October 2018

Able but Unwilling to Enforce: Cooperative Dilemmas in Group Lending

Nicholas Sabin
CABDyN Complexity Centre, Saïd Business School, University of Oxford
Facultad de Administración y Economía, Universidad de Santiago de Chile

Felix Reed-Tsochas
CABDyN Complexity Centre, Saïd Business School, University of Oxford
Oxford Martin School, University of Oxford
Department of Sociology, University of Oxford

Saïd Business School WP 2018-17

The Saïd Business School’s working paper series aims to provide early access to high-quality and rigorous academic research. Oxford Saïd’s working papers reflect a commitment to excellence, and an interdisciplinary scope that is appropriate to a business school embedded in one of the world’s major research universities.

This paper is authored or co-authored by Oxford Saïd faculty. It is circulated for comment and discussion only. Contents should be considered preliminary, and are not to be quoted or reproduced without the author’s permission.
Able but Unwilling to Enforce:
Cooperative Dilemmas in Group Lending

Nicholas Sabin
CABDyN Complexity Centre, Saïd Business School, University of Oxford
Facultad de Administración y Economía, Universidad de Santiago de Chile

Felix Reed-Tsochas
CABDyN Complexity Centre, Saïd Business School, University of Oxford
Oxford Martin School, University of Oxford
Department of Sociology, University of Oxford

Corresponding Author: Felix Reed-Tsochas. Saïd Business School, Park End Street, Oxford, OX1 1HP, UK. Phone: +44 1865 288502. Email: felix.reed-tsochas@sbs.ox.ac.uk. We gratefully acknowledge very useful feedback provided by David Barron, Michael Biggs, Ronald Burt, Thomas Powell, Tom Snijders, and Brian Uzzi on earlier drafts of this paper. The support of the Skoll Centre for Social Entrepreneurship (to N.S.), the Complexity Economics Programme of the Institute for New Economic Thinking at the Oxford Martin School Grant INET12-90001 (to N.S. and F.R.-T.), and FET-Open Project FOC-II FP7-ICT-2007-8-0 Grant 255987 (to N.S. and F.R.-T.) is gratefully acknowledged.
Able but Unwilling to Enforce:

Cooperative Dilemmas in Group Lending

Abstract

How does a group’s social structure influence informal sanctioning behavior in cooperative dilemmas? It is generally accepted that the ability to punish non-cooperators increases with greater social connectedness and should improve cooperation. However, this hypothesized ability often does not correspond to the observed collective outcomes. We propose that an important missing factor that can determine collective outcomes is the structural effect on the willingness to punish. In this paper, we develop a theoretical framework in which variation in a group’s social structure produces a tension between ability and willingness to enforce sanctions. These tendencies are often in conflict because the same underlying social mechanisms that promote the ability to sanction often decrease the interest in carrying out the punishment. The empirical support for our framework involves an in-depth analysis of group lending in Sierra Leone. Group lending reflects a clear cooperative dilemma: if one member does not repay, the others are held financially responsible. We complement statistical modelling with ethnographic analysis in a nested research design, the highest level including 5,582 repayments made by 1,884 borrowers. Two measures of a group’s social structure, (1) structural cohesion and (2) disconnected subgroups, are examined in light of the ability and willingness to enforce. We find that structural cohesion consistently increases economic cooperation to a point, beyond which unwillingness to punish outweighs the benefits of increased ability, resulting in worse group repayment. Furthermore, groups that consist of disconnected subgroups are more willing to punish defectors in the out-subgroup. However, they are less able to effectively sanction and overall performance suffers. The distinction between ability and willingness allows one to better explain collective outcomes that are non-monotonic and sensitive to interaction effects.
INTRODUCTION

A key element promoting collective action is the ability to sanction those who are not cooperating (Olson 1965; Ostrom 1999). Without a central authority to administer sanctions, groups often rely on informal punishments or rewards, for example through the loss of reputation or ostracism (Oliver 1980; Heckathorn 1990). It intuitively follows that groups with greater social connectedness will have a greater ability to effectively punish defectors, resulting in improved collective outcomes (Homans 1950; Coleman 1990). However, this intuition can be fundamentally misleading if the effect on a group’s willingness to enforce is not explicitly considered.

To illustrate the difference, consider group lending. It is a common financial practice offered to low-income clients that presents a clear cooperative dilemma (Anthony 2005; Armendáriz and Morduch 2010). A group of borrowers enter into a joint-liability contract under which each member receives an equal portion of a loan. If one of the group members does not repay, the entire group is held responsible by the lending institution, losing access to future credit. There is an incentive to free-ride and leave the financial burden to the other members. This situation typifies what is referred to as the ‘first-order cooperative dilemma,’ the temptation to share in the benefits of a collective good without personally contributing. In this context, it is often expected that well-connected groups would be better able to sanction potential defaulters, for example by applying social pressure or public shaming (Besley and Coate 1995; Wydick 1999). However, empirical research attempting to map the social structure of microcredit groups to their collective repayment has been highly contradictory (see Hermes and Lensink 2007 for a review).

The potential problem has been more broadly identified in the sociology literature: highly cohesive groups often fail at collective action (Gould 1993; Portes and Sensenbrenner 1993; Flache and Macy 1996; Anthony 2005). The poor performance may stem from the group’s unwillingness to carry out the social enforcement. In informal groups, enforcement is a public good in itself (Yamagishi 1986). This raises what is referred to as the ‘second-order cooperative dilemma,’ the temptation to share in the collective benefits of norm enforcement without personally contributing to enforcement (Oliver 1980).
Consider the group lending example again. Each group member faces two basic cooperative dilemmas (Heckathorn 1993): should she contribute her financial portion of the loan (level-one dilemma) and should she contribute to sanctioning a delinquent group member (level-two dilemma). Does the nature of her relationships to the other group members affect the likelihood that she will carry out one or both tasks? In other contexts, researchers have noted that while increased social connectedness may mitigate the first-order dilemma, it may potentially exacerbate the second-order dilemma, (Flache and Macy 1996; Hechter and Opp 2001; Horne 2004).

