and repays the informal loans. We formulate this situation in the following way: in the social game, the borrower interacts with the lender in a social relation that can be represented by a symmetric infinitely repeated generalized prisoners' dilemma. The payoff structure of the social stage game is given by Table 5.

Table 5: Social Stage Game with Symmetric Payoffs

Social		Lender j	
		C_s	D_s
Borrower i	C_s	c, c	b, a
	D_s	a, b	$0, 0$

The social game is a typical generalized prisoners' dilemma as introduced before. The payoff structure is assumed to satisfy $c > 0$, $a > 0 > b$ and $2c \geq a + b$. Both players always cooperating is an equilibrium path in this infinitely repeated social game whenever $\frac{c}{1-\delta} \geq a$ is satisfied. Thus, the social capital equals:

$$S = \frac{c}{1-\delta} - a = \frac{c-(1-\delta)a}{1-\delta}. \tag{5}$$

Note, however, that even if $\frac{c}{1-\delta} \geq a$ is satisfied, there is another equilibrium path in the social game in which the players never cooperate.

Table 6: (Strictly) Linked Game

Linked		Lender j	
		YC_s	ND_s
Borrower i	RC	$([f(I)-(1+r)I],c),((1+r)I,c)$	$(0,b),(I,a)$
	DD_s	$(f(I),a),(0,b)$	$(0,0),(I,0)$

The incentive constraint for the borrower to repay his loan and to cooperate in the social relation is given by

$$E(I)+\frac{c}{1-\delta}\geq f(I)+a. \tag{6}$$

If $\frac{c}{1-\delta}\geq a$, then the social capital S can facilitate cooperation in the linked game. Rearranging (6), we obtain:

$$f(I)\geq\frac{1+r}{\delta}I-\frac{1-\delta}{\delta}S. \tag{7}$$

Denote the RHS of (7) by

$$\ell_1(I):=\frac{1+r}{\delta}I-\frac{1-\delta}{\delta}S.$$

The incentive constraint for the lender always both to lend and to cooperate incorporates the payoffs of the social interaction into inequality (4) and is given by

$$\frac{(1+r)I}{1-\delta}+\frac{c}{1-\delta}\geq\frac{I}{1-\delta}+a$$

which rearranges as

$$rI\geq a(1-\delta)-c. \tag{8}$$

Suppose social capital plays a positive role when $\frac{c}{1-\delta}\geq a$, i.e. $c-a(1-\delta)\geq 0$, then inequality (8) is satisfied as long as $r\geq 0$ and $I\geq 0$. Combining the incentive constraints (7) and (8), we summarise the equilibrium credit market with exogenous social capital in Figure 3.

In the absence of social capital, the borrower is constrained in his demand for credit. At each point in time any potential borrower faces a constraint in the form: $I\in[0,\hat{I}]$ where $\hat{I}\leq I_D$ (see Figure 2). Here $\hat{I}$ is the maximum the lender is willing to lend in the absence of social capital, whereas I_D is the amount that would be borrowed if the credit constraint did not exist. In the combined game, when the economic game and the social game are strictly linked, the payoff structure differs from that in the infinitely repeated game shown in

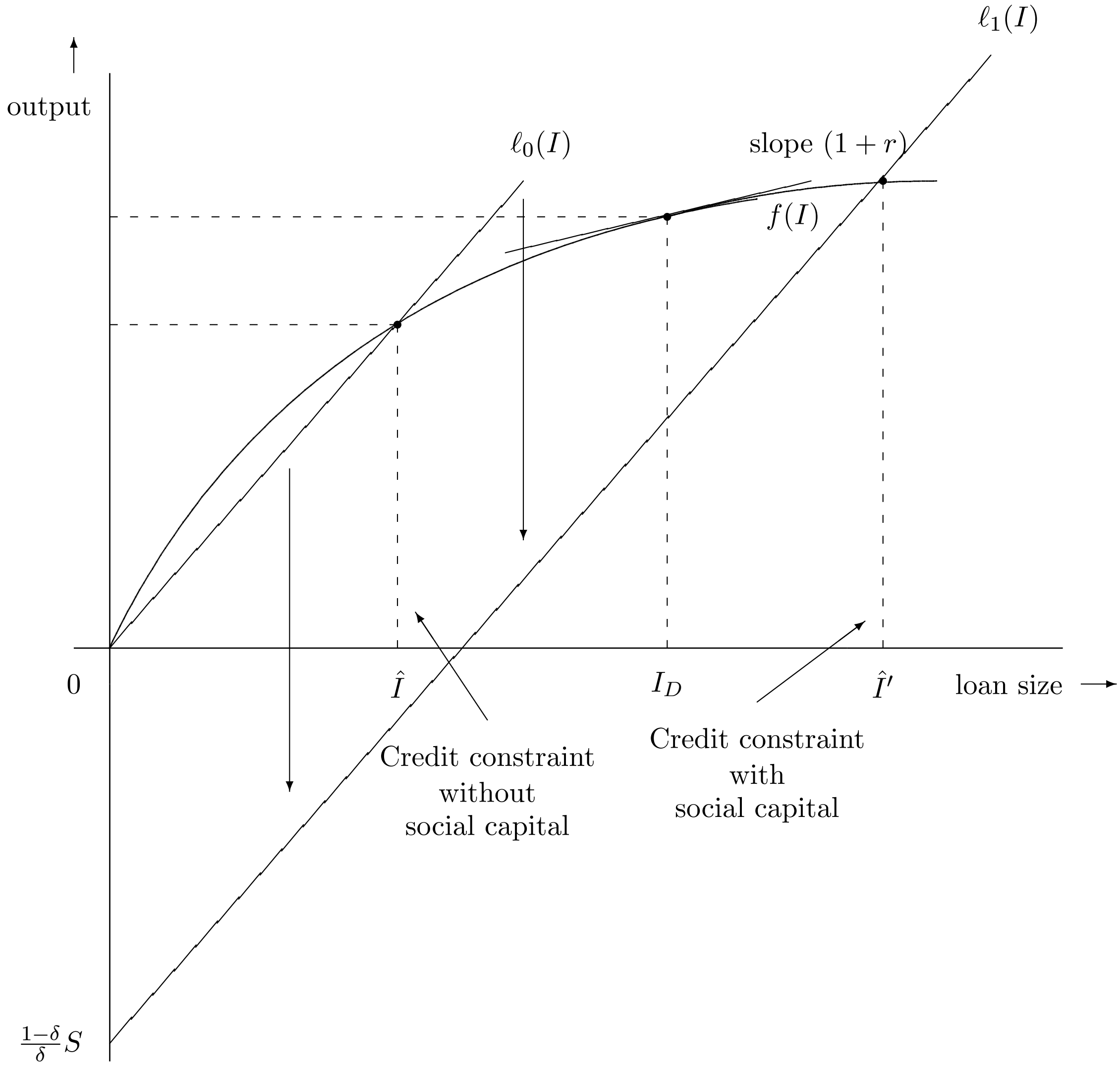

Figure 3: Credit Constraint with Exogenous Social Capital

Section 2. After introducing social capital, as illustrated in Figure 3, the line $\ell_0(I) = \frac{1+r}{\delta}I$ is shifted downwards to the line $\ell_1(I) = \frac{1+r}{\delta}I - \frac{1-\delta}{\delta}S$, where the amount S of social capital is positive. The intersection of the line $\ell_1(I)$ and the production function $f(I)$ defines the maximal incentive compatible informal loan $\hat{I}'$ under the new condition.

As indicated in Figure 3, whenever S is sufficient large, the amount $\hat{I}'$ will not be less than I_D. Thus, the borrower is 'unconstrained' in the credit market. This is summarised in the following proposition.

Proposition 3. *If the social capital S is large enough, then it can promote cooperation in the economic game where the informal loan may always be granted and repaid.*

By introducing exogenous social capital, the credit constraint is ameliorated. Since we assume the output of the project enables the borrower to repay the loan, the business environment with less constrained credit is preferable, as social capital increases the amount of credit supplied and hence investment.

5. Credit Market with Endogenous Social Capital

In order to explore the insights concerning social capital further, we consider a simple investment problem with *endogenous* social capital. Assume the borrower is willing to link his social interactions with his borrowing and repayment of informal loans. We formulate this situation in the following way: in the social game, the borrower interacts with the lender in a long-term social relationship that can be represented by a symmetric infinitely repeated generalized prisoner's dilemma as before. The borrower discounts the future payoffs with the factor $0 < \delta < 1$. He is assumed to have the same discount factor in the social game as in the economic interaction.

After the borrower obtains the informal loan of size I, he spends a fraction $0 < \theta < 1$ of the loan, i.e. the amount θI, as the *economic investment* for his project. Meanwhile, he spends the rest of his loan, i.e. $(1 - \theta)I$, as a *social investment* to increase the payoff of the social game. For example, a restaurant owner who is a borrower treats a lender to a lavish banquet which both of them enjoy.[34]

Assumption 4. *The variable θ is an exogenous variable and is given by the custom of the country.*

We assume that the social investment yields social payoffs if the players cooperate in the repeated linked game. The payoff in the social stage game when the borrower chooses to repay is $c(1 - \theta)I$. The payoff variable c in the social game is an exogenous scale factor such as kinship or closeness. The crucial assumption in the social investment problem is that in order to obtain positive payoffs in the social game, at least one of the players must invest resources into the social relation. Therefore, social capital is costly to maintain.

[34]See e.g. Bian (2001,[12]).

The social capital in this particular game is given by:

$$S(I;\theta) := \frac{c(1-\theta)I - (1-\delta)a}{1-\delta} \tag{9}$$

where the counterpart of the familiar assumptions for the social game hold, i.e. $c(1-\theta)I > 0$, $a > 0 > b$ and $2c(1-\theta)I \geq a + b$.

When the players face each other in the linked game, they consider the consequences of their actions in both games. The incentive compatibility constraint for the borrower is satisfied if:

$$E(I;\theta) + S(I;\theta) \geq f(\theta I), \tag{10}$$

where

$$E(I;\theta) := \sum_{t=1}^{\infty} \delta^{t-1}\left[f(\theta I) - (1+r)I\right] = \frac{1}{1-\delta}\left[f(\theta I) - (1+r)I\right].$$

This is equivalent to:

$$f(\theta I) \geq \frac{1}{\delta}\left[1 + r - c(1-\theta)\right] I + \frac{1-\delta}{\delta} a. \tag{11}$$

The lender's participation constraint if the two games are strictly linked is:

$$\frac{1+r}{1-\delta} I + \frac{c(1-\theta)}{1-\delta} I \geq \frac{I}{1-\delta} + a. \tag{12}$$

Rearranging inequality (12), we obtain:

$$I \geq \frac{a(1-\delta)}{r + c(1-\theta)}. \tag{13}$$

The loan contract is self-enforcing if and only if both inequalities (11) and (13), i.e. the incentive constraint for the borrower and the participation constraint of the lender, are satisfied.

Now we turn to the equilibrium in the credit market. We focus on the equilibrium strategies that the borrower and the lender consider in the repeated game which prescribes the 'same' actions in the economic and the social game. They cooperate in every period, unless there is a profit from ending cooperation or the other ended the cooperation first. To obtain the outcome that is optimal from his perspective, the borrower solves the following optimization problem, assuming the lender follows the above strategy.

$$\max_{I}\ f(\theta I) - M \cdot I$$

Subject to

$$f(\theta I) \geq \frac{M \cdot I + N}{\delta} \tag{14}$$

$$I \geq \frac{N}{r + c(1-\theta)} \tag{15}$$

$$f(\theta I) \geq (1+r)I \tag{16}$$

where $M := 1 + r - c(1-\theta)$ and $N := (1-\delta)a$.

This decision problem can be understood as follows.

As before, we assume the borrower's objective function is linearly separable in the payoffs from the two relations:

$$[f(\theta I) - (1+r)I] \quad + \quad [c(1-\theta)I].$$

Rearranging and simplifying it, the borrower's objective functions is written as

$$f(\theta I) - M \cdot I.$$

Constraint (14), deduced from inequality (11), is the incentive compatibility constraint for the borrower to ensure that he repays in each stage game. Constraint (15), deduced from inequality (13), defines the participation constraint for the lender. It indicates she is willing to grant a loan of size I to the borrower in each period. Constraint (16) states that the income generated by the project is sufficient to repay the informal loan.

One constraint that does not occur in this decision problem is

$$I \geq \frac{N}{c(1-\theta)}, \tag{17}$$

which denotes that social capital is non-negative. There are two reasons not to impose this constraint. Firstly, even if social capital is negative and the economic interaction can be 'unlinked' from social interaction, the borrower may be worst off by doing so. Unlinking would loosen the credit constraint and thus allow him to borrow more, but it would also remove his payoff from the social interaction. Secondly, it seems plausible that it may be difficult to unlink economic and social interaction in the context of informal loans. If the loan is granted by a lender who already has a social relation with the borrower, it may go against local custom not to provide the investment in social capital. Furthermore, the borrower may have difficulties finding a lender with whom he does not have a social relationship that is willing to provide an informal loan. Such lender would typically lack the information that allows her to make a founded decision about granting the loan, as the credible transmission of such information would be expected to take place in a multiplex (social) relation.

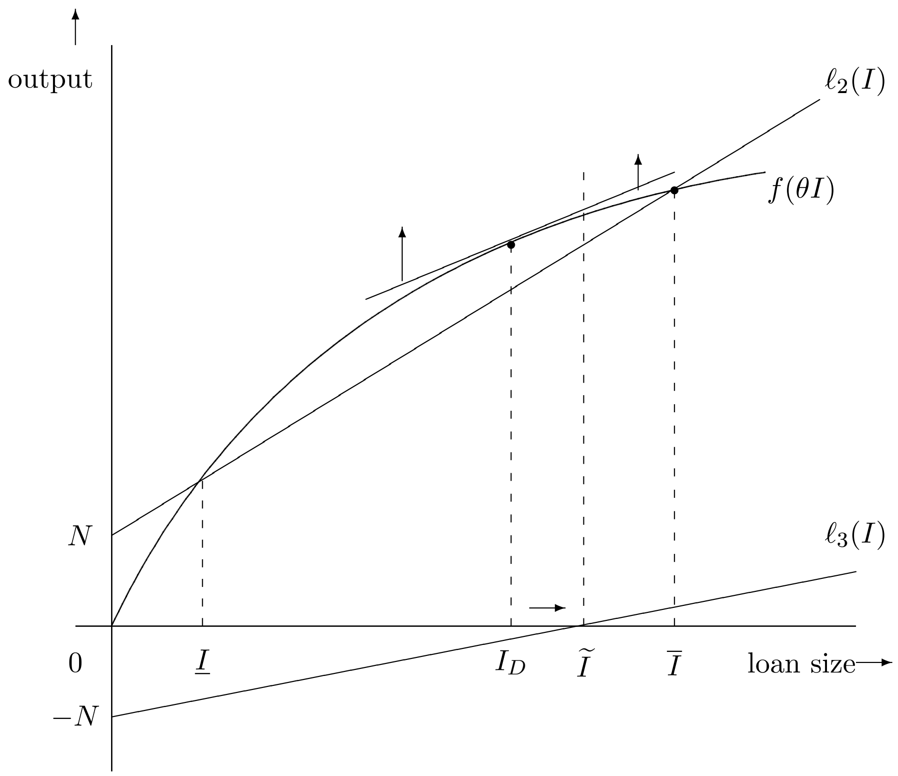

Figure 4: Credit Constraint with Endogenous Social Capital for $M > 0$

The decision problem of the borrower is depicted in Figure 4. Denote

$$\ell_2(I) := \frac{1}{\delta}[M \cdot I - N].$$

The incentive constraint of the borrower is satisfied with equality where the straight line $\ell_2(I)$ intersects the concave production function $f(\theta I)$. Similarly, denote

$$\ell_3(I) := [r + c(1 - \theta)] \cdot I - N.$$

The participation constraint of the lender is satisfied whenever $\ell_3(I) \geq 0$. In Figure 4, $\widetilde{I}$ denotes the minimal loan size for which the participation constraint of the lender holds, $\underline{I}$ denotes the smallest incentive compatible loan size and $\overline{I}$ denotes the largest incentive compatible loan size.

The slope of the iso-payoff line is M, whereas the slope of $\ell_2(I)$ equals $\frac{M}{\delta}$. Since $0 < \delta < 1$, the iso-payoff line is flatter than the line $\ell_2(I)$.

Proposition 5. *Let $I_D(r,\delta;\theta)$ denote the optimal unconstrained loan size in the presence of endogenous social capital. Let M be as before. The optimal constrained loan size in the presence of endogenous social capital now is*

- *For $M > 0$:*

$$I^*(r,\delta;\theta) := \begin{cases} \widetilde{I} & \text{if} \quad I_D(r,\delta;\theta) < \widetilde{I} \\ I_D(r,\delta;\theta) & \text{if} \quad \widetilde{I} \leq I_D(r,\delta;\theta) \leq \overline{I} \\ \overline{I} & \text{if} \quad I_D(r,\delta;\theta) > \overline{I}, \end{cases}$$

  provided that there exists a loan size that satisfies both the incentive compatibility for repayment and the participation constraint of the lender, i.e. $\overline{I}$ is well defined and $\overline{I} > \widetilde{I}$. Otherwise

$$I^*(r,\delta;\theta) := 0.$$

- *For $M \leq 0$:*

$$I^*(r,\delta;\theta) := \begin{cases} I^{\max} & \text{if} \quad \max\left\{\underline{I}, \widetilde{I}\right\} \leq I^{\max} \\ 0 & \text{otherwise.} \end{cases}$$

  where $I^{\max}$ denotes the maximal loan size for which repayment is possible.

Proof: See Appendix.

Proposition 5 distinguishes two cases, $M > 0$ and $M \leq 0$. The first case occurs when the marginal cost of repayment of the informal loan, $(1+r)$, exceeds the marginal benefit that the borrower derives from the resulting increase in social capital, $c(1-\theta)$. The potential outcomes are loan sizes I that satisfy both the incentive constraint for repayment and the participation constraint of the lender, i.e. $\widetilde{I} \leq I \leq \overline{I}$.[35] If $\widetilde{I}$ exceeds $\overline{I}$ there is no loan the lender would be willing to grant, as her participation constraint and/or the incentive constraint for repayment is violated. If, however, $\widetilde{I} \leq \overline{I}$, then some loan I^* with $\widetilde{I} \leq I^* \leq \overline{I}$ will be applied for and granted. The loan size I^* is the value in this interval that is closest to the optimal unconstrained loan size in the presence of endogenous social capital. This situation is depicted in Figure 4.

[35] Note that $\widetilde{I}$ is never smaller than $\underline{I}$.

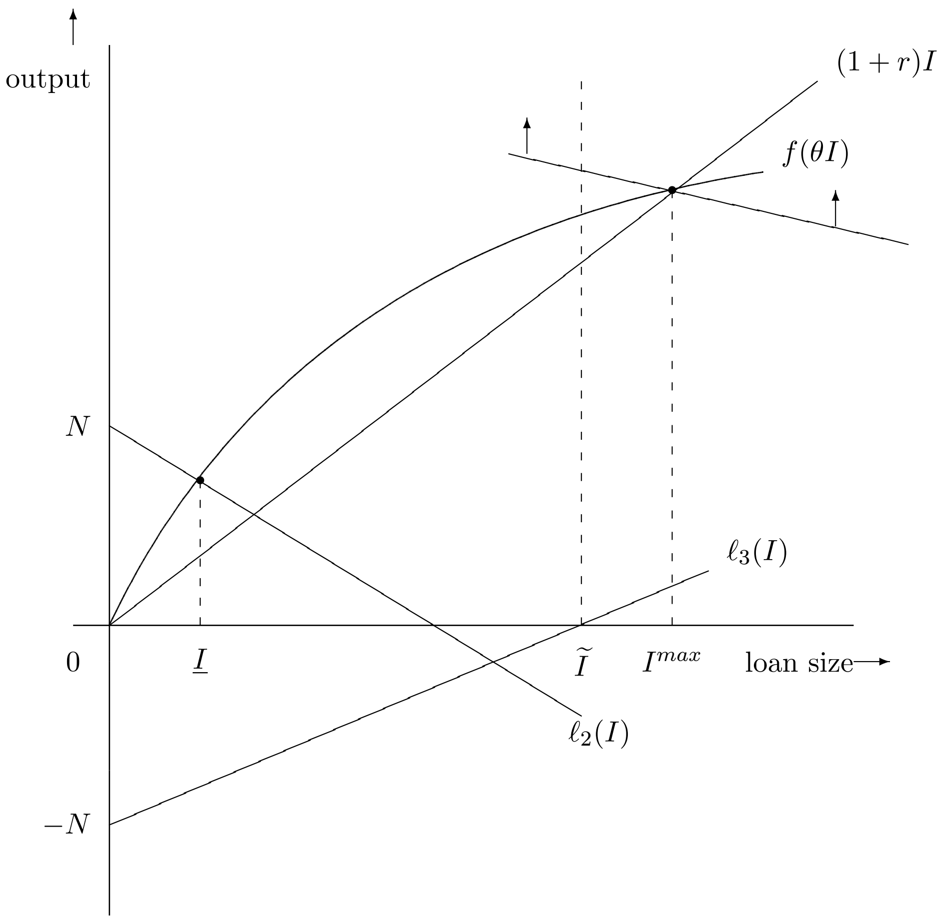

Figure 5: Credit Constraint with Endogenous Social Capital for $M \leq 0$

The second case in Proposition 5, $M \leq 0$, occurs when the marginal cost of repayment of the informal loan is less than or equal to the marginal benefit for the borrower from the resulting increase in social capital. Now the borrower applies for and obtains the largest loan he can repay, $I^{\max}$, whenever it satisfies both the participation constraint of the lender and the incentive constraint for repayment. This is illustrated in Figure 5. If at least one of these constraints is violated no loan will be granted, i.e. $I^* = 0$.

In interactions between borrowers and lenders, offering credit requires a level of security that can be based on legal measures, trust or coercion. Small-scale producers and traders in less developed countries have limited access to legal measures and therefore have to rely on other safeguards, notably trust and reputation. For a given country at a give time, there may exist an 'appropriate' level of social capital. Our results illustrate that social capital, as determined by a range of parameters, such as a, c, and δ, may have an important impact on the level of investment. Some levels of social capital may promote loans that otherwise would not be granted. Thus, our model suggests that because of the presence of social capital, some emerging economies such as China have managed to grow *despite* the absence of many conventional institutions like the rule of law. It also indicates that even in the presence of informal credit there may be a role for formal institutions that provide micro-finance, as some loans may be too small to be granted.

It should be noted that the optimal level of θ, which we assumed to be exogenously given, can be determined endogenously in a similar way as the optimal level of investment I. In this case, the extent of the credit market is limited by several parameters both from the economic and the social interaction, i.e. a, c, r, δ and I, for which cooperation could remain self-enforcing.

6. Concluding Remarks

In this paper we considered the problem of enforcing informal loans and the attendant possibility of the voluntary default. Loan contracts in the informal sector are rarely explicitly recorded and enforced by formal legal institutions. Repayment may be facilitated partially through informal enforcement mechanisms, such as social sanctions in linked relations in repeated interactions. In large part, compliance is ensured by the threat of reduction or elimination of access to credit in the future. The natural model to study the enforcement problem is one of repeated interactions in the credit market, which is described in Section 2.

The essential question is to what extent access to credit is a binding constraint on households' productive activities. Those borrowers who desire more credit and the non-borrowers who could, against their wishes, not obtain credit, are credit constrained. We explore this issue from different perspectives. Firstly, we analyse a model of a credit market without considering social capital, and find that in equilibrium credit constraints may arises.

Secondly, we show that the same framework can be adapted to understand more realistic markets taking *social capital* into account. Following Spagnolo (1999,[49]), we define social capital as the slack of enforcing power present in the social relation. This is the amount of credible social punishment power available as a threat in excess of the amount required to maintain cooperation in the social interaction. We start by considering the amount of social capital to be exogenously given. In this case, the credit constraint may disappear if the social capital exceeds some cut-off value. The most extreme examples can be found in hierarchically structured extended family settings, in which a patriarch (or 'godfather') holds an extraordinarily large set of obligations on the part of other people that he can call in as and when necessary. The analogy to financial capital is direct. We then proceed to endogenize social capital by introducing the possibility of investing in social capital. In this case some borrowers will find that only excessive loans are granted by the lender.

Our analysis emphasizes the importance of self-enforcing contracts in the informal credit market. It must be noted that our analysis does not imply that formal third-party enforcement is unimportant. In the model, social capital works only imperfectly in dealing with the problem of weak contract enforcement when the mobility of borrowers is high. Nevertheless, our research indicates how informal governance can function as a stepping-stone toward efficient formal institutions. In the long run, it seems essential for emerging market economies such as China to develop their formal contract enforcement systems and enhance the rule of law. This improves transactional efficiencies and fosters the growth of the private sector.

Even though some empirical studies show that the relationship between social capital and economic performance is ambiguous,[36] our analysis focuses on its positive effects in order to understand the successful private business sector and its credit arrangements. Such arrangements involve a combination of social obligation, good-will, and trust among the participants. In communities with high levels of social capital, people may trust each other more because the community's networks provide better opportunities to punish deviants.[37] At the same time, in these communities people may rely more on others keeping their promises as a result of a moral attitude inculcated with education.[38] The key idea behind the enhancing effects of social capital in this paper is that it may positively affect the repayment incentive of borrowers, and consequently, tend to mitigate or even solve their credit constraint problem.[39] This has some important implications for a number of aspects concerning the design of development policy.

[36] See e.g. Durlauf (1999,[21]) and Guiso, Sapienza and Zingales (2004,[33]).
[37] See also Coleman (1990,[16]) and Spagnolo (1999,[49]).
[38] See Banfield (1958,[8]) and Coleman (1999,[17]).
[39] The only exception are small loans, which may be too small to be granted when social capital is endogenous.

Loan may, however, be too small to be granted, wenn social capital is endogenous. Therefore, our model is not at odds with the strong demand for micro-finance in rural areas where social ties are strong and borrowers are immobile.

One further extension of the model is worth commenting on. We could relax the assumption that the borrower cannot use his accumulated savings from previous successful projects. On the one hand, in the stage game, this would introduce correlated default with considerations of the possibility of self-financing. Under relational lending, the borrowers become less likely to have sufficient incentives to repay. Therefore, the lender will increase the interest rate by charging a risk premium. The interest rate may become too high to sustain an informal credit market. In an environment which is characterized by a high level of physical, economic, and political uncertainty, the discount factor in the economic game is low because the realisation of future benefits may be considered unlikely. Cooperation in both games, based on the longer time horizon of personal relationships, however, could still be obtained when the discount factor in the social game is sufficiently high. Hence, both extending the literature on credit cooperatives and taking account of different discount factors in different types of games could be a fruitful further development.

Note that although this mechanism, that social capital has enhancing effects on repayment incentives, may work in China,[40] it may not be effective in other countries. Wydick (1999,[57]) finds that improvements in repayment rates are associated with variables that represent the ability to monitor and enforce group relationships, such as knowledge of the weekly sales of fellow group members in western Guatemala. He finds little impact, though, of social ties per se: friends do not make more reliable group members than others. In fact, group members are sometimes softer on their friends, worsening average repayment rates. Wenner (1995,[56]) investigates repayment rates in 25 village banks in Costa Rica and finds active screening that successfully excludes the worst credit risks. Hence, providing a more comprehensive analysis of the differences between the two lending schemes which rely on different mechanisms is a promising subject for further research.

[40]See e.g. Allen, Qian and Qian (2002,[3]), Batjargal and Liu (2002,[9]), Xin and Pearce (1996,[58]) and Yeung and Tung (1996,[59]).

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APPENDIX

Proof of Proposition 1:

The optimal unconstrained demand for credit is obtained from

$$\max_I \pi(I;r).$$

Since $\pi(I;r)$ is strictly concave in I, for each interest rate $r \geq 0$ there is a unique solution $I_D(r)$ that satisfies the F.O.C.

$$f'(I_D) = 1 + r.$$

The credit constraint is obtained from the inequality

$$f(I) \geq \frac{1+r}{\delta} I,$$

the maximal amount of credit that satisfies this inequality follows as $\hat{I}(\delta, r)$ for which

$$f(\hat{I}) = \frac{1+r}{\delta} \hat{I}.$$

Denote by $\hat{\delta}(r)$ the discount factor for which the unique optimal unconstrained demand for credit $I_D(r)$ is the maximum for which the inequality still holds, i.e.

$$\hat{\delta} = \frac{(1+r)I_D}{f(I_D)}.$$

For any $\delta < \hat{\delta}(r)$ the inequality

$$f(I_D) \geq \frac{1+r}{\delta} I_D$$

is violated, as the RHS increases, while the LHS remains constant. Therefore, the borrower faces a binding credit constraint for any $\delta < \hat{\delta}(r)$.

For any $\delta > \hat{\delta}(r)$ the borrower faces no credit constraint by similar reasoning.

End of Proof.

Proof of Proposition 5:

In order to solve the optimization problem of the borrower in the stage game in Section 5, we start by considering the feasible interval defined by the constraints (14) and (15). There are two cases to be considered.

- **Case I When** $M > 0$.

This case holds when $(1 + r) > c(1 - \theta)$. This seems to be the 'normal' situation.

When $M > 0$, there are three potential sub-cases to consider:

Ia) *two intersections.*

In this sub-case, since $M > 0$, the line $\ell_2(I)$ has a positive slope. Define $\Psi(I) = f(\theta I) - \ell_2(I)$.

The solutions for $\Psi(I) = 0$ are $\underline{I}$ and $\overline{I}$ with $\underline{I} < \overline{I}$.

Therefore, we obtain an interval for I from constraint (14): $[\underline{I}, \overline{I}]$. For each loan size in this interval, the borrower benefits from making the loan, as the slope M of the iso-payoff line is smaller than the slope $\frac{M}{\delta}$ of the line $\ell_2(I)$.

We also obtain an interval for I from constraint (15): $[\widetilde{I}, \infty)$. We discuss under which conditions the interval $[\underline{I}, \overline{I}]$ and the interval $[\widetilde{I}, \infty)$ have a non-empty intersection. This intersection is the feasible interval defined by the constraints (14) and (15).

If $\overline{I} < \widetilde{I}$, then there is no interval for I defined by constraints (14) and (15).[41] Thus, the lender would not grant any loan, i.e. $I^*(r, \delta; \theta) := 0$.

Otherwise, the feasible interval for I defined by constraints (14) and (15) is:

$$[\max\{\underline{I}, \widetilde{I}\}, \overline{I}].$$

[41] As can be seen in Figure 4, for δ sufficiently close to zero the inequalities (14) and (15) form a contradiction and this case occurs.

The unconstrained demand for credit $I_D(r,\delta;\theta)$ in the presence of endogenous social capital exceeds $\underline{I}$, as the slope $\frac{M}{\delta}$ of $\ell_2(I)$ exceeds the slope M of the iso-payoff line. For the optimal constrained loan size we obtain:

$$I^*(r,\delta;\theta) := \begin{cases} \widetilde{I} & \text{if} \quad I_D(r,\delta;\theta) < \widetilde{I} \\ I_D(r,\delta;\theta) & \text{if} \quad I_D(r,\delta;\theta) \in [\widetilde{I},\overline{I}] \\ \overline{I} & \text{if} \quad I_D(r,\delta;\theta) > \overline{I}. \end{cases}$$

Ib) *one intersection.*

As $N \geq 0$ and $f'(\infty) = 0$, this case can only occur when $\ell_2(I)$ is tangent to $f(\theta I)$, in which case the reasoning of case Ia) applies.

Ic) *no intersections.*

In this sub-case, it is possible that there is no intersection by $f(\theta I)$ and $\ell_2(I)$. The latter line always lies above the former curve and the lender would not grant any loan.

- **Case II When** $M \leqq 0$.

This case occurs when $(1+r) \leq c(1-\theta)$. There is no limit to the size of the loan that the borrower would be willing to take and constraint (16), that repayment is possible, comes to bear. Denote the maximum loan size for which repayment is possible by $I^{\max}$.

In this case there is one intersection of $f(\theta I)$ and $\ell_2(I)$, i.e. $\Psi^{-1}(0) = \underline{I}$. Thus, the feasible interval for I from constraint (14) is $[\underline{I},\infty)$. In addition, we obtain an interval for I from constraints (15) and (16) as $[\widetilde{I}, I^{\max}]$. Therefore, the feasible interval for I as defined by constraints (14), (15) and (16) is: $[\max\left\{\underline{I},\widetilde{I}\right\}, I^{\max}]$. If this interval is empty, the lender would not grant any loan, i.e. $I^*(r,\delta;\theta) := 0$.

From this we obtain

$$I^*(r,\delta;\theta) := \begin{cases} I^{\max} & \text{if} \quad \max\left\{\underline{I},\widetilde{I}\right\} \leq I^{\max}. \\ 0 & \text{otherwise.} \end{cases}$$

End of proof.