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Keywords: Social Capital, Social Collateral, Group Lending, Repayment Performance

JEL Classifications: D82 ; D85 ; D71 ; G21 ; O16 ; O18 ; Z13

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Abstract

Microfinance group lending with joint liability allows asset-poor individuals to replace physical collateral by social collateral. The literature on microfinance lacks a rigid framework for analyzing the consequences of using social collateral for borrowing behavior and repayment. This paper fills the gap by providing a theoretical framework to evaluate the impact of social collateral pledged by group borrowers on group lending repayment. Our approach is novel as we take into account the external ties of group borrowers, i.e. the social ties linking borrowers to non-borrowers from their community, whereas previous work in this field has looked solely at internal ties (i.e. between group members). One of the important features of our model is that we stress the impact of network configuration on the amount of social collateral pledged. Our model shows why the group lending methodology works better in rural areas than in urban areas, namely because rural social networks are typically denser than urban ones, which results in higher social collateral.

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1. Introduction

Microfinance institutions (MFIs) grant loans backed by social collateral to poor entrepreneurs whose incomes originate mostly from informal economic activities. As a consequence, MFIs are often committed to rely on soft information to assess borrowers' creditworthiness. Group lending with joint liability is seen as an effective instrument to circumvent information asymmetries, because it incentivizes group members to use their social ties to screen, monitor, and enforce loan repayment on their peers. The social ties embed social capital, and facilitate the collective actions of group members, allowing them to coordinate their repayment decisions and cooperate for their mutual benefit.

This paper sheds light on the role of social capital in group lending contracts. We provide a new concept of social capital by including *internal ties* (ties between group members) as well as *external ties* (ties of group borrowers with other individuals living in the same community). We suggest looking at both types of ties in order to understand how group lending works. In particular, by using this approach, we can better understand how social capital may be used for screening, monitoring, and loan enforcement.

The microfinance literature on social capital focuses on the social ties between group members.[1] Different proxies for these *internal* ties are used to show that they help predict the repayment performance of group loans. Recent studies by Dufhues *et al.* (2011a, 2011b, 2012 and 2013) randomly select individual and group borrowers from various areas of Thailand and Vietnam and map their *external* ties to identify how their stock of individual social capital predicts access to credit and repayment performance. However, no study in the theoretical or the empirical literature has focused simultaneously on both internal ties and external ties. We

[1]See Sharma and Zeller (1997), Zeller (1998), Wydick (1999), Godquin (2004), Hermes *et al.* (2005, and 2006), Van Bastelaer and Leathers (2006), Karlan (2007), Cassar *et al.* (2007), Ahlin and Townsend (2007), Feigenberg *et al.* (2010), Al-Azzam and Mimouni (2012).

argue that the combination of internal and external ties is instrumental in determining the amount of social capital pledged by individual borrowers as social collateral. This paper aims at filling this gap.

We stress that the social collateral pledged by group borrowers consists of the resources embedded in internal ties, but also in resources embedded in external ties. The external ties pledged as social collateral depend on the network configuration. The threat of compromising a borrower's internal as well as external social ties may deter her moral hazard behavior. A group borrower's internal and external ties may be compromised when she does not meet her peers' expected behavior – for instance, when she fails to repay her loan. If the information regarding the concerned group borrower's failure to respect the group agreement goes beyond the group, she may lose reputation within her network. Hence, her access to the resources embedded in her external ties may be reduced. Thus, we argue that the credibility of the threat of social sanctions depends on the size and importance of both internal and external ties. This, in turn, influences the effectiveness of social capital as disciplining device.

The remainder of this paper is organized as follows. Section 2 reviews the evidence on social capital and group lending with joint liability. In section 3 we explore the conceptual issues surrounding social capital in the context of microfinance group lending, while in section 4 we present our new theoretical framework. Section 5 provides conclusions and suggestions for future research.

2. Social Capital in Microfinance: A Brief Review of the Literature

The concept of social capital has been widely explored in the sociological and economic literature. Two of the socio-economic strands explain how social capital produces economic returns.[2] The first[3] views social capital as the pool of resources embedded in an individual's social network. The theory predicts that the richer and/or larger the pool, the higher the social return. In this line of thought, all social ties have an identical role, regardless of the stock of social capital mobilized to achieve a certain outcome. The second strand[4] defines social capital in terms of actual use. According to this strand, economic returns are driven by the social capital embedded in the ties that are actually mobilized to achieve a certain outcome.

Social capital plays an important role in microfinance. MFIs use the method of group lending with joint liability to reduce information asymmetries and increase repayment performance. The joint liability element is seen as an effective instrument to circumvent information asymmetries, because it incentivizes group members to use their social ties embedding their social capital to screen, monitor, and enforce loan repayment on their peers. In particular, in joint liability lending programs the members of a borrowing group act as guarantors for each other's loans. This encourages them to collect soft information from their social networks to screen and select each other. Once the group is formed, borrowers use this information to monitor each other and ensure that peers are using the loan for the promised income-generating purpose (i.e. to mitigate *ex-ante* moral hazard problems), as well as to avoid strategic default (i.e. to mitigate *ex-post* moral hazard). To preserve their social capital, group members may curb their own moral hazard behavior. Thus, by being jointly liable for the repayment of a group loan, borrowers pledge their social capital embedded in their ties with other borrowers, i.e. they provide social collateral.

[2] See Lin (2008) for a detailed discussion on social capital theories from a network-based perspective.
[3] See Bourdieu and Wacquant (1992), Belliveau *et al*. (1996), Woolcock (1998), Nahapiet and Ghoshal (1998).
[4] See Coleman (1990), Fukuyama (1995), Putnam (1995), Thomas (1996).

Although the success of microfinance relies at least partly on the use of social collateral, evidence on the role of social capital in a microfinance context is scarce. Defaulters' social ties can be compromised in two ways: directly, via the threat of losing social ties with co-borrowers, and indirectly through a reputational effect transiting through the information channels embedded in the social network. Therefore, social sanctions for repayment misconduct can be heavy. In the context of group lending, the first strand of literature suggests a linkage between individual social capital and repayment performance, whereas the second strand suggests a linkage between internal ties only and repayment performance.

The available evidence on microfinance group lending confirms the theoretical prediction that internal ties among borrowers affect their screening, monitoring and enforcement efforts, which in turn determines the repayment performance of group borrowers.[5] Several proxies have been used in empirical studies to gauge the intensity of social ties. They include factors such as the duration of relationship, geographic proximity, role relationship (i.e. whether group members are relatives, friends, or acquaintances), frequency of contact, and sharing between group members.

With respect to screening, it has been stressed that the group lending model allows in many cases for endogenous formation of groups. This self-selection allows borrowers to use their social ties to screen each other. Empirical evidence on the importance of self-selection and the role of social ties is scarce, however. One of the few studies investigating this is from Sharma and Zeller (1997), who find that self-selected groups lead to better repayment performance than do exogenously formed groups. Hermes *et al.* (2006) show that repayment problems decrease when the group leader knew the other group members before forming the group.

[5] See Ghatak and Guinnane (1999), Morduch (1999) and Hermes and Lensink (2007) for overviews of the theoretical literature of microfinance group lending.

Empirical research on monitoring efforts and the role of social ties is relatively more abundant. Several papers argue that monitoring and information sharing are easier when group members live close by. Simtowe *et al.* (2006), Karlan (2007), Cassar *et al.* (2007), and Al-Azzam and Mimouni (2012) find that geographic proximity improves repayment performance. However, Wydick (1999) finds that the positive impact of proximity only holds in rural areas, perhaps because individuals in these areas form tightly-knit networks. In contrast, in urban areas, the lack of information channels may render geographic proximity useless. Hermes *et al.* (2005) show that within-group moral hazard is lower when the group leader lives close to the group members, as well as when the group leader pays regular visits to her peers. As the result is specific to group leaders, this implies that they monitor and collect information more effectively than do the other group members.

Feigenberg *et al.* (2010) show that in India more frequent group meetings are associated with fewer default occurrences. Frequent meetings allow group members not only to share information, but also to strengthen the social capital embedded in their ties. More valuable ties translate into more credible threats of social sanctions. Strikingly, Van Bastelaer and Leathers (2006) find the opposite result based on data from Zambia, which, as they suggest, may be because the frequency of meetings is triggered by crisis conditions.

Evidence that the presence of relatives in the group can impact on repayment performance is mixed. On the one hand, Sharma and Zeller (1997) and Ahlin and Townsend (2007) find a positive impact in Bangladesh and Thailand, respectively. On the other hand, Al-Azzam *et al.* (2012) obtain the opposite result using data for Jordan. Apparently, in Jordan group members are more willing to threaten relatives with social sanctions. A second Jordan study shows that friendship between the group leader and other group members improves on-time repayment (Al-Azzam and Mimouni, 2012).

A number of studies measure internal ties through gender homogeneity. According to Wydick (1999), homogeneity facilitates intra-group insurance in rural areas of Guatemala, but not in urban ones. In urban areas, gender homogeneity significantly decreases repayment performance. Hermes *et al.* (2005) rationalize this outcome by showing that moral hazard is higher in same-sex groups. Based on a sample from Eritrea, the authors find that in gender-homogenous groups the probability of moral hazard behavior increases.[6] Gender homogeneity may make threats of social sanctions less credible.

Another proxy for internal ties is the intensity of resource-sharing among group members. Ahlin and Townsend (2007), Van Bastelaer and Leathers (2006), Gine and Karlan (2009), among others, calculate group-level sharing as the total number of types of goods/services/advice shared by the members of a group. Overall, sharing seems to improve the group repayment performance. However, Ahlin and Townsend (2007) show that sharing among non-relatives is bad for repayment, whereas sharing among relatives is positively related to repayment conduct.

The age of the group is another proxy used to measure the strength of internal ties. The relationship between group age and repayment performance may go both ways. On the one hand, older group members use their ties more efficiently to enhance repayment performance (Khandker, 2012). On the other hand, in older groups there may be a so-called *matching problem* (Paxton, 1996). With time, the credit needs of the group members may vary, possibly leading to tensions within the group. Moreover, if group members have known each other for a long time, they may be reluctant to check up on and sanction each other. The results of Godquin (2004), Ahlin and Townsend (2007), and Al-Azzam *et al.* (2012) confirm the

[6]Gender may also influence repayment performance through other channels (Guerin, 2011). Agier and Szafarz (2012) show that gender is a source of discrimination in loan granting. The gender gap in loan size is mainly attributable to loan officers (see also Labie *et al.*, 2010). Servin Juarez (2012) shows that the loan officer's gender affects repayment performance.

negative correlation between group age and timely repayment. Simtowe *et al.* (2006) prove that the number of loan cycles is positively associated with moral hazard. However, even if moral hazard increases in older groups, this may be offset by social capital accumulation, which promotes trust and reciprocity. This may eventually result in higher loan recovery rates.

Dufhues *et al.* (2011a, 2011b, 2012, and 2013) are the only scholars to define social capital in terms of a social network. For households in Thailand and Vietnam where at least one member is a borrower, the authors map the social network of the household head. They identify four types of ties depending on both the strength of the tie and the social distance between individuals. To measure a tie's strength, they use the following proxies: role relationships (whether individuals are relatives, friends or acquaintances), frequency of contact per month, duration of relationship, and closeness of relationship. Next, they use occupational prestige to build a proxy for the social distance between individuals. Their empirical results show that strong ties between individuals in the same position of authority improve repayment in Vietnam. In contrast, repayment in Thailand is enhanced by weak ties between individuals in different positions of authority.

In sum, the available empirical evidence on the role of social ties and the importance of information sharing is inconclusive in predicting repayment performance for group loans. Arguably, this inconclusiveness is linked to the lack of a consensual definition of social ties. Undeniably, however, social ties and information sharing shape the social collateral pledged by an individual group borrower. Social collateral determines the credibility of the threat of social sanctions. To avoid losing social collateral, group borrowers may deter each other's moral hazard behavior. In order to measure social collateral, we need to restructure the concept of social capital by measuring both internal and external social ties. In the next section we illustrate the definitional issues that need to be overcome in order to conceptualize social collateral properly.

3. Social Ties: Definitions

The sociological literature provides numerous definitions of social capital,[7] mostly centered on the resources embedded in social networks. Social networks are patterns of social exchange and interaction that persist over time (Uphoff, 2000). The link between any two members of a social network is called a social tie. The resources embedded in social ties are both pecuniary[8] and non-pecuniary. Non-pecuniary benefits include information sharing, moral support, advice, etc. The extent to which an individual can transform these resources into personal assets depends on her trust relationships. High trust relationships allow individuals to better harness social ties because they give access to more reliable soft information, and better risk-hedging; they also facilitate collaboration.

Social ties embed expectations of reciprocity,[9] which may be critical for people living in resource-scarce environments and coping with idiosyncratic shocks. Social ties are thus highly valuable to asset-poor individuals. Trust is embedded in the ties between individuals, and it shapes their stocks of individual social capital.

In the microfinance context, an internal social tie links two members of the same borrowing group. In contrast, an external tie relates one group borrower to another member of the local community. To formalize these concepts, let us consider a joint liability group B made up of two borrowers $B = \{a, b\}$.[10] The borrowers belong to a larger community. In order to illustrate the notions of internal and external ties, we use the network diagrams in Figs. 1 to 8, where individuals are represented by nodes, and social ties by edges.

[7] See Adler and Kwon (2002) for an overview.
[8] In case of need, network members may provide financial and/or in-kind aid.
[9] If an individual receives aid from a peer, the latter expects aid from the former at a future point in time (in case of need). This can be referred to as a case of mutual aid.
[10] For expositional clarity, we restrict the number of participants to the borrowing group to two. In practice, however, the number of group members vary with the type of lending methodology. For instance, they can include up to 6 group members for the Grameen type lending, or up to 35 in case of village banking.

[Insert Figures 1 to 8 here]

We focus on these distinct network configurations shown in the figures to illustrate the role of internal and external ties for information transfer, which is critical for screening, monitoring, and loan enforcement. In Fig. 1, the two group borrowers, *a* and *b*, are linked by an internal tie only. This is a simplified model of reality, since it does not take into account any relevant ties with the rest of the community, made up of the $(n - 2)$ other members. Yet, this representation is commonly used in the microfinance literature on group lending. The group members are considered as being isolated from the rest of the community, meaning that the outcome of the joint-liability loan will not affect the relationships between group members and the external world. This assumption is restrictive given that a person's actions in the context of a joint liability loan may be communicated to external ties. This may affect her reputation within the community as a whole, and may also influence her interpersonal trust relations, fostering cooperation between individuals (Putnam, 1995). In turn, this may affect the individual's access to the resources embedded in external ties.

To enlarge the scope, we consider several situations including external ties. In the simplest case, in Fig. 2, borrower *b* has an external tie with individual *c*, who does not belong to *B*, the group of borrowers. In Fig. 2, borrower *a* is not connected to *c*. Although in this situation, we include a relationship with the rest of the community, there will be no transmission of information about the behavior of the group members to individuals outside the group, because the members do not share common external ties.

In reality, borrowers may have numerous connections with other members of the community in which they live. Depending on the density of the social network, the probability that borrowers share common external ties increases. In Fig. 3, individual *c* is linked to both borrowers *a* and *b*. In such a situation, *a* and *b* may use their common tie with *c* as a channel

not only to screen and monitor each other, but also to transfer information to *c* about the peer's behavior. Therefore, we call *information channel* any path[11] going from one borrower to the other one. The *information channel* from *a* to *b* is said to be *direct* when it includes only one external node, and therefore two edges, such as in Fig. 3. *Indirect information channels* consist of three or more edges, and two or more external nodes. For instance, Fig. 4 illustrates an *indirect information channel*. Three edges connecting external nodes are needed to link *a* to *b*.

However, some external ties do not belong to any information channels. As mentioned above, Fig. 2 features a simple example of an information-channel-free network, since individual *c* connects to *b*, but not to *a*, either directly or indirectly. Likewise, Fig. 5 shows that the two borrowers may have unlinked external ties in a way that excludes information channels.

Fig. 6, Fig. 7 and Fig. 8 are examples of network configurations highlighting the differences in information channels embedded in these networks. In the three figures, borrowers *a* and *b* have an equal number of external ties. Fig. 6 excludes any direct or indirect information channel. Such a loose configuration is specific to urban areas, where people's networks are highly dispersed. Borrowers barely know the friends and relatives of their group members.

In contrast, Fig. 7 shows a tightly knit network, capturing the typical configuration of rural social networks. This configuration facilitates information collection, and improves the effectiveness of borrowers' screening and monitoring. Information channels may also be used to transmit information to the wider network. Tightly knit external ties ease information propagation within the network and make social sanctions more credible. In particular, by

[11]A path refers to a sequence of nodes and edges.

using information channels group borrowers may inform the defaulter's social network about her behavior. Failure to respect the group agreement may result in loss of trust and reputation for all the members of the network.

In Fig. 8, *a* and *b* have an identical number of social ties, but with different configurations. There is a single direct information channel (*a-e-b*) and two indirect ones (*a-f-e-b*) and (*a-g-f-e-b*). However, *b* has an informational advantage over *a*, because *b* can collect and disseminate information about *a* more easily than *a* can do about *b*. Indeed, *a* can rely on *c* only, while *b* can also use the other members having ties with *a* via indirect information channels passing through *c*.

The above discussion has provided a broader conceptual framework of social ties in microfinance group lending by focusing on internal as well as external ties of group borrowers. In the next section we elaborate on the consequences of bringing external ties into the discussion of how social ties may affect the behavior of group lending borrowers and their repayment performance.

4. Social Ties and Group Lending: A Conceptual Approach

The impact of external ties on repayment performance has so far been disregarded in the microfinance literature. This section proposes a new formalized framework to examine social capital by including both internal and external social ties. This approach is designed in a way that helps measure social collateral in group lending more rigorously than at present. It is based on the assumption that social collateral depends on internal ties, external ties, as well as the configuration of the whole social network. All these elements influence the credibility of

the threat of social sanctions, and hence affect the effectiveness of social capital as a disciplining device.

We start by looking at social interactions within and beyond the borrowing group and examining how credible threats of social sanctions may shape the behavior of group borrowers. The theoretical model of Besley and Coate (1995) explains the effectiveness of social sanctions from the payoff perspective. The group lending methodology incentivizes borrowers to repay the loans of the peers that undertake unprofitable projects. However, moral hazard is mitigated by the threat of social sanctions. A shirking peer is socially sanctioned for imposing costs on her contributing peer. Social sanctions depend on the discomfort and the material loss inflicted by the non-contributing member on her contributing peer. The aim of our model is to conceptualize this loss.

For simplicity, we assume that defaults are strategic only. The social cost that can be inflicted on shirkers may add up to the value of their social collateral, which consists of the resources embedded in the borrower's internal and external ties. In case of default, the other borrowers may wish to inform the defaulter's social network about her breach of trust. Depending on the availability of information channels, this may result in a loss of trust relationships at the level of the network as a whole. In this way, the informed network members will reduce the defaulter's access to the resources embedded in their ties. Additionally, the defaulter's kin may also be affected (La Ferrara, 2003).

We argue that the social collateral pledged by a group borrower encompasses resources embedded in internal ties, as well as in a number of external ties. The extent to which external ties are pledged as collateral depends on the network configuration. Hence, the network configuration affects the credibility of the threats of social sanctions. We rationalize social sanctions through the loss of trust, which reduces the individual's access to the resources

embedded in her social network. Drawing on the examples in Figs. 1 to 8, we present a simple representation of social ties and social sanctions for strategic default.

Let us consider a joint liability group made up of two borrowers, $B = \{a, b\}$. These borrowers belong to a community comprising (n+2) persons: C = {1, …, n, a, b}, i.e. the two borrowers and n other members. Initially, i.e. before any default decision is made, each member of community C benefits from several social ties. The ties are symmetric and represented by a square matrix of size (n+2) denoted $G = (g_{ij})$, where $g_{ij} \in \{0,1\}$.[12] A social tie embeds information sharing and trust. When $g_{ij} = 0$, individual i has no direct contact with individual j. In contrast, when $g_{ij} = 1$, individual i will inform individual j if a borrower defaults. Since the relationship involves trust, individual j will then act on this information and cut her tie, if any, with the defaulter. In this way, social sanctions rely on two different channels: the information channel (i.e. learning about whom is defaulting), and the trust channel (i.e. cutting the tie with the defaulter). We assume that the two borrowers share an internal social tie, meaning that: $g_{ab} = 1$. Any tie linking a borrower to a non-borrower is referred to as an external tie.

A borrower's stock of social capital consists of the resources embedded in internal ties, as well as in the external ties that *directly* link her to other community members. In contrast, information is not limited to direct ties. It transits via any succession of ties. Stated differently, we assume that direct and indirect information channels share the same efficiency to reach community members in general, and borrowers' external ties in particular.

Ex ante each borrower benefits from a stock of individual social capital (*SCap*), which is given by the number of her dyadic ties:

[12] We assume that social ties are symmetric and binary. These simplifying assumptions are introduced to avoid unnecessary notational complexity. In empirical applications it may be useful to use more nuances, including asymmetric and/or continuous tie intensity.

$$SCap(a) = 1 + \sum_{j=1}^{n} g_{aj} \quad (1a)$$

$$SCap(b) = 1 + \sum_{j=1}^{n} g_{bj} \quad (1b)$$

where the first term on the right-hand side equals the social capital embedded in the internal tie (i.e. $g_{ab} = 1$), and the second counts the borrower's external ties.

Next, we look at the social interactions and information channels of group borrowers within and beyond the group in order to measure the social collateral pledged by an individual group borrower. The defaulting borrower risks losing the resources embedded in the ties that she pledges as social collateral. The potential social loss for borrower *a*, respectively *b*, equals her social collateral. The threat of losing social collateral affects the borrower's decision to strategically default or not.

We assume that the borrower who bears the responsibility of a default incurs a social sanction materialized by the loss of all the ties pledged as social collateral. That collateral is composed of all the social ties with community members who can be informed about the default. More precisely, if, say, borrower *a* causes a default, then she will lose the trust of all her dyadic ties who are informed directly or indirectly by borrower *b*. As a result, information channels cause losses of social capital. Financial misconduct implies a loss of trust and reputation from those who are informed. The network configuration is thus important in defining social collateral.

For expositional facility, let us first assume that the network includes social ties only. Hence, a group borrower's social collateral (*SColl*) is given by the resources embedded in her single internal tie:

$$SColl\ (a) = g_{ab} = 1 \quad (2a)$$

$$SColl\,(b) = g_{ba} = 1 \qquad (2b)$$

Hence, $SColl\,(a) = SColl\,(b) = 1$. This simple situation where social collateral is limited to internal ties corresponds to the standard assumption in the microfinance literature on social capital.

Next, we go beyond this standard approach and pay attention to external ties, which are the social relationships borrowers share with non-borrowing members of community *C*. Plausibly, external ties pledged as collateral play an important role in the success of group lending. However, the complete stocks of individual social capital represented in Eqs. (1a) and (1b) may not be entirely collateralized. The extent to which external ties are pledged as social collateral depends on the information channels, and therefore on the network configuration including the ties between non-borrowers in set {1, … , *n*} who can act as information channels.

To model information channels, we introduce the concept of social paths. *A social path of length* (*p* + 1) is said to link community members *i* and *j* if there are *p* distinct individuals $k_1, k_2, \ldots, k_p \in \{1, \ldots, \mathrm{n}\}$ such that: $g_{ik_1} g_{k_1k_2} \ldots g_{k_pj} = 1$. All paths are finite and their lengths never exceed $(n+1)$. Likewise, we define the *informational distance* between individuals *i* and *j*, denoted $d(i,j)$, as the length of the shortest social path linking them. More precisely $d(i,j) = p + 1$ if:

$$\forall(k_1, k_2, \ldots, k_{p-1}):\ g_{ik_1} g_{k_1k_2} \ldots g_{k_{p-1}j} = 0 \text{ and } \exists(k_1, k_2, \ldots, k_p): g_{ik_1} g_{k_1k_2} \ldots g_{k_pj} = 1. \quad (3)$$

Direct information channels correspond to paths of length equal to 2.[13] Thus, indirect information channels are described by paths of length greater than 2. Importantly, some

[13] A length of 2 means that the path includes one external node only.

individuals are not connected at all, because there is no social path between them. In this case, the *informational distance* is conventionally fixed to infinity: $d(i,j) = \infty$ if:

$$\forall p \in \mathbb{N}, \forall (k_1, k_2, \dots, k_p): g_{ik_1} g_{k_1 k_2} \dots g_{k_p j} = 0 \quad (4)$$

Hence, the social collaterals (*SC*) pledged by the borrowers are:

$$Scoll\ (a) = 1 + \sum_{j=1}^{n} g_{aj}\, \mathbb{I}_{d(b,j)<0} \quad (5a)$$

$$Scoll\ (b) = 1 + \sum_{j=1}^{n} g_{bj}\, \mathbb{I}_{d(a,j)<0} \quad (5b)$$

Where $\mathbb{I}_{d(i,j)<0}$ is the binary variable taking value one if there is a social path between *i* and *j*, meaning that information can pass from *i* to *j*:

$$\mathbb{I}_{d(i,j)<0} = \begin{cases} 1 & \text{if } d(i,j) < \infty \\ 0 & \text{otherwise} \end{cases} \quad (6)$$

The social collateral of a borrower adds up the social capital embedded in the existing ties who can be informed about a default, if any. First, the co-borrower is always informed, which justifies the first term on the right-hand side of Eqs. (5a) and (5b). Second, anyone linked to the potential defaulter by a social path will be informed (for instance, $\mathbb{I}_{d(b,j)<0} = 1$). Among the informed, only those having an existing tie with *a* (for instance,$g_{aj} = 1$) will be affected. This combination explains the second term on the right-hand side of Eqs. (5a) and (5b).

To illustrate the definitions, Table 1 gives the social capital in Eqs. (1a and b), and the social collateral in Eq.(5a and b) for all the examples sketched in Figs. 1 to 8.Without external ties (Fig. 1), group borrowers pledge only their internal tie as social collateral. There are no external social sanctions in case of default.

Table 1: Social Capital and Social Collateral for Figs. 1 to 8

Fig.	Social Capital		Social Collateral	
	$SCap(a)$	$SCap(b)$	$Scoll(a)$	$Scoll(b)$
1	1	1	1	1
2	1	2	1	1
3	2	2	2	2
4	2	2	2	2
5	2	2	1	1
6	4	4	1	1
7	5	5	5	5
8	4	4	4	2

In Fig. 2 there is a single external tie linking *b* to *c* ($g_{ac} = 0$, $g_{ab} = 1$). With respect to Fig. 1, *b*'s social capital increases by one, but her social collateral is the same as in Fig. 1. Due to the lack of external information channels, borrower *a* cannot inform *c* about *b*'s potential default. The threat of social sanctions is limited to losing the resources embedded in the dyadic tie between *a* and *b*. This example clearly shows that equating social collateral to social capital can be misleading. Social capital is not always pledged as collateral entirely. The share of collateralized social capital depends on the network configuration.

In Fig. 3 both *a* and *b* are linked to *c* via external ties. There is a direct information channel between the two group borrowers (i.e., path *a*-*c*-*b*, or symmetrically *b*-*a*-*c*) that makes the threat of social sanctions more credible, since the social collateral increases to 2. In Fig. 4, borrowers *a* and *b* share no external tie, but individuals *c* and *d* form an indirect information channel, allowing them to collect and transmit information on the borrowers. Hence, *a* can inform *c* about *b*'s default (channel *a*-*d*-*c*), while *b* can inform *d* about *a*'s default (channel *b*-*c*-*d*). Thus, both *a* and *b* pledge as collateral their entire stocks of social capital. In Fig. 5, *a* and *b* have the same individual social capital as in Fig. 4, but there is no information channel between *c* and *d*. Therefore, the borrowers pledge a lower amount of social collateral.

Figs. 6, 7, and 8 display more complex network configurations. In Fig. 6, both *a* and *b* have social capital made of four ties. However, due to the lack of information channels their social collateral is limited to their internal tie. That is, *a* and *b* in Fig. 6 pledge a lower social collateral than in Figs. 3 and 4, although they have higher social capital. Fig. 6 can be viewed as representative of urban social networks, where members of a borrowing group share few social ties. In contrast, Fig. 7 features a tightly-knit network, specific to rural areas. In this case, borrowers *a* and *b* collateralize their entire stocks of social capital. Moreover, the direct information channels are doubled up by indirect information channels[14], making the threat of losing the entire stock of social capital highly credible.

Last, Fig. 8 shows that group borrowers living in the same environment may not pledge the same amount of social collateral. In this figure, borrowers *a* and *b* have the same stock of individual social capital (one internal tie and three external ties). However, they do not pledge the same amount of social collateral. While *a* pledges her entire stock of social capital, *b* pledges only the social capital embedded in her internal tie and one external tie (with *e*). As a result, *a* has a higher incentive to repay than *b*.

According to our approach, information channels increase the amount of social collateral involved and the threat of social sanctions in case of default. Information channels are especially dense in rural areas where tightly-knit networks improve the capacity to collect and transmit information. Our model thus provides theoretical support for the empirical findings that group lending works better in rural areas than in urban ones (Wydick, 1999; Ahlin and Townsend, 2007). More generally, we point out the instrumental role of the network configuration on the effectiveness of social capital as a disciplining device in group lending.

[14] This is the type of setting where "everyone knows everyone."

5. Concluding Remarks

This paper provides a novel theoretical framework to measure the social collateral pledged by microfinance joint liability borrowers and to show its impact on borrower repayment behavior. In particular, we rely on an extended notion of social capital including both *internal ties* (between group borrowers) and *external ties* (between group borrowers and others). We use concepts from network theory to measure the social capital pledged as collateral by microfinance institutions. Our main message is that the threat of compromising a borrower's internal as well as external social ties may deter her moral hazard behavior. A group borrower's internal and external ties may be compromised when she does not meet her peers' expected behavior – for instance, when she fails to repay her loan. If the information regarding the concerned group borrower's failure to respect the group agreement goes beyond the group, she may lose reputation within her network. Hence, her access to the resources embedded in her external ties may be reduced. Thus, we argue that the credibility of the threat of social sanctions depends on the size and importance both of internal and of external ties, which in turn influences the effectiveness of social capital as a disciplining device. One important feature of our approach is that the extent to which external ties are pledged as collateral depends on the network configuration.

This paper may have important policy implications for product design in microfinance. In particular, when implementing microcredit programs in certain social environments and/or contexts, MFIs need to consider the social collateral that their clients are able to pledge. One policy message based on our analysis may be that using joint liability group lending may work better in rural areas than in urban ones. More generally, it may be important for loan officers in a microfinance program to be informed about the social embeddedness of group borrowers in the community in which they reside.

We acknowledge that our theoretical framework is far from complete and can be extended in several ways. Here, we highlight some potentially important extensions. First, any analysis of the consequences of using social collateral in group lending should also gauge the potential effects of that collateral, not only for the borrowers (as we have done in this paper), but also for the MFI. One potential consequence of using social collateral may be that borrowers collude against the MFI, something that has actually been shown in some studies (Ahlin and Townsend, 2007). The probability of such an outcome depends heavily on the strength of borrowers' internal social ties, but also on their ties with the loan officer in charge of monitoring the group. While the ties with loan officers lie beyond the scope of this paper, our methodology is easily adaptable to such an extension.

Second, depending on the network configuration, borrowers may not always be able to assess whether or not a default is strategic. In this case, the assumption that social sanctions are enforced with respect to strategic defaulters falls short. Credible threats of social sanctions can put unnecessary pressure, with potentially harmful consequences (Schicks, 2013). Additionally, losing social ties may result in a reduction of information channels for the whole community. Taking into account such externalities in a game-theoretic perspective of social sanctions is a promising avenue for further research based on our conceptual framework.

Third, we have assumed that social ties are symmetric whereas in reality they are often asymmetric. Between two individuals, there is often a professional or familial hierarchic link. Ties do not embed the same resources from both parties. For instance, weak ties do not give access to the same resources as strong ties, and their role is instrumental for soft information transmission within the social network (Granovetter, 1973 and 1983; Levin and Cross, 2004). If ties are indeed asymmetric the effectiveness of social capital as a disciplining device in group lending may be different for different group members. Obviously, this has consequences for the calculation and interpretation of the outcomes of our model. Any future

extensions should therefore incorporate the possibility of having asymmetric ties between individuals.

Fourth, we have assumed that dyadic ties are binary (zero or one). However, relationships may have diverse intensities. Moreover, people might have enemies, meaning that social ties can even have negative values. Social ties are also dictated by social norms guiding interactions with others, including reciprocity (Cornée and Szafarz, 2013). Undeniably, all these characteristics will influence the nature of social capital. These factors should therefore be taken into account when determining the impact of social collateral on group behavior, both theoretically and empirically.

Finally, we have implicitly assumed that information is accurately transmitted regardless of the length of the information channel. In reality, the longer the path, the poorer the quality of information transfer. While assuming that there is no loss of information in direct information channels seems quite reasonable, the assumption is more questionable regarding indirect information channels.

All of the above suggestions may be taken into account and can be incorporated into future elaborations of our model. This will enable us to further explore the role social capital plays in determining the screening, monitoring and enforcement behavior of group members and to what extent it has an impact on the repayment performance of borrowing groups. Another important and potentially fruitful future research avenue would be to empirically test the outcomes of our model. This involves collecting detailed information about the nature of social ties borrowers have with group members as well as with other members of the community in which they live.

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List of Figures

Figure 1: Internal Tie Only

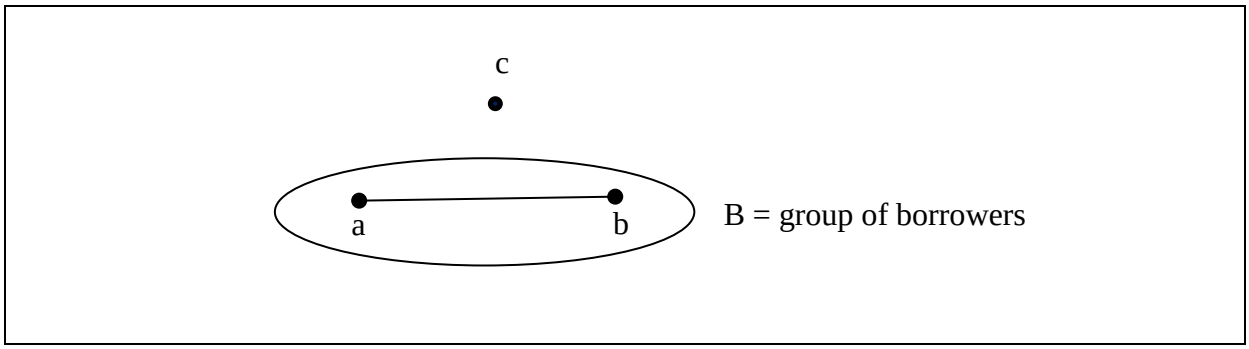

Figure 2: Internal and External Ties

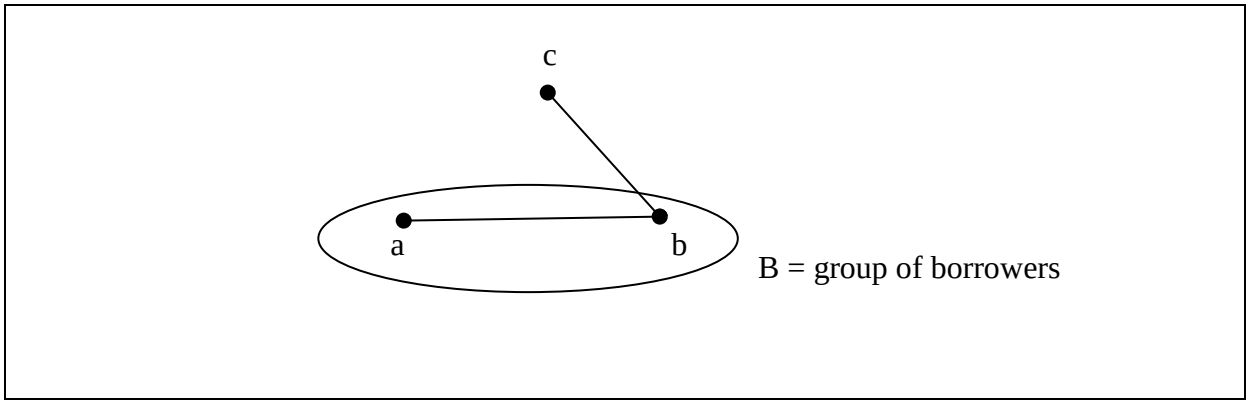

Figure 3: Direct Information Channel

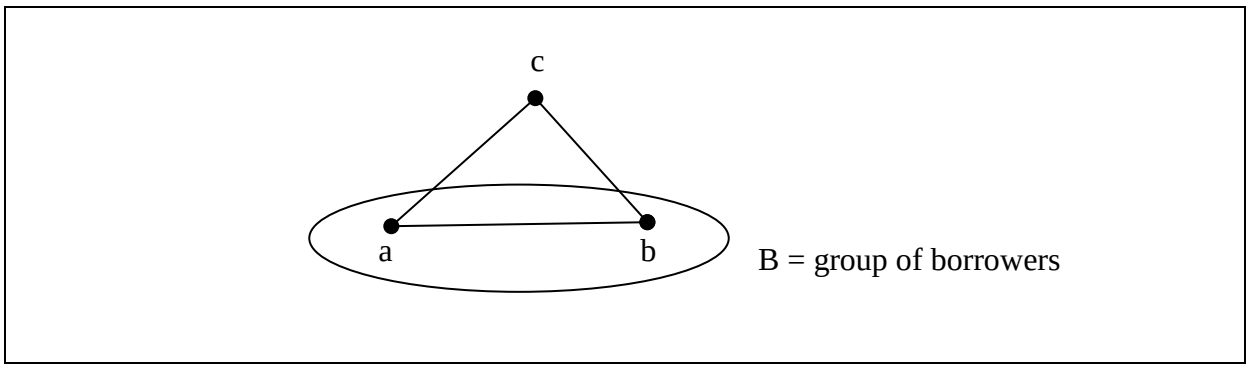

Figure 4: Indirect Information Channel

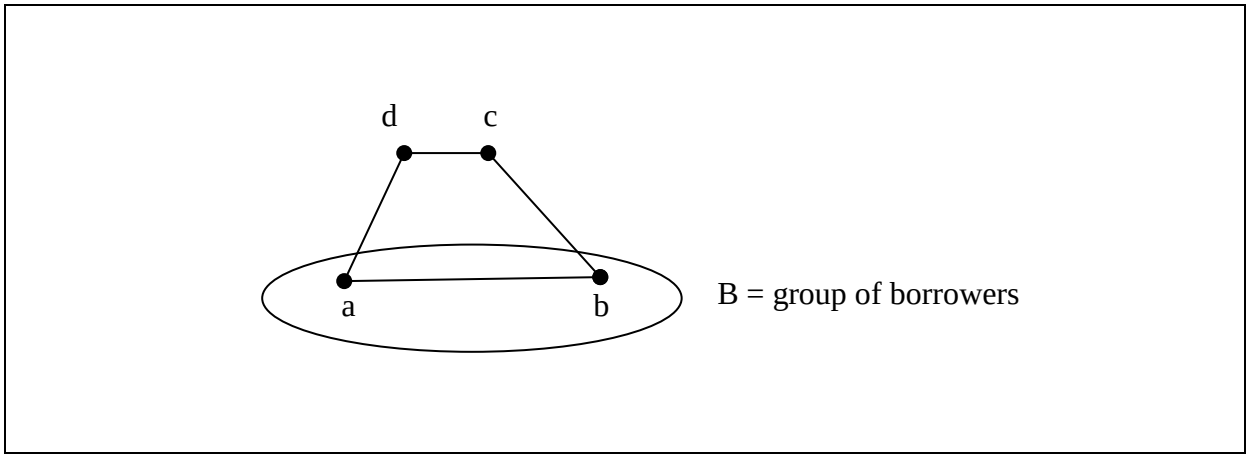

Figure 5: No Information Channel

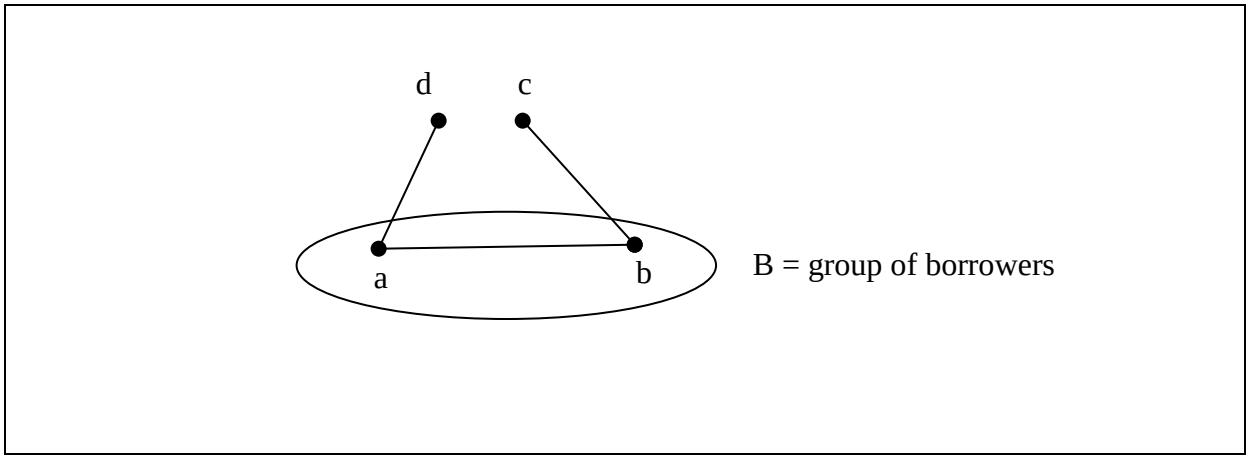

Figure 6: Complex Network 1

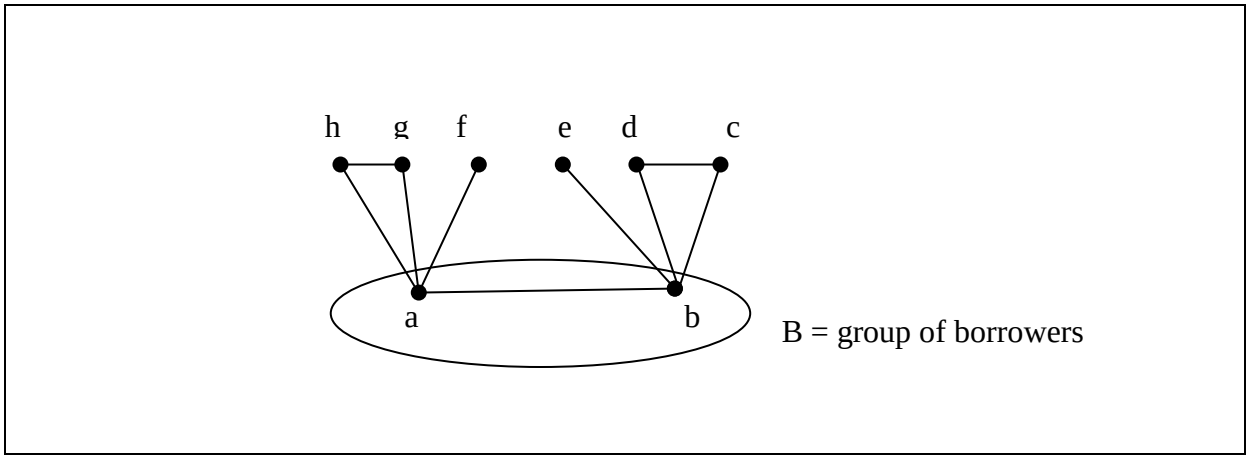

Figure 7: Complex Network 2

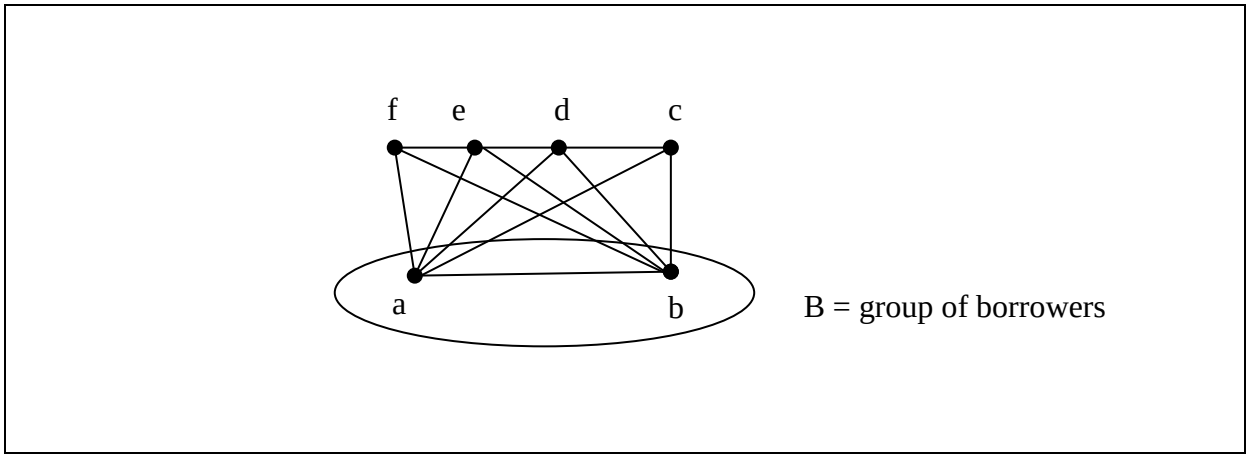

Figure 8: Complex Network 3