This problem introduces a fundamental question underlying collective efficacy, not just restricted to the case of highly cohesive groups. Does variation in social structure produce systematic effects on the relationship between ability and willingness to enforce cooperation? We suspect that this a common and widespread tension that results from basic underlying mechanisms mediated by social interaction. Examples range from opportunities to punish team members violating work productivity norms (Homans 1974) to chastising community members not active in political movements (Chong 1991). If we can better distinguish the structural tendencies regarding ability and willingness to enforce, we can better understand how social context shapes collective outcomes.

In the first half of this paper, we develop a theoretical framework in which variation in a group’s social structure may simultaneously mitigate the first-order dilemma while exacerbating the second-order dilemma. This fits with an active line of research in which scholars have called for progress beyond the idea that social interaction enhances cooperation to distinguish how and when structure may trigger multiple, potentially conflicting, mechanisms (Gould 2003; Cook, Levi, and Hardin 2009; Baldassarri 2015). We approach this by first theoretically pulling apart the structural effects on ability and willingness to enforce. Once disentangled, we attempt to put them back together, in order to understand which behaviors are most likely to dominate collective levels of cooperation (Fehr and Gintis 2007). A key implication of the theoretical framework is that there are causal reasons, stemming from the underlying group structure, why ability and willingness will often be in conflict. The tension may be so central to cooperative behavior that if willingness is not
incorporated in one’s expectations, the estimates for the effect of social structure on the collective outcome may be incorrect, both in terms of magnitude as well as direction.

Having substantiated that a group’s ability and willingness may often be in conflict, a second implication of the framework regards how this disparity should be integrated in our expectations for collective outcomes. Researchers have noted that for sanctioning to act as a cooperation-enhancing mechanism, both ability and willingness are necessary (Ostrom 2000; Reuben and Riedl 2013). Ability and willingness may be actual or perceived, but if one is viewed as lacking, the value of the sanctioning system will be weak. For example, though a joint-liability group may have extensive opportunities to shame delinquent borrowers, if it is well known that the group is not willing to follow through, the ability has minimal effect on promoting repayment (Al-Azzam, Hill, and Sarangi 2012), and vice versa. We argue that for different group structures, the lesser of the two enforcement tendencies will determine the extent that sanctions can improve the group outcome.

This approach for incorporating differential tendencies in ability and willingness to enforce allows us to make refutable hypotheses regarding the cooperative outcomes for specific group structures. Specifically, we examine two dimensions of a group’s structural embeddedness (Granovetter 1985; Uzzi 1999): structural cohesion (Burt 1987; Coleman 1988) and the existence of disconnected subgroups (Festinger, Schachter, and Back 1950; Frank and Yasumoto 1998), as well as the interaction of these two features.

In the second half of this paper, we provide an in-depth empirical analysis of economic cooperation using mixed methods. The context is group lending in Sierra Leone. Here, group members must make cooperative decisions with high-value stakes, for example, between damaging long-term relationships and forgoing crucial sums of money. The combination of quantitative and qualitative methods enable us to statistically test broad cooperative patterns while also explicating the underlying "social cogs and wheels" (Hedström and Bearman 2009, 17).

We test the hypothesized relationships using an empirical dataset provided by a microfinance institution. The design is nested with each subset including greater detail on the social mechanisms of interest (Small 2011). The highest level includes 1,884 borrowers involved in 5,582 group repayment
transactions spanning the period from 2006 to 2011. At this level, the quantitative analysis involves group structures based on high-resolution spatial data, individual borrower characteristics, and fine-grained group outcomes. The analysis also offers a methodological contribution, demonstrating how individual-level GPS spatial coordinates can be used to construct proxies for a group’s social structure. At the mid-level, we test for construct validity using social network data collected on a subset of borrowers. Finally, at the most granular subset we examine ethnographic data on borrower behavior in lending groups. We explore the structural constraints and enforcement processes of 64 borrowers in their own words. While the analysis at the higher levels provides statistical significance of our hypotheses, the qualitative inquiry enhances our understanding of the causal linkages (see King, Keohane, and Verba 1994; Small 2013). The benefits of the mixed methods design in this study can be categorized as both 'confirmatory', i.e. triangulation of data types to ensure that the findings do not depend primarily on the particular kind of data collected, as well as 'complementarity', i.e. combining data types to compensate for the specific interpretation challenges of the other data type (Small 2011).

The analysis supported three substantive relationships. (1) We found that structural cohesion increases economic cooperation to a point, beyond which unwillingness to punish outweighs the benefits of increased ability, resulting in statistically worse group repayment. Though leniency is often described as an exception for a friend, the consistency of exceptions in the borrower descriptions provides intuitive examples of why highly cohesive groups perform worse on average. (2) We examined the ability-willingness tension in regards to a different structural measure, the existence of disconnected subgroups. We found that the disconnect between subgroups increased the willingness to punish by accentuating out-group bias, but at the same time weakened the effectiveness of social punishment mechanisms. For a group with average overall cohesion in our dataset, the inability to effectively enforce outweighed the increased willingness. This resulted in bifurcated groups exhibiting statistically worse group repayment. (3) Groups naturally exhibit different levels of disconnect between subgroups. We examined this by testing the interaction effect between overall group cohesion and the existence of disconnected subgroups. We hypothesized a positive interaction
effect in which overall cohesion moderates enforcement behaviors towards out-subgroup members, i.e. enforcement inability and willingness to punish are most extreme in groups with minimal overall cohesion. The empirical results confirmed that if a group has disconnected subgroups, increased overall cohesion is correlated with improved group repayment. Overall, the results indicate how structural forces promote counteracting tendencies regarding ability and willingness to enforce. The tradeoffs are systematic, allowing one to better estimate collective outcomes that are non-monotonic and sensitive to interaction effects. The article concludes with contributions to our current understanding of collective behavior, practical implications, and directions for further research.
THEORY AND HYPOTHESES

Group Lending and the Foundations of Social Collateral

We begin by reviewing theory focused on group lending before turning to a wider literature on collective action to develop our hypotheses. 'Social collateral' refers to the use of borrower's relationships as security against loan default (Besley and Coate 1995). Group lending makes explicit use of social collateral by having clients enter into a joint-liability contract. This means that, from the perspective of the lending institution, the group members share a collective outcome. For example, if the group is unwilling to repay for a defecting member, the financial institution does not attempt to distinguish who failed to contribute. If the loan is not paid in full, all of the group members lose access to future loans. This loan structure produces a social dilemma in which there is a tension between the interests of the individual (i.e. to leave the repayment burden with the other members) and of the group (i.e. maintain collective access to future credit) (Anthony 2005). Such group contracts have been a key feature of the microfinance movement over the last four decades and have played a role in extending financial services to impoverished populations historically excluded from the financial market (Armendáriz and Morduch 2010). The global spread of group lending has produced numerous cultural adaptations based on organizational formality, group size, and membership criteria, to name just a few variations (Huppi and Feder 1990; Hermes and Lensink 2007).

Group lending's mixing of social mechanisms with economic incentives has attracted significant attention from social scientists. Seminal works by anthropologists (Geertz 1962; Ardener 1964) considered the theoretical basis of social collateral in the context of Rotating Savings and Credit Associations, an informal predecessor to joint-liability contracts. They noted that group repayment was driven by strong community relationships and the avoidance of public shame. Repayment was conceptualized as a matter of "honour" or "solemn duty" (Ardener 1964, 216). Hechter (1988) extended this work by exploring how norms of social control emerge and are institutionalized in these groups.
Subsequent research has attempted to examine how variation in social interdependence affects group repayment in more formal joint-liability groups. Theorists drawing on development economics, typically employing a rational choice framework for group members, have focused on the concepts of peer monitoring (Stiglitz 1990; Varian 1990), the ability to informally sanction defecting members (Besley and Coate 1995), and selective interaction and screening by peers (Ghatak 1999). Scholars drawing on economic sociology have explored group outcomes in which agent behavior may not be limited to self-interest, such as enhanced group identity and solidarity (Anthony 2005), social capital and trust (Woolcock 2001), and group gender composition (Anthony and Horne 2003).

A number of empirical studies relating social interdependence to group repayment have produced contradictory findings, in which they have found positive, insignificant, and even negative relationships (e.g. Zeller 1998; Wydick 1999; Paxton et al. 2000; Karlan 2007; Ahlin and Townsend 2007). The studies often employ different methods which makes direct comparisons difficult. However, basic unresolved questions, such as the expected benefits and hindrances of group cohesion on repayment, suggest that our understanding of social collateral may be flawed or incomplete (see Hermes and Lensink 2007 for a review).

We argue that our understanding of social collateral would be greatly enhanced by expounding the critical tension between ability and willingness to enforce in cooperative dilemmas (Oliver 1980; Axelrod 1986; Heckathorn 1993). The existing literature on social collateral has primarily focused on how interdependence influences the first-order cooperative dilemma, for example how a socially connected microcredit group has a greater ability to sanction and increase the cost to a defaulting member. However, if one attempts to map social structure to collective outcomes without distinguishing the change in willingness, predictions will be misleading. Some scholars have specifically emphasized that willingness to enforce should be incorporated as a key theoretical factor in group credit (Anthony 2005; Ahlin and Townsend 2007; Paal and Wiseman 2011). In the following sections, we delineate how variation in a group’s structure produces conflicting, but predictable, pressures on enforcement behavior.
Structural Cohesion and Compliance Enforcement

The starting point of our theoretical framework is social embeddedness, the concept that economic activity is submerged in a system of social relations (Polanyi 1944; Granovetter 1985). This provides scaffolding on which we can link structural forces with economic cooperation. Specifically, we focus on two structural features of a group’s embeddedness: structural cohesion and disconnected subgroups. This allows us to explore how different structural features may produce similar tradeoffs between ability and willingness to enforce. To help clarify how mechanisms may be in conflict, we will theoretically examine how group structure affects enforcement ability distinct from enforcement willingness, before considering the combined effect.

The cohesion of groups has been studied extensively and conceptualized in numerous ways, often to highlight different context-specific features (e.g. Durkheim 1893; Albert 1953; Bourdieu 1986; Bettenhausen 1991; Putnam 1993). Intuitively, the structural aspect of cohesion reflects a group’s level of connectedness (Frank 1996; Moody and White 2003; Friedkin 2004). Researchers have often operationalized cohesion with structural measures such as tie density (Homans 1950; Burris 2005) and multiplicity of tie types between actors (Blau 1964; Uzzi 1999; Lazega and Pattison 1999).

Extensive research suggests that there is a positive relationship between cohesion and cooperation (Homans 1950; Olson 1965; Marwell and Oliver 1993; Kim and Bearman 1997). The finding that groups of well-connected actors exhibit cooperative benefits in comparison to groups of weakly-connected actors has received such support that it can almost be considered a sociological truism (Flache 2002). A key element of the relationship is that cohesion increases the opportunity to sanction group members, as well as the effectiveness of sanctions (Coleman 1988; Heckathorn 1990; Portes and Sensenbrenner 1993; Fehr and Gintis 2007). By 'sanction', we are referring to "a punishment (or reward) enacted on the basis of a social agreement that a given course of action ought (or ought not) occur" (Hechter and Opp 2001, 403). Furthermore, by 'ability to sanction' we are referring to both the opportunity to sanction and its potential effectiveness.² To ground this analysis in microfinance, informal social sanctions in a microcredit group typically involve: peer pressure
expressed as pestering or cajoling a delinquent member in the marketplace or in their home; public shaming or tarnishing their reputation; and ostracism, both in social terms, as well as exclusion from future business activities (Montgomery 1996; Rankin 2002; Brett 2006).

However, there is more disagreement among scholars regarding the motives that might link cohesion with sanctioning. Models based on rational choice assume that actors are primarily self-interested and that cohesion changes the fundamental costs and benefits of the dilemma: more frequent interaction increases the practical opportunities to apply sanctions (Voss 2001; Lin 2002); greater public awareness of behavior increases the value of reputation (Coleman 1988; Ostrom and Walker 2003); the risk of damaging multiplex relationships that provide other benefits (social or economic) increases the cost of defection (Brass, Butterfield, and Skaggs 1998; Gómez-Gardeñes et al. 2012).

By contrast, models based on symbolic interaction assume that actors are primarily motivated by meanings and identities (Tajfel 1974; Turner 1982). Increased group solidarity and identity can promote the development of group norms for sanctioning, increase the psychological weight of a sanction, and facilitate moralizing and coercion (Abrams and Hogg 1998; Portes 1998; Horne 2007).

Here, rational and normative motives suggest a similar positive relationship between structural cohesion and an increased ability to enforce compliance. Before considering willingness to enforce, there is substantial theory and empirical evidence to formalize the following proposition:

**Proposition 1a:** As a group’s structural cohesion increases, the ability to enforce compliance increases, ceteris paribus.

In the context of microfinance, this suggests that increased structural cohesion should enhance social collateral as security against group loan default.

Despite the intuitive benefits of cohesion, there is a long history of evidence for highly cohesive groups producing worse collective outcomes (Durkheim 1893; Weber [1922] 1978; Gould 1993; Entwisle et al. 2007). Flache and Macy (1996, 3) pointedly stated that the obvious benefits of highly cohesive groups have "obscured a potentially devastating weakness of strong ties." This effect
could have severe implications for the expected value of social collateral for microfinance as it is often based on highly cohesive groups of borrowers.

Scholars have noted that without centralized authority, the enforcement of compliance norms on defectors is a public good in itself (Yamagishi 1986). The second-order cooperative dilemma refers to the incentive to partake in the benefits of enforcement while allowing others to bear the enforcement expense (Oliver 1980). If too many actors free-ride on enforcement, the threat of punishment declines and the first-order problem is exacerbated. This emphasizes that the value of social collateral backing a group loan derives not just from an ability to enforce, but from a willingness of group members to do so.

Flache and Macy (1996) argue that a key source of the enforcement dilemma is structural. In highly cohesive groups social control flows into the maintenance of interpersonal relationships at the expense of compliance with group obligations. Their argument is an extension of the cohesion-compliance framework (Homans 1974; Coleman 1990), in which cohesive groups are more dependent on each other for social approval and are more willing to trade compliance for approval. Flache and Macy's (1996) cohesion-resistance framework augments the model by not limiting actors to dissimilar resources, i.e. actors can engage in exchanging approval for approval. Actors in a highly cohesive group may value social approval more than compliance, providing a structural disincentive for enforcement.

The enforcement dilemma can arise from both game-theoretic and norm-based arguments. In a highly cohesive group, the cost of sanctioning may increase as a result of damaging valuable reciprocal relationships. For example, a member may be delinquent on the group loan, but also regularly looks after other members’ children. As the cost of sanctioning increases, rational choice models predict a decrease in sanctioning (Anderson and Putterman 2006; Carpenter 2007). A reduced willingness to enforce may also be motivated by conflicting norms. "Norms do not exist in splendid isolation; instead they are linked in various ways to other norms" (Hechter and Opp 2001, 401). Cohesive groups may have norms against punishment of its members. For example, one may be expected to show leniency to well-connected friends.
The reduction in enforcement is most likely to occur under certain conditions. A critical contextual feature is the value of the social connections in relation to the benefit of the collective good (Oliver 1980; Yamagishi and Takahashi 1994; Horne 2007). For highly embedded ties, the incremental benefit in social approval resulting from contributions to the particular good may be small in relative terms (Flache and Macy 1996). The balance may also lean towards non-enforcement if increased social interdependence does not increase the value of the collective good (Horne 2004; Anthony 2005). Past social history may also exacerbate weak enforcement if actors have already entered into a behavioral pattern of trading approval for approval (Flache and Macy 1996).

In the context of microfinance, empirical evidence suggests that the scope conditions that increase the risk of highly cohesive groups may be prevalent. The formation of groups with highly-embedded social ties are often promoted by microfinance institutions, (Schreiner 2001; Hermes and Lensink 2007), resulting in a higher value of the social relationships relative to the loan contract from the perspective of borrowers. Theory and evidence support formalizing the following relationship.

**Proposition 1b:** As a group’s structural cohesion increases, the willingness to enforce compliance decreases, *ceteris paribus.*

If a group’s social structure were to result in high ability to sanction and high willingness to do so, the forces would be complimentary and the net effect on compliance would be more straightforward, i.e. typically high ability and willingness to enforce improves cooperation, other things being equal.

However, Propositions 1a and 1b indicate that changes to structural cohesion tend to place these forces in opposition. As a group becomes more cohesive, ability increases while willingness declines, and vice versa. What relationship should we then expect between structural cohesion and a group’s cooperative outcome? Do changes in ability and willingness cancel each other out or produce some other effect on cooperation?

To build appropriate expectations, a key point is that a group’s ability and willingness to enforce should not be viewed as independent factors contributing to cooperation. Rather, both ability and willingness are necessary for social sanctions to positively influence collective behavior. An excess of one cannot offset a lack of the other. Field and experimental research has shown that for
sanctioning to serve as a collective action enhancing mechanism, both effective opportunities and (perceived) willingness to sanction must be present (Ostrom 2000; Reuben and Riedl 2013). Note this does not mean sanctions must be carried out; the threat of sanctions are known to influence cooperative behavior. However, the threat must be credible, i.e. there must be perceived willingness.

For example, consider a group structure that results in high ability to enforce, but low willingness (numerous opportunities to sanction, but agreed norms not to sanction). The net result is not a moderate level of (expected) enforcement. The most likely behavior is low enforcement because it is known that the group is not likely to carry out the sanctions. Alternatively, if a group is very willing to sanction, but has a low structural ability to do so, the inability to sanction will be the limiting factor. The extra willingness on its own does not enhance cooperation. Structures that produce willingness without ability, or vice versa, will not benefit from the value of enforcement.

Therefore, the role social sanctions may play in stimulating cooperative behavior will be restricted by the group’s propensities towards ability and willingness to enforce. If the two tendencies are in opposition, the lesser value determines the likely role enforcement will have on the collective outcome. This produces an interesting implication for the relationship between structural cohesion and a group’s overall economic cooperation. At low levels of cohesion, the limiting enforcement factor will be low ability. At high levels of cohesion, the limiting enforcement factor will be low willingness. At moderate levels of cohesion, we can theorize a point at which ability and willingness intersect. Here, the role of net enforcement will be greatest as both limiting factors are at moderate values. This suggests that the average relationship between structural cohesion and economic cooperation should follow an inverted U-shape. Building on Propositions 1a and 1b, we formalize the combined effect as a hypothesis for empirical validation.

**Hypothesis 1:** An increase in a group’s structural cohesion improves its economic cooperation up to a certain threshold through increased ability to enforce compliance; beyond the threshold, an increase in cohesion reduces economic cooperation through decreased willingness to enforce compliance.
Note that this theoretical argument does not suggest that highly cohesive groups are categorically restricted to poor performance. Empirical evidence has documented that such groups at times excel (e.g. Zhao 1998; Chwe 1999). The underlying relationships outlined in Propositions 1a and 1b represent mean propensities rather than hard upper bounds. Though each group member chooses whether to contribute and whether to enforce, the social structure produces predictable tendencies. In the context of microfinance, this suggests that once structural cohesion surpasses a threshold, the value of social collateral as security against default reverses and declines.

**Disconnected Subgroups and Compliance Enforcement**

Group cohesion receives much attention in collective action research. From a different perspective, if we turn to research based on social network analysis and the related literature on community detection in the emerging interdisciplinary field of network science, we find a breadth of ways to meaningfully characterize group structure. Do other measures of social structure also relate to the tension between ability and willingness to enforce cooperation? In this section, we theorize that by examining the effects of an additional measure of group structure, again in light of the choices faced at the first level (contribution to the public good) and at the second level (contribution to enforcement), we can better explain the group’s collective outcome.

We specifically consider a feature of a group’s substructure that has been found to play a key role in collective action: the existence of disconnected subgroups (Kim and Bearman 1997; Frank and Yasumoto 1998; Macy et al. 2003). The mesolevel concept of the cohesive subgroup has motivated significant research, particularly in terms of how such cohesive subgroups form (Heider 1946; Cartwright and Harary 1956; Feld 1981) and how they can be structurally defined and detected (Burt 1978; Girvan and Newman 2002; Bansal, Bhowmick, and Paymal 2011). Though there are numerous ways in the literature to formally conceptualize the idea of cohesive subgroups, the intuition can generally be characterized as subsets of actors in a population which have substantially greater connection density within the subset than across subsets (Festinger et al 1950; Wasserman and Faust 1994; Frank and Yasumoto 1998).
Several scholars have noted that the relationship between group substructure and collective outcomes may engage potentially counteracting mechanisms (Gould 1993; Heckathorn 1993). A collective with cohesive subgroups is vulnerable to cleavage formation (Heckathorn 1993; Moody and White 2003; Friedkin 2004), which affects the opportunities and effectiveness of social sanctions. The ability to effectively enforce sanctions across subgroups has been found to be weaker, potentially because one values the sanction or rebuke of a direct connection more heavily (Frank and Yasumoto 1998; Kitts 2006). A significant body of research has also recognized that disconnected subgroups are less likely to communicate regularly and share information even if the information that is then shared may hold greater novelty or value (Granovetter 1973; Burt 2005). Decreased awareness of actor behavior in the case of infrequent interactions also decreases the value of indirect reciprocity (Nowak and Sigmund 1998) and the value of sanction-based enforceable trust (Portes and Sensenbrenner 1993).

Prior research has predominately found that when collectives exhibit disconnected subgroups, several mechanisms related to the ability to enforce compliance are weakened. To focus the scope at this point, we concentrate on the change in behavior across subgroups. We follow the same hypothesis development approach used previously to first clarify the underlying propositions regarding ability and willingness separately, before considering the combined effect. Drawing on existing theory and empirical evidence we articulate the following proposition.

**Proposition 2a:** The existence of disconnected subgroups decreases the ability to enforce compliance on out-subgroup members, ceteris paribus.

While disconnected subgroups may decrease the ability to enforce cooperative behavior, evidence suggests that subgroups exhibit a counter force: an increased willingness to punish defectors. Social cognition theory suggests that groups at any level may exhibit in-group identification, developing a deindividuated state of identity, often with comparatively negative views of out-groups (Tajfel 1981; Hogg 1992). The development of an in-group-out-group bias can arise from relatively arbitrary categorizations (Berkowitz 1968; Brewer 1979) and can produce potentially antagonistic factions without the knowledge or intent of the actors (Macy et al. 2003). Significant evidence has
shown that such information affects enforcement behavior so that actors are more likely to punish members of a perceived out-group (Brewer 1979, Frank and Yasumato 1998; Portes 2014). In a similar vein, Desmond (2012) notes that actors may be more likely to enforce on acquaintances rather than strong relations because the tie is viewed as 'disposable' and more easily replaced.

This substantial willingness to punish out-group members can be formalized in terms of behavior between structural subgroups.

**Proposition 2b:** The existence of disconnected subgroups increases the willingness to enforce compliance on out-subgroup members, ceteris paribus.

Thus, disconnected subgroups in the context of microcredit should exhibit the following tension. A borrower may be more eager to apply a sanction to a member of an out-subgroup in default. However, the opportunities and effectiveness of the potential sanctions will typically be diminished.

In order to theorize the net effect of these opposing forces, we make the same key assumption discussed previously. The role of compliance enforcement will be limited by the lesser of ability to enforce compliance or willingness to enforce compliance, all else being equal. We proceed by considering the effect of disconnected subgroups on an otherwise average group, i.e. moderate cohesion, not at the extremes of either ability or willingness to enforce. The disconnect is associated with both a decrease in ability and an increase in willingness to enforce across subgroups. In this case, the reduction in ability to sanction produces a negative effect for an otherwise average group. The additional willingness to punish the out-subgroup is of little consequence because, other factors being equal, the lesser tendency limits net enforcement. The following hypothesis will be tested for empirical validation.

**Hypothesis 2:** The existence of disconnected subgroups decreases a group’s overall economic cooperation as net compliance enforcement will be limited more by the reduced ability to enforce on out-subgroup members than the increased willingness to do so, ceteris paribus.

In the context of microfinance, the effect of disconnected subgroups on social collateral has received little attention. This proposition indicates that a disconnected group substructure may fundamentally decrease the value of the group’s social collateral overall.
**Interaction of Disconnected Subgroups and Overall Cohesion**

A population consisting of structural subgroups could have substantially different levels of overall cohesion. Feld (1981) theorized that the spectrum of connection strength between subgroups is primarily a result of their overlapping social foci. Subgroups may be weakly or moderately connected based on the extent of shared activities, such as workplaces, social clubs, hangouts, etc. The interaction between overall structural cohesion and disconnected subgroups provides insight to varying levels of inter-subgroup cohesion.

Researchers have noted that the interaction effect of overall cohesion and group substructure on cooperation is complex (Heckathorn 1993; Kim and Bearman 1997). To form expectations regarding how this interaction relates to enforcement, we again distinguish the tendencies regarding ability and willingness. As a starting point, it is intuitive that weakly-connected subgroups, as compared to moderately-connected subgroups, are at greater risk of splintering socially into fully demarcated subgroups (Zachary 1977; Moody and White 2003; Macy et al. 2003). Overall cohesion moderates the severity of the cleavage between subgroups by incrementally increasing the probability of overlapping ties and interaction. Other factors held constant, the disconnect between subgroups is reduced with an increase in overall cohesion and exaggerated with a decrease in overall cohesion, assuming that the change in connections is homogeneously distributed across actors in the collective. As connections increase across subgroups, the opportunities to enforce rise and carry more social weight. This may be viewed as an extension of the logic in Proposition 1a applied to behavior across subgroups.

**Proposition 3a:** As a group’s overall cohesion increases, the ability to enforce compliance on out-subgroup members increases, ceteris paribus.

Likewise, we expect that overall cohesion moderates enforcement willingness associated with a structural cleavage. Willingness to punish a defector is stronger if the norm violator belongs to an out-group (Bernhard, Fehr, and Fischbacher 2006). Connections and shared activities between groups often mitigates the severity of the out-group bias (Ashforth and Mael 1989). In addition to psychological factors, a decrease in willingness may be rationally motivated. As overlapping ties
between subgroups increase, the expectation for future exchange in other situations should also increase, i.e. punishment becomes more costly (Carpenter 2007). Multiple mechanisms support the following relationship between overall cohesion and disconnected subgroups.

**Proposition 3b:** As a group’s overall cohesion increases, the willingness to enforce compliance on out-subgroup members decreases, ceteris paribus.

Propositions 3a and 3b can be summarized as overall cohesion attenuates the enforcement differences resulting from disconnected subgroups. In the context of microcredit, as subgroups become more connected through overlapping foci, such as trading in the same market or attending the same religious organization, the risks associated with a full social cleavage decrease.

There are clear expectations for the net impact of the interaction effect on a group’s cooperation if the lesser value of ability and willingness determines the likely role enforcement will have on the collective outcome. In Hypothesis 2, reduced ability across subgroups was proposed as the more limiting factor, harming a group’s overall performance. The evidence supporting Proposition 3a suggests that overall cohesion will strengthen the ability to sanction across groups. Alleviating the more restricted factor would enhance net enforcement. Thus, we expect a positive interaction effect as summarized in the following hypothesis.

**Hypothesis 3:** Structural cohesion has a positive interaction effect with the presence of disconnected subgroups on a group’s overall economic cooperation; increased overall cohesion mitigates the limiting factor of inability to enforce compliance on out-subgroup members, ceteris paribus.

Alternatively stated, if a group exhibits a structural cleavage, lower overall cohesion is likely to exacerbate the enforcement problem between subgroups. This offers a final testable hypothesis regarding how variation in group structure should shape our expectations for the efficacy of social collateral in microfinance.
DATA AND METHODS

Our analytic strategy involves mixed methods. Poteete, Janssen, and Ostrom (2010) have argued that the greatest advances in our theoretical understanding of collective action have resulted from methodological cross-fertilization. The benefits of multi-methods have been found both sequentially, strengthening findings across studies, as well as within the same research project (ibid). The design in this study is nested (Small 2011) with different sized samples including complimentary data types from the same population of microcredit borrowers in Sierra Leone. The large-N field samples are quantitative, and as will be discussed shortly, are also nested, which allows us to test for statistically significant effects of structure on collective outcomes. The most granular sample involves ethnographic analysis of borrower behavior to examine the veracity of the proposed social enforcement mechanisms. For the sake of readability, we have structured our account of the research design so that we first discuss the quantitative analysis, and then follow with the ethnographic analysis. However, in practice insights gained by applying mixed methods to different data sources informed each other throughout the development of the study, helping to identify when additional confounding factors should be included in the statistical analysis or which interview topics needed further probing.

All the empirical data involve a microfinance organization which uses a standard credit model based on small, joint-liability group loans (see Morduch 1999). Borrowers are jointly liable for the loan that they take out, such that if one or more members of the group do not repay, the other members are held financially accountable. This type of lending model is well-known for incorporating social collateral (Besley and Coate 1995) and is strongly dependent on the economic cooperation of the group (Anthony 2005).

The organization of interest has been in operation since 2002 and has a client base of over 18,000 borrowers spread through semi-rural Sierra Leone. Potential clients that are interested in taking out a microfinance loan are instructed by the organization to form a group of potential borrowers, typically five, in order to enter into a joint-liability contract. They are told to select members that they "know and trust" to pay back the loan. This organization does not allow members
of the same group to be direct kin (i.e. parents, spouses, or siblings). Each borrower must also have
his or her own business, roughly deemed capable by the loan officer of supporting repayment of the
loan. As typical of many microfinance lending programs, the majority of clients are women (Morduch
1999). In this dataset, 84 percent of the borrowers are female.

We restricted our data samples to: group loans, i.e. excluding alternative products such as
individual or agricultural loans; the city where the microfinance organization is headquartered and
focuses its lending activity; and a time window in which the organization’s group lending practices
had been standardized.6

All the loans were intended for investment in individual micro-businesses and were scheduled
for monthly repayment over 6 to 12 months. Members of the same group all received equal loan
amounts and the same loan terms. The amount of the group loans ranges from 1.2 million to 7.5
million Leones (SLL), with each borrower receiving between 300 thousand to 1.5 million SLL,
approximately $70 to $345 USD respectively at the time of data collection.

STATISTICAL ANALYSIS

The largest of the three data samples, on which we focus the statistical testing of our
hypotheses, consists of 1,884 unique borrowers constituting 406 unique groups. These groups
received a total of 741 loans over a five-year period, from 2006 to 2011. During that period 5,582
monthly group repayment transactions were recorded. Table 1 provides a summary of descriptive
statistics.

[Table 1]

**Dependent Variables**

We modeled a microcredit group's economic cooperation using loan repayment data. For each
group loan, the number of days early or late that each monthly payment was made has been recorded.
The detail of the repayment distribution is more fine-grained than that used by numerous other studies
of microcredit that have focused on the default rate (e.g. Wydick 1999; Paxton, Graham, and Thraen
Days early or overdue provides significant insight to group behavior because default is relatively rare (6.2 percent of loans in this study). To construct a loan-level cooperation measure, we used the maximum number of days overdue for all the scheduled payments of the loan. Days early are coded as positive and days overdue as negative, so that a higher value of the dependent variable indicates better group repayment. We took various steps to verify that the results are not sensitive to our treatment of the dependent variable. See Appendix A for detail on hazard rate and censored data models.

We consider this repayment measure primarily to be an indicator of a group's cooperation rather than financial ability for three reasons. First, ethnographic fieldwork on group lending, including but not limited to our own fieldwork in Sierra Leone, suggests that almost all clients participating in such programs are under significant financial constraint and that variation in a group's repayment is predominately an issue of group cooperation rather than unusual financial circumstances of its members (Geertz 1962; Anthony 2005). Second, if the microfinance organization deems that a group as a whole has encountered an event that prevents it from repaying, for example if the members' business stalls were co-located and damaged in a fire, the organization will reschedule the loan. Third, the microfinance organization requires that 10 percent of each loan is immediately placed into a group deposit account. If the group is financially unable to make a payment, they have the option of using this account to cover the missing payment. However, this option is rarely used by overdue groups, suggesting a failure of group cooperation rather than financial inability to repay.

**Independent Variables**

Our hypotheses involve two measures of a group’s structural embeddedness: (1) average structural cohesion, and (2) the existence of disconnected subgroups. In the largest data sample, we propose using fine-grained spatial structures of the groups as reasonable proxies for these measures of structural embeddedness. We motivate this approach with extensive previous research and validate the method using a nested subset of quantified social affiliation data from the same microcredit borrowers in Sierra Leone.
Numerous scholars have demonstrated a systematic relationship between spatial propinquity and social proximity (Bossard 1932; Zipf 1949; Blau 1977; Latané et al. 1995). The relationship has been found to be robust across varying distances and contexts (Hare and Bales 1963; Leskovec and Horvitz 2007; Rivera, Soderstrom, and Uzzi 2010). The consistency of the correlation results from underlying socio-spatial mechanisms. Spatial structure can be summarized as shaping social interaction in two fundamental ways: (1) through the likelihood of tie formation and (2) by influencing the nature of ongoing interaction (Festinger et al. 1950; Feld 1981).

Feld’s (1981) theory on the focused organization of social ties notes how physical entities, such as workplaces, hangouts, and religious organizations, often serve as foci that shape a community’s overall social structure. Physical distance plays a key role in tie formation by increasing the likelihood of passive contact; for example, a chance encounter walking by a neighbor’s door (Festinger et al. 1950). Post tie-formation, proximity influences the frequency of interaction and information exchange (Caplow and Forman 1950), as well as the effort required to maintain a relationship (Martin and Yeung 2006).  

We found substantial support for this theoretical argument in our own ethnographic fieldwork in Sierra Leone. When microfinance clients were asked open-ended questions regarding how they knew other group members, they frequently responded with social connections resulting from spatial proximity. Varied descriptions included personal relationships based on living in the same neighborhood (“We grew up right next to each other,” “We babysit each other’s children,” “We eat rice together and laugh”); connections through religious or community organizations (“We are all Christians and go to the same church nearby,” “We see each other every day in the Mosque,” “We used to do Osusu [community savings group]”); and business-associated relationships (“We stay in the same business area and do the same business [sell palm oil],” “My colleagues [group members] work in the same market, the Big Market”).

To serve as an effective proxy, high-resolution spatial data was needed. In this dataset, all the borrowers live in a single city in Sierra Leone with a population of roughly 100,000 residents spread over 16 square kilometers. GPS coordinates for residential addresses registered with the microfinance
institution were collected by the authors using a Trimble Juno SC unit with ArcGIS software. See Figure 1 for a map of the distribution of clients.

[Figure 1]

The high-resolution GPS data captures continuous measures between all clients rather than aggregated block areas. Other researchers have demonstrated the value of incorporating such advances in geographic technology to enhance the value of spatial data in sociological analysis (Downey 2006; Yenkey 2015). We were able to collect spatial data on 95.2 percent of the borrowers. The unknown spatial data was primarily due to human error during the original recording of borrowers’ addresses; we consider the 4.8 percent of the missing spatial data to be at random.

**Structural Cohesion.** Groups with greater structural cohesion are often characterized as having a greater number of redundant ties (Coleman, 1988) or a greater multiplicity of tie types between actors (Uzzi, 1999). We construct a proxy for structural cohesion based on the assumption that microfinance clients in Sierra Leone that live near each other are likely to have a greater number of such ties. However, our approach here is conservative, and we first examine the veracity of this assumption empirically.

We surveyed a subset of 410 microfinance clients in Sierra Leone regarding their social affiliations. The subset included all the microcredit clients receiving a loan from the lending institution over the first six months of 2011. Complete survey data was collected on 378 of the 410 clients receiving a disbursement (92.2 percent). Clients were asked to list their social affiliations in terms of (1) religious organization, (2) place of business, (3) educational organization, (4) Osusu, informal savings group (see Geertz 1962), and (5) ethnic tribe. Clients were instructed only to report affiliations in which they had been active in the prior six months (referring to affiliations 1-4). Table 2 provides a summary of the social affiliation data.

[Table 2]

It is a common methodological approach in social network analysis to use shared social affiliations to infer likely direct connections, by formally converting a two-mode network into a one-
mode network (Wasserman and Faust 1994). Figure 2 provides a visualization of the data in the format of a projected one-mode network. A tie represents a shared social affiliation.

We examined the relationship between spatial proximity and the probability of a multiplex tie between any two clients. A multiplex tie was operationalized as having two or more social affiliations in common (religious organization, place of business, educational organization, or informal lending group). We fitted a binary logistic regression model to the likelihood of a multiplex tie. Such a connection is possible between any two members of the 378 survey respondents, producing a potential 71,253 ties. The model included controls for individual attributes that may affect the probability of a tie: tribe, gender, marital status, group leader status, business type, business strength, number of children, and number of additional dependents.

Table 3 provides the results of the regression. Model 1 provides a baseline control model. Referring to Model 2, the coefficient of spatial distance is negative and significant with a p-value < 0.001. As spatial distance increases, the likelihood of a multiplex social tie decreases significantly. The nature of the relationship is as hypothesized and also exhibits a relatively low level of noise. Figure 3 displays how rapidly the probability decays with distance. The figure displays both the functional form fit by the regression model and the empirical deviation around the functional form. The analysis provides further empirical support that a group’s spatial structure in this context may serve as an effective proxy for its structural cohesion.

To quantify a group’s spatial structure we use the Euclidian Minimum Spanning Tree (EMST) based on borrowers' residential addresses. The EMST calculates the shortest overall distance to connect a group’s set of geographical points (see Eppstein 2000). The value between each pair of points is the Euclidian distance. See Figure 4 for EMST examