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To cite this article: Luminita Postelnicu, Niels Hermes & Roselia Servin (2019) External Social Ties and Loan Repayment of Group Lending Members: A Case Study of Pro Mujer Mexico, *The Journal of Development Studies*, 55:8, 1784-1798, DOI: [10.1080/00220388.2018.1464148](https://doi.org/10.1080/00220388.2018.1464148)

To link to this article: <https://doi.org/10.1080/00220388.2018.1464148>



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External Social Ties and Loan Repayment of Group Lending Members: A Case Study of Pro Mujer Mexico

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(Original version submitted September 2017; final version accepted April 2018)

ABSTRACT We investigate how external social ties, that is, social ties with individuals outside the borrowing group, determine loan repayments of individual borrowers in joint liability group lending. We measure the resources in external ties in terms of the informal risk insurance arrangement they embed. The ties borrowers have with individuals outside the group and the informal risk insurance arrangement they represent, help to survive in general, and repay their loans in particular. The risk of losing these ties increases the willingness to repay loans, that is, these ties can be regarded as a form of collateral to stimulate loan repayment. The extent to which these external ties are effectively pledged as collateral depends on the extent to which social networks of group members are overlapping: the more borrowers' networks of external ties overlap (referred to as information channels), the higher the risk of losing the informal risk insurance arrangement in case of non-repayment. We use data from 802 mapped social networks of borrowers' internal and external ties from a microfinance institution in Mexico. We find that group borrowers with external ties, representing a strong informal risk insurance arrangement while at the same time being information channels, have lower repayment problems

1. Introduction

Microfinance institutions (MFIs) around the world have been successful in reaching financially excluded poor households by implementing group lending with joint liability, a lending methodology that targets poor individuals. The main features of this methodology are that loans are granted to groups of individuals and that group members are jointly responsible for repayment. This obligation incentivises group members to use their social ties to screen, monitor, and enforce loan repayment by these other group members. In other words, it induces them to use their individual social networks – defined as the sum of personal social ties and the tangible and non-tangible resources embedded in them, that is, their social capital – as collateral for loan repayment.

The effectiveness of using social capital as collateral has been acknowledged in the microfinance literature. Social capital prevents payment default in two ways. First, it incentivises group borrowers to curb delinquent behaviour when the threats of social sanctions (that is, losing social ties and the

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Supplementary Materials are available for this article which can be accessed via the online version of this journal available at <https://doi.org/10.1080/00220388.2018.1464148>

tangible and non-tangible resources they represent) are real (Besley & Coate, 1995). Second, it offers support that can be invoked to help borrowers repay their instalments. Several studies have empirically identified the interaction between group members based on their social ties as a determinant of the success of group lending (Feigenberg, Field, & Pande, 2013; Hermes, Lensink, & Mehrteab, 2005; Karlan, 2007; Wydick, 1999).

Yet, these studies focus on *internal* social ties, that is, ties with other group members. The importance of *external* social ties – that is, social ties with individuals outside the borrowing group – in determining loan repayment of individual borrowers in joint liability group lending has not been taken into account. We are the first to address this issue. The aim of this paper is to add to the literature on the role of social capital in joint liability group lending by focusing on understanding the role played by these *external* ties. Just like internal ties, these external ties may hold valuable resources, which borrowers may use in case of need. As such, they are part of a so-called informal risk insurance arrangement the borrower has with individuals in the community. This provides incentives to a borrower to repay loans, because non-repayment may lead to losing access to the informal risk insurance arrangement. Not repaying a loan may mean these external ties are no longer willing to support the borrower in case of need. In addition, if social networks of borrowers outside the group overlap (community members outside the group may be part of the network of two or more group members, in this papers referred to as information channels), these community members can diffuse information about a borrower's repayment behaviour into the borrower's network. If this is the case, the borrower runs a higher risk of losing (part of) her informal risk insurance arrangement, that is, other network members, including the other borrowers in her group, may also no longer be willing to provide support in case of need.

We empirically test how group borrowers' external social ties determine individual loan repayment by using a large, original dataset mapping the social networks of 802 borrowers of Pro Mujer, a microfinance programme in Mexico. We find that group borrowers who pledge strong *external ties* (ties with community members outside the borrowing group embedding valuable resources) as collateral face fewer repayment problems. Borrowers with stronger informal risk insurance arrangements have a higher capacity to pay than borrowers with weaker informal risk insurance arrangements. Moreover, the fact that social networks of group borrowers overlap outside the group reduces repayment problems, because the cost of losing valuable ties due to non-repayment increases. These overlapping networks thus provide an additional incentive for borrowers to repay. Our results are robust to different specifications of the empirical model.

The remainder of this paper is organised as follows. Section 2 develops a theoretical framework explaining the potential role social capital plays in group lending and discusses the hypotheses we investigate in our empirical analysis. Section 3 continues with a discussion of the dataset, whereas in Section 4 we present the empirical model. Section 5 provides a discussion of the empirical results. In Section 6 we present our conclusions and policy recommendations.

2. Theoretical framework

Several studies have examined the social ties between borrowers of joint liability groups, also referred to as *internal ties*, and their importance for a group member's ability to screen, monitor, and enforce loan contracts of her fellow group members. These studies argue that social ties can embed trust, reciprocity and mutual support and that therefore they may be used as informal methods of support in case of need. The proxies for social ties used by these studies include the type of relationship (such as family, friends, or acquaintances; see, among others, Ahlin & Townsend, 2007; Al-Azzam et al., 2012; Griffin & Husted, 2015), duration of the relationship (Hermes et al., 2005; Wydick, 1999), meeting frequency (Feigenberg, Field, Pande, Rigol, & Sarkar, 2014; Feigenberg et al., 2013; Van Bastelaer & Leathers, 2006), geographic proximity (Karlan, 2007), and sharing between individuals (Ahlin & Townsend, 2007; Van Bastelaer & Leathers, 2006).

These studies provide mixed results with respect to the relationship between social ties and repayment performance of group loans. While they add to our understanding of why and when social ties between group members may increase their repayment performance, they do not take into account the potential importance of ties with individuals outside the borrowing group (*external ties*). Yet, we argue that these ties may (also) affect a borrower's repayment performance and that therefore a more in-depth analysis of such external ties, what they embed, and how they are used in social exchange between individuals forming a community, is warranted.

The starting point for such an in-depth analysis is the notion that an individual usually shares several ties with other individuals within (and possibly even outside) the community (village, neighbourhood, and so forth) in which she lives. A tie consists of social exchange and interaction between two individuals. These ties form her social network. Social networks are patterns of social exchange and interaction that persist over time. Social ties embed access to tangible and non-tangible resources, such as mutual support, reciprocity, and trust. These resources enable individuals to use their ties as *informal risk insurance devices*, that is, in case of need they can make use of these resources to survive and overcome difficult situations.

A tie's capacity to act as an informal risk insurance device is determined by the value (that is, the resources) it can provide in cases of need. In the literature this value is referred to as the *strength* of the tie, which is determined by the combination of the time two individuals spend together and the emotional intensity, intimacy (mutual confidence), and reciprocal services between them. The strength of a tie is the result of multiple social interactions over time. Strong ties are associated with a high degree of reciprocity between two individuals. In case of strong ties, individuals may be more willing to step in and help each other out, because the high degree of reciprocity raises the probability that this support will be received back later in case of need.

Stronger ties are associated with a higher probability of repayment of group borrowers. Ties that embed important financial resources may provide direct financial help for the loan repayment. Ties that embed high non-financial resources may also translate into better loan repayment. This occurs because non-financial resources may consist of labour input, sharing input and/or physical capital, and so forth. Moreover, factors such as moral support, psychological aid, and social validation may indirectly improve the economic success of borrowers. In the context of group lending, the informal risk insurance arrangement may be embedded in the borrower's *internal ties* (her ties with the other group members) as well as in her *external ties*, that is, the ties with individuals outside the borrowing group.

Social ties can also be used to collect information available within the network (Granovetter, 1973, 1983; Lin, 1986). Since two individuals are linked to each other through a tie, they may know about each other's behaviour. Information exchange between borrowers of the same group happens automatically as part of the group lending system, as members meet regularly to discuss their business and make repayments. However, information may also be shared with other members in the network of both individuals *outside* the group. The more the networks of two individuals outside the group overlap, the higher the potential of information is diffused to other network members of both individuals. This is referred to as ties having *information diffusion potential*. In the context of group lending, the information diffused within the network of borrowers may be about who is having problems repaying a loan and why these repayment problems occur. Based on this sharing of information, members of the network inside and outside the lending group may decide whether they provide resources to support the non-repaying borrower or put pressure on the borrower to make repayments. They may also threaten, and perhaps ultimately break the ties they have with this borrower, that is, they use a social sanction, because by not repaying the loan they believe the borrower is misbehaving.

Summarising the above discussion, social capital has economic value for an individual. When entering into a group lending programme with joint liability, an individual is effectively pledging her social capital as collateral, because not repaying the loan may ultimately lead to a loss of value a borrower obtains from the resources embedded in the ties. This occurs when network members decide to break the ties they share and stop supporting the borrower in times of distress. They may decide on this after being informed about the repayment behaviour of the borrower. Fellow group members

(*internal ties*) are able to directly observe this behaviour, because they interact with the borrower on a regular basis. Network members outside the group (*external ties*), however, may have more difficulties in observing this behaviour. Most likely, they may be informed when they are in the network of the borrower, as well as in the network of at least one other borrowing group member. In this case, networks of borrowers overlap and information can be diffused from the network of one individual to the network of another individual. The extent to which social networks outside the group overlap determines to what extent a borrower runs the risk of losing access to informal risk insurance arrangements in case of non-repayment.

The previous discussion makes clear that in order to be able to analyse how social capital affects repayment by members of group lending models, *external ties* need to be taken into account, next to the *internal ties*. When evaluating the role social capital plays in group lending, these networks and the internal and external ties they entail, need to be mapped. Moreover, the value of each of the ties of the network should be measured along two dimensions: its capacity to act as an informal risk insurance device and its potential to diffuse information within the borrower's network. However, research on the role of social capital in joint liability group lending only focuses on internal ties and typically does not measure the value of these ties. We address both these issues: we emphasise the role of external ties and explicitly measure the value they embed.

To formalise the above discussion, let us consider a community, C , comprised of n individuals, $C = \{1, 2, \dots, n\}$, and a joint liability borrowing group, B , comprised of two individuals from community C ; thus $B = \{a, b\}$.¹ To illustrate the importance of internal and external ties, we use the network diagrams in Figures 1 and 2. In these figures, nodes represent individuals and edges represent dyadic social ties. In Figure 1, the two borrowers, a and b , are linked by an *internal tie*. Information is directly diffused within internal ties, because group member a (b) knows when borrower b (a) has repayment problems.

When the *internal ties* of a group borrower are strong (the degree of reciprocity between two individuals is high), group members may be more willing to step in and help the respective borrower with repaying the loan. With strong ties, a borrower is more willing to help out a fellow borrower who is struggling with making repayments, because the high degree of reciprocity raises the probability that this support will be received back later in case of need. Thus, borrowers have a better repayment

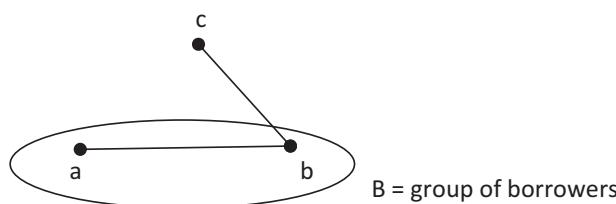


Figure 1. Internal and external ties.

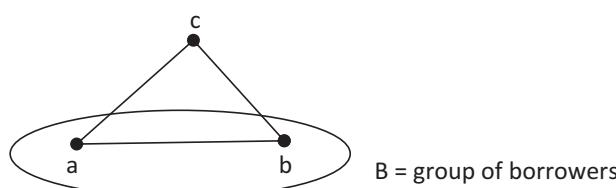


Figure 2. Direct information channel.

capacity (or fewer repayment problems) when they have a higher number of strong internal ties. Moreover, having strong internal ties may increase the potential cost a group borrower incurs in case she does not repay a loan as she runs the risk of losing access to important resources embedded in the borrower's internal ties once she does not repay the loan. This may curb delinquent behaviour to avoid losing access to these resources.

A borrower may also have strong *external* social ties, that is, ties with a high degree of reciprocity with individuals outside the borrowing group. In Figure 1, borrower b has a strong external tie with individual c . Yet this individual does not belong to B , the group of borrowers. Moreover, borrower a is not linked to c . The strong external ties with individual c are part of individual b 's overall informal risk insurance arrangement (together with the strong internal ties with a). Like strong internal ties, strong external ties may play an important role in reducing repayment problems. In case of problems, the borrower may ask for loan repayment assistance from the informal risk insurance arrangement embedded in the borrower's external ties with individual c . A strong informal risk insurance arrangement embedded in a borrower's external ties improves repayment capacity. In addition, having strong external ties may increase the cost a group borrower incurs in case she does not repay a loan: when social sanctions go beyond the group, the borrower runs the risk of losing access to important resources embedded in the borrower's external ties once she does not repay the loan. This may curb delinquent behaviour to avoid losing access to these resources. The size of the informal risk insurance arrangement embedded in the borrower's strong external ties increases with the *absolute number* of strong external ties an individual has developed.² The higher the number of external ties, the larger the pool of resources to which an individual may have access. Thus, we expect fewer individual repayment problems the higher the number of strong informal risk insurance arrangements through her external ties.

Hypothesis 1: *A higher number of strong external ties of a group borrower is associated with a lower probability of repayment problems*

Since borrower b has an external tie with individual c and since borrower a is not linked to c , transmission of information by individual a about the behaviour of group member b to individuals such as c outside the group will not be possible, because the members' external networks do not overlap. However, the situation changes in Figure 2, when individual c is also linked to borrower a . In this case, two borrowing group members have a tie with the same individual outside the group. This allows individual a to transmit information about individual's b behaviour to individuals in the network of b outside the group (individual c in our example). We define these type of external ties as *information channels*.

As discussed above, information channels facilitate the diffusion of information within the borrower's social networks. If information can be diffused within the borrower's social network outside the borrowing group, she runs a higher risk of losing access to informal risk insurance arrangements embedded in her external ties in case of non-repayment. The threat of social sanctions in terms of losing external social ties in case of non-repayment of the loan increases. The threat of losing valuable external ties may incentivise group borrowers to better assess ex ante their capacity to repay the loan and to make regular repayments once the loan has been obtained. From an information-diffusion perspective the existence of information channels increases the likelihood of information diffusion within the network. The likelihood of information diffusion increases with the *absolute number* of such information channels a borrower has developed. Consequently, borrowers will face fewer repayment problems, because they will more seriously assess their own repayment capacities before taking a loan and consider making timely repayments after having obtained the loan.

Hypothesis 2: *The number of external ties being information channels is associated with a lower probability of repayment problems of a group borrower*

In principle, information channels may or may not hold important tangible and non-tangible resources. In case information channels do hold important resources (they can be classified as strong external ties), these ties may not only have the potential to transfer information, but may also be a potentially valuable component of the borrower's informal risk insurance arrangement. Assume borrowers *b* and *c* are linked through a strong tie (a tie acting as part of the informal risk insurance device; see [Figure 2](#)). In cases of economic problems, not only may *b* ask *c*'s help, but *a* may also ask *c* to help *b* with repayment. In these circumstances, information channels are being used as part of the informal risk insurance arrangement, improving the borrower's repayment capacity. At the same time, however, information channels that can be classified as strong external ties may also increase the cost a borrower incurs in case she does not repay a loan. Information channels also being strong external ties increase the risk of losing access to important resources embedded in the borrower's external ties once she does not repay the loan. This may further curb delinquent behaviour to avoid losing access to these resources. We therefore expect borrowers with a high *absolute number* of strong information channels to face fewer repayment-related problems.

Hypothesis 3: *The number of information channels, which can be classified as strong external ties, is associated with a lower probability of repayment problems of a group borrower*

3. The dataset³

3.1. Institutional setting

To test our hypotheses we collected detailed information on the social networks of 802 group borrowers associated with Pro Mujer Mexico,⁴ during the period of April to June 2014. Pro Mujer is a non-governmental organisation that provides joint liability group loans to nearly 40,000 women who lack access to basic financial services. Group meetings are usually held every two weeks, which are attended by most group borrowers. The monitoring of borrowing group members and their (strong) mutual ties, in combination with the close monitoring by the loan officers, help in reducing repayment problems of borrowers.

3.2. Data collection process

To get the relevant information, the data collection process was organised as follows. Pro Mujer provided us with the portfolios of 54 randomly selected loan officers. We pooled the groups managed by these officers and randomly selected 300 groups. Randomisation resulted in a sample of 300 groups managed by 51 of the 54 loan officers working in 27 branches across six Mexican regions. The groups in our sample have between four and 25 members. The next step was to collect data from 900 randomly chosen borrowers, that is, three from each randomly selected group.

To map the social networks of the borrowers in our sample, we used a unique survey instrument specifically developed for this research project. First, to map their *internal ties*, we collected the names of all group members of a surveyed borrower from the archives of Pro Mujer. All borrowing group members were then interviewed and answered a number of questions providing information about their personal characteristics. Second, during the interviews we held with the borrowers we collected detailed information about their *external ties*. In particular, we asked them to provide information about up to three people outside the group who were part of their network and who they knew were also part of the network of one of the other borrowers in the group, that is, we asked for external ties being information channels (see [Figure 2](#)). Next, each interviewed borrower answered a series of questions to identify whether these external ties were considered weak or strong ties, that is, they can be used by the borrower as part of her informal risk insurance arrangement. To illustrate the data collection procedure, take the example of borrower *b* who is a member of a group of five borrowers. For this borrower, the maximum number of external ties for which we could potentially collect data is

12 (five borrowers minus borrower b times three external ties for each of the other four borrowers). In our data set, the number of external ties for which we finally collected data ranged from zero to 42.

The survey consists of 15 questions at the *group* level, capturing general information about the group, information related to non-financial services provided by Pro Mujer, the overall repayment behaviour of the group, and the presence of moral hazard behaviour within the group (that is, whether any group member has misused the loan).

The survey for the *individual borrowers* contains 16 different sections, each covering different characteristics of borrowers and their social networks. Sections 4–6 are most important for our analysis as they capture questions related to the internal and external ties of borrowers.⁵ Sections 4 and 5 map internal and external ties and capture specific dimensions for each tie, such as the relationship between borrower and her tie, closeness of relationship, geographic proximity, and the frequency of meetings outside the group. The questions in Section 4 are used to map all internal ties of an individual borrower. The questions in Section 5 are used to map external ties, with a maximum of three as explained above. In selecting these three ties, a borrower was asked to mention the names of the first three ties that come to mind. This methodology is used extensively in sociological studies and is known as the *name-generator* approach. Marin and Hampton (2007) argue that the first names that come to someone's mind are the ones she considers her strongest ties. Thus, we assume that the first three ties mentioned by an individual are the strongest. In our research, we are specifically interested in knowing more about the strongest ties of a borrower, as these ties are most important for her informal risk insurance arrangement. These are also the ties she would like to keep, that is, they are assumed to provide the strongest incentive to repay the loan.

Section 6 captures information related to *aggregated resources embedded in all external ties* of group borrowers by using questions that have been adapted from research in sociology (Marin & Hampton, 2007) to measure resources embedded in external ties. In particular, we ask the following questions:

- ‘How many people outside the group could you ask to take care of your kids/house if you are unable (sick, away from home)?’
- ‘How many people outside your group could you ask to lend you a small sum of money if you needed it?’
- ‘How many people outside your group could you ask to lend you a large sum of money if you needed it?’
- ‘How many people outside your group could you ask to give you some advice related to your work/business if you needed it?’
- ‘How many people outside your group could you ask to lend you a bike/motorbike/car?’

Marin and Hampton (2007) argue that the use of these types of questions leads individuals to think about their close relationships with core family members or friends. Therefore, the answers to these questions, which refer to the social network of an individual *as a whole* (and not just the three most important ones), can be used as an indication of the *stock of all resources* embedded in an individual's external ties. They thus reveal information about the value of the external ties that form the individual's informal risk insurance arrangement.

Table 1 summarises our final sample. In total, we interviewed 802 borrowers from 289 groups managed by 51 loan officers from 27 branches, across six Mexican regions. Our dataset contains 6782 internal ties and 6450 information channels, that is, ties an individual outside the group has with two members of the same borrowing group. Borrowers reported 797 internal ties with one external information channel (that is, the social networks of both group members are overlapping with respect to one individual outside the group), 494 internal ties with two information channels, and 1555 internal ties with three information channels. This means that of the 6782 internal ties, 42 per cent (2846 internal ties) are ties that have at least one information channel. For the remaining 3936 internal ties it holds that they do not have any overlapping network with other members in the group.

Table 1. General description of collected sample

<i>Number of Mexican Regions</i>	6
<i>Number of Branches</i>	27
<i>Number Loan Officers</i>	51
<i>Number of Groups</i>	289
<i>Number of Borrowers</i>	802
<i>Number of Internal Ties</i>	6,782
<i>Total Number of Direct Information Channels</i>	6,450
Number of Internal Ties with One Info Channel	797
Number of Internal Ties with Two Info Channels	494
Number of Internal Ties with Three Info Channels	1,555
<i>Number of Direct Information Channels per Borrower</i>	0–42

3.3. Measuring the resources embedded in individual ties: strong versus weak ties

For each internal tie and for each of the (maximum of three) external ties for which we have collected detailed information, we measure the resources they embed based on the questions in Sections 4 and 5 of the survey. In particular, we examine the following six dimensions as proxies for measuring the resources embedded in social ties: (1) the type of the relationship (that is whether individuals are core family, other family, friends, acquaintances, or other⁶); (2) the duration of relationship; (3) the closeness of relationship; (4) meeting frequency outside the group meetings; (5) geographic proximity; and (6) sharing during the last 12 months. These six dimensions allow us to identify whether a tie is strong (meaning that the resources it embeds are part of the borrower's informal risk insurance device) or weak.

To identify whether a tie is strong or weak (that is, whether or not it acts as part of the borrower's informal risk insurance device), we use a clustering methodology that has been used elsewhere in the literature on social ties (Dufhues, Buchenrieder, Euler, & Munkung, 2011a; Dufhues, Buchenrieder, & Munkung, 2013; Dufhues, Buchenrieder, & Quoc, 2012; Dufhues, Buchenrieder, Quoc, & Munkung, 2011b). Following this method, we consider a social tie to be a point in the space of the specified six dimensions. We use two-means cluster analysis to identify two clusters of ties, that is, a cluster of strong ties and a cluster of weak ties.⁷ The two-means cluster analysis method aims to partition ties as defined by the aforementioned six coordinates into one of these two clusters. First, using a clustering algorithm, this method randomly takes two observations from the dataset. Next, in an iterative process, the remaining observations are assigned one by one to one of the two groups based on their proximity (in terms of Euclidian distance) to the group centre. Every time a new observation is assigned to a group, the group centre changes according to the new mean of the observations forming that group. The process is repeated until the algorithm converges.^{8,9} When clustering ties from our dataset, we pool all ties (that is, both internal ties and information channels) and mark each tie so that we know whether it is an internal tie or an information channel.¹⁰ The clustering is performed after removing the ties with missing values on at least one of the six dimensions.¹¹

We refer to the cluster with the highest group mean as the cluster of strong ties and the cluster with the lowest group mean as the cluster of weak ties. The first cluster is formed by ties characterised by a strong type of relationship in which two individuals have known each other for a longer time, feel closer to each other, meet each other more often outside group meetings, live closer, and have shared goods or services during the last 12 months. The opposite is true for the ties forming the second cluster.

Our cluster analysis provides the following results. The cluster of strong ties contains 2552 social ties, 761 of which are internal ties and 1791 are information channels. The cluster of weak social ties contains 7602 ties; 4118 are internal ties and 3484 are information channels. Table 2 provides the summary of the results of the clustering analysis. These outcomes show that in general the borrowers in a group do not have strong ties: only 15 per cent of internal ties can be characterised as strong ties. For external ties this is 34 per cent.

Table 2. Results of clustering

Social Ties Cluster	Number of Ties
<i>Strong</i>	2,552
of which:	
Internal Ties	761
Information Channels	1,791
<i>Weak</i>	7,602
of which:	
Internal Ties	4,118
Information Channels	3,484

4. The empirical model

To empirically test our hypotheses, we use the following logistic model:

$$P_{ij} = E\left(Y_{ij} = 1 | E_{ij}, D_{C_{ij}}, C_{ij}^s, I_{ij}^s, N_{ij}, D_{ij}, G_j\right) = \frac{1}{1 + e^{-Z_i}},$$

where $Z_{ij} = \ln\left(\frac{P_{ij}}{1-P_{ij}}\right)$, and

$$Z_{ij} = \alpha + \beta^* E_{ij} + \gamma^* D_{C_{ij}} + \delta^* C_{ij}^s + \lambda^* I_{ij}^s + \varphi^* N_{ij} + \chi^* D_{ij} + \omega^* G_j + \varepsilon. \quad (1)$$

Y_{ij} , the outcome variable, captures the repayment problems of borrower i from group j . To measure the dependent variable in our model, we ask borrowers about repayment problems during the past two loan cycles. To quantify repayment problems, we identify whether the borrower faced at least one of the following situations during the past two loan cycles:

- ‘I had to borrow money from someone else in order to repay at least one instalment’;
- ‘I had to withdraw my savings in order to pay at least one instalment’;
- ‘I quarrelled/had arguments/disputed with my spouse or other family members because of difficulties to repay the loan that I took’;
- ‘I had to sell some household assets to repay at least one of the instalments’;
- ‘I had to make personal sacrifices (eat less/withdraw children from school/neglect my health) to repay at least one of the instalments’; and
- ‘Other problems’.

Our dependent variable takes the value 1 if the borrower mentioned encountering at least one of the problems mentioned above, and 0 if the borrower reported no problems with repaying. In other words, it distinguishes borrowers who encounter problems to repay their loans from borrowers who do not experience problems repaying their loans. We select this variable to measure the repayment problems of borrowers, because all borrowers in our sample have a clean portfolio, that is, they always manage to find a solution to repay their loans. This suggests that problems with loan repayment borrowers are faced with are due to cash flow management problems, instead of failing to make the necessary repayments. The descriptive statistics of the dependent variable show that only 10 per cent of the borrowers encountered repayment problems. This finding is not uncommon in research on micro-finance group repayment.

We predict the likelihood of repayment problems by including the following variables into the model. E_{ij} is a vector of variables measuring different types of resources embedded in all external ties of borrower i from group j . In the analysis, we include measures based on the answers given by individuals to the questions in Section 6 of the survey. As explained, these

Table 3. Descriptive statistics of the main variables used in the empirical analysis

Variable	Obs	Mean	Std.Dev	Min	Max
Repayment problems (dependent variable)	6740	0.10	0.30	0	1
Number of information channels	6447	8.37	8.36	0	42
Number of strong information channels	1791	2.42	5.21	0	42
Number of external ties who can lend a small amount of money	6764	5.05	47.06	0	1000
Number of external ties who can lend a large amount of money	6763	1.35	2.06	0	30
Number of external ties who can take care of kids/house	6761	1.91	2.04	0	20
Number of strong internal ties	761 ^a	1.36	2.24	0	14

Notes: ^aThe 761 strong internal ties from our sample are distributed among 299 borrowers (that is, 299 borrowers who have strong internal ties, with the remaining number linked to their peers by weak internal ties only). The borrowers from our sample have 0–14 strong internal ties, with a mean of 1.36.

questions provide information on the number of people outside the group a borrower can ask to take care of her kids/house, borrow a small/large sum of money from, give advice related to work or business, and/or borrow a bike/motorbike/car. These measures are included to test *Hypothesis 1*.

$D_{C_{ij}}$ represents the number of information channels of borrower i from group j to test *Hypothesis 2*. C_{ij}^s is the number of strong information channels of borrower i from group j , allowing us to investigate *Hypothesis 3*.

Next to these variables, we include a number of control variables. I_{ij}^s represents the number of strong internal ties of borrower i from group j . N_{ij} captures the adherence to social norms, values, and beliefs of borrower i from group j . D_{ij} represents the demographic characteristics of borrower i from group j . Finally, G_j represents the characteristics of the group j . The selection of these control variables is based on previous empirical research with respect to the determinants of repayment performance of group lending. A summary table describing the definitions of the main and control variables used in the empirical analysis, as well as a table with the descriptive statistics of the control variables can be found in the Supplementary Materials. The descriptive statistics of the main variables used in the analysis are presented in **Table 3**.

5. Empirical results

5.1. Baseline results

We start by discussing the baseline results for the model described in Equation (1). These results are presented in **Table 4**. We follow a stepwise approach, that is, we start by presenting the results for the variables related to the three hypotheses discussed in **Section 2**, and add a large set of control variables to check whether our results for the variables of interest are robust in terms of the stability of the signs and significance of the coefficients. In column [1], we present the results for the variables measuring internal and external ties based on the full model (including all control variables).¹² We follow this approach, because we have no theory based on which we are able to exclude variables from the model.

Next, we rerun the full model but exclude control variables on statistical grounds in two consecutive rounds, that is, we delete all control variables that are not statistically significant in the full model and then repeat this procedure for the set of controls that is left after the first round of excluding non-significant control variables (columns [2] and [3]). This approach is also known as the general-to-specific approach (Brooks, 2002). One of the advantages of this approach is that ‘... the statistical consequences, from excluding relevant variables are usually considered more serious than those from including irrelevant variables’ (Brooks, 2002, pp. 209–210).

As discussed in **Section 2**, our first hypothesis states that a strong informal risk insurance arrangement embedded in the external ties of a group borrower reduces repayment problems. Having a strong

Table 4. Logit regression (dependent variable ‘repayment problems’: 1 = Yes, 0 = No)

DEPENDENT VARIABLE	(1)	(2)	(3)
	Repayment Problems	Repayment Problems	Repayment Problems
INDEPENDENT VARIABLES			
Number of information channels	-0.062 (0.042)	-0.013 (0.034)	-0.005 (0.032)
Number of strong information channels	-0.244** (0.105)	-0.205** (0.081)	-0.177** (0.079)
Number of external ties who can lend a small amount of money	-0.007 (0.007)	-0.004 (0.004)	-0.003 (0.003)
Number of external ties who can lend a large amount of money	0.259** (0.104)	0.200** (0.094)	0.149** (0.070)
Number of external ties who can take care of your kids/house	-0.374** (0.188)	-0.190 (0.147)	-0.183 (0.143)
CONTROL VARIABLES			
Number of controls	YES	YES	YES
Constant	-3.219 (2.241)	-3.614** (1.602)	-2.836** (1.410)
Pseudo R2	0.4221	0.3403	0.3071
Observations	10,664	12,648	12,932

Notes: Robust standard errors are in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0$.

informal risk insurance arrangement may improve the borrower’s ability to repay, because she may get help in case of problems related to loan repayment. To test this hypothesis, we use the answers to three of the five questions addressed in Section 6 of the survey, that is, the number of external ties who can lend a small amount of money, the number of external ties who can lend a large amount of money, and the number of external ties who can take care of house/kids in cases of need.¹³

The results presented in column [1] of Table 4 suggest that the support for the hypothesis that a strong informal risk insurance arrangement embedded in the external ties of a group borrower is associated with a lower probability of repayment problems is mixed. Two of the three variables measuring the informal risk insurance arrangement have the expected negative sign, but only one is statistically significant (the number of external ties who can take care of house/kids in cases of need). The variable measuring the number of external ties who can lend a large amount of money is significant, but has the opposite sign, that is, being able to borrow a large amount of money from an individual outside the group increases the probability of repayment problems.

According to our second hypothesis, we expect the number of the borrower’s information channels to be negatively related to the borrower’s repayment problems. This hypothesis assesses the effect the credibility of the threat of social sanctions has within the community of group borrowers. In other words, the extent to which the social networks of the borrower’s peers overlap with the borrower’s social network is expected to be positively related to the credibility of the threat that information can be diffused into the borrower’s social network. Given the higher credibility of the threat, a borrower may have incentives to better assess her personal capacity to repay a loan (that is, not over-state ability to avoid future repayment problems) and/or may be more motivated to make timely repayments. As expected, we find a negative relationship between repayment problems and the number of direct information channels, but it is not significant (see column [1]).

Our third hypothesis states that the number of strong information channels is negatively related to repayment problems. In other words, we expect borrowers pledging a high number of strong information channels as collateral to have better repayment capacities. As explained in Section 2, these strong information channels not only have the potential to transfer information, they are also a

valuable component of the borrower's informal risk insurance arrangement. In case of repayment problems, information channels can be used as part of the informal risk insurance arrangement, improving the borrower's repayment capacity. Information channels, also being strong external ties, increase the risk of losing access to important resources embedded in the borrower's external ties once she does not repay the loan. This reduces delinquent behaviour to avoid losing access to these resources. The results presented in column [1] clearly support hypothesis 3. Pledging a high number of strong information channels as collateral is negatively associated with the probability of repayment problems.

Overall, our results suggest that having a strong informal risk insurance arrangement embedded in the external ties or having a high number of information channels alone is not strongly related to having lower repayment problems. Rather, it is the *combination* of the two (for example, having external ties that represent a strong informal risk insurance arrangement that are also information channels) that matters in terms of helping and incentivising borrowers to make loan payments. Thus, having strong external ties (capturing valuable financial and non-financial resources) with individuals who are also part of the network of one or more of the other members of the borrowing group seems to reduce repayment problems of an individual borrower.

We control for a wide range of variables. The choice of these variables is based on the results from previous studies on group lending repayment performance. We have organised these control variables into three groups. The first group captures various individual borrower characteristics. This group includes a measure of the number of internal ties of the individual borrower. Previous research on the impact of social capital on the repayment performance of individual borrowers has exclusively focused on internal ties. Therefore, we deem adding a measure of internal ties important, that is, we keep this variable into our model, even if it turns out to be insignificant. Other variables measuring individual borrower characteristics include age, marital status, religion, education, household size, household income, membership of formal and informal networks, and so forth. The second group consists of borrowing group characteristics, such as the age, size, loan amount, and average interest rate paid. Finally, we add control variables measuring the borrower's values, beliefs, and social norms related to microcredit activity. In total, we include 30 different control variables. Several control variables are significantly associated with repayment problems.¹⁴

In column [2], we present the results when rerunning our baseline model, excluding the control variables that were not statistically significant in the full model presented in column [1]. This does not affect the main results for our three hypotheses. We still do not find evidence for the hypothesis that a strong informal risk insurance arrangement embedded in the external ties of a group borrower is related to repayment problems (hypothesis 1). The relationship between the number of information channels and repayment problems remains insignificant as well, lending no support to hypothesis 2. At the same time, however, the negative and significant relationship between strong information channels and repayment problems (hypothesis 3) remains robust to excluding insignificant control variables.

We repeat the procedure of rerunning our model, this time excluding the insignificant control variables in column [2]. The outcomes of rerunning the model are presented in column [3]. Of the 30 control variables we started with in the full model, 13 remain in our specification in column [3]. All but two (including internal social ties) are statistically significantly associated with repayment problems. Most importantly, however, the results for the variables measuring external ties of borrowers do not change when rerunning the model for the second time. We therefore conclude that, whereas we do not find evidence for the first two hypotheses, we do find support for the third hypothesis, that is, the number of strong information channels holding important resources is associated with lower probability of repayment problems of a group borrower.

5.2. Robustness checks and testing for endogeneity

Next, we carry out a number of robustness checks and test for endogeneity. First, we use alternative clustering methods to determine the strength of ties. Second, we run the logit model with clustering of the standard errors of observations at the group level. Third, we address problems related to omitted

variable bias by using a method developed by Altonji, Elder, and Tauber (2005). Finally, we address reverse causality problems by following Dufhues et al. (2012). A more detailed discussion of these additional analyses can be found in the Supplementary Materials.

The results of these analyses are generally similar to those of the baseline regressions. Therefore, the main message of the paper, that is, the number of strong information channels holding important resources is associated with lower probability of repayment problems of a group borrower, still holds.

6. Conclusions

This paper focused on analysing how social networks of microfinance group borrowers come into play in determining the repayment of joint liability group loans. We used a new framework that allows us to measure the resources embedded in the *external* social ties of group borrowers, that is, social ties with individuals outside the borrowing group. In particular, we focus on their role as information channels as well as their contribution to the informal risk insurance arrangement of the borrower. To the best of our knowledge, we are the first investigating the importance of external ties of group borrowers. Our analysis is based on a large and original dataset containing 802 mapped social networks of borrowers from Pro Mujer Mexico.

Our main finding is that group borrowers having a strong informal risk insurance arrangement embedded in their external ties or having a high number of information channels alone is not strongly related to having lower repayment problems. Instead, our analysis suggests that the *combination* of the two (that is, having external ties that represent a strong informal risk insurance arrangement and that are also information channels) really matters in terms of helping and incentivising borrowers to make loan payments. Thus, having strong external ties (capturing valuable financial and non-financial resources) with individuals who are also part of the network of one or more of the other members of the borrowing group reduces repayment problems of an individual borrower. Our results confirm that social capital plays an important role in supporting the success of joint liability group lending and that social capital embedded in *external* ties is indeed important in this respect. To the best of our knowledge, this finding is new to the literature.

Our results are robust to different specifications of our empirical model. Moreover, we test for potential omitted variable bias and reverse causality problems. The tests suggest that these problems do not affect our main results. Still, we cannot rule out the possibility that our analysis is affected by endogeneity problems. Therefore, we would like to stress that our results should be taken as evidence for an association, rather than a causal relation between borrowers having social ties and their repayment performance.

Overall, our results add to the outcomes of earlier studies, which suggest that social capital can be used by MFIs as an effective device to ensure the success of joint liability group lending. The main practical implication of this study relates to the way MFIs inform themselves about how groups are formed and how this information is used in the loan disbursement process. In particular, MFIs could take into account our outcomes in decisions about the location of new branches. Our research indicates that successful repayment of loans is to be expected in areas where networks between individuals are tight, not only between borrowing group members as most of the microfinance literature suggests, but also between borrowers and other individuals in the community where they live.

Future research may further investigate how group borrowers' repayment capacities are driven by social mechanisms. To start with, our study may be replicated in other cultural contexts to determine whether these results can be generalised. External social ties seem to be important predictors of the repayment capacities of group borrowers, but different aspects of the networks' configurations may be more important than others in different cultures. Moreover, research on the interaction between group borrowers and loan officers as external ties is scarce. Our methodology can be used to examine the social ties between group borrowers and loan officers. Such research may reveal new insights into the social mechanics behind the group lending methodology. Morvant-Roux, Guérin, Roesch, and Moisseron

(2014) argue that the interaction of loan officers with their borrowers is complex and that their capacities to build close relationships depend on the loan officers' integration within the local social context.

Acknowledgements

We thank COLPOS for their support by pre-financing the logistics on the field. We would like to thank Johan Bastiaensen, Solene Morvant-Roux, Marek Hudon, Arian Szafarz, and the participants of the 2015 European Research Conference on Microfinance (ERCM), Geneva, Switzerland, for their valuable comments on earlier versions of the paper.

Funding

This work was financially supported by ADA, Luxemburg, which is duly acknowledged. The research has been carried out in the framework of an 'Interuniversity Attraction Pole' on social enterprise, funded by the Belgian Science Policy Office.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes

1. We restrict the number of group members to two for expositional clarity.
2. See Rooks, Sserwanga, and Frese (2014) on the determinants of innovative performance of entrepreneurs in Uganda. They also use the *number of contacts* in the network as a measure of the resources available in the network of an individual to support his/her innovative performance.
3. A more detailed description of the dataset and how it was collected is provided in the Supplementary Materials.
4. In the remainder of the text we will refer to the organisation as Pro Mujer, instead of Pro Mujer Mexico.
5. For a discussion of the questions in the other sections of the survey, see the Supplementary Materials.
6. In the category 'other', we include the peers that the group borrower said she does not know well, or individuals with whom she has a bad relationship.
7. Factor analysis is not suited for testing our hypotheses, because it focuses on grouping variables according to patterns of variation (correlation), not grouping objects (ties in our case) according to their proximity. Separation of ties acting as informal risk insurance devices (strong ties) from other ties (weak ties) is essential for testing our hypotheses.
8. The algorithm *converges* when the best two groups are found (that is, when all observations are assigned to their corresponding group *and* any further reassignment step does not have any effect). The continuity of the iterative process until the convergence of the algorithm is important. After the first assignment of the last observation from the dataset to one of the two groups, the algorithm calculates the new group centre and may conclude that several observations that were previously assigned to one group should be re-assigned to the other. In this case, the algorithm will be resumed and run until such changes are no longer necessary (the algorithm converges). If two clusters cannot be partitioned on the basis of the dataset (the algorithm cannot converge), the data will remain distributed within one cluster.
9. The clustering method is sensitive to the choice of the starting values and outliers. When the data does not contain clearly defined, well-separated clusters, there is a good chance that clusters based on different starting values will be different (Makles, 2012). We therefore rerun the analysis by using alternative random starting values for generating the two clusters. These alternative clustering results are generally consistent with the results presented in the paper.
10. It is important to pool all ties when clustering, rather than perform separate clustering of internal ties for direct information channels, to avoid biases due to the sensitivity of the random setting of the starting values and outliers that may be specific to a subsample. In this way, we ensure an internal tie characterised by specific values along the six dimensions will be part of the same group as an information channel characterised by the exact values along the six dimensions.
11. In the clustering process, we lose 1903 (28%) internal ties and 1175 (18%) information channels. Loss of ties also occurs in other empirical studies using cluster analysis for social ties (see Dufhues et al. 2011a, 2011b, 2012, 2013).
12. The full results, including those of the control variables, can be found in the Supplementary Materials (see Table 4).
13. After analysing the data, we identified high pairwise correlations between three variables that measure resources embedded in external ties (based on the questions in Section 6 of the survey). In particular, 'the number of people outside the group that can take care of your house/kids' is highly correlated with 'the number of people outside the group that can give you advice

- on your business' and 'the number of people outside the group that can help you with a bike/motorbike/car if you need it'. We dropped the latter two variables, retaining the former because it has the highest explanatory power for the model (based on pseudo-R² comparisons).
14. To save space we refrain from a detailed discussion of the regression results for the control variables. These results are available upon request to the authors.

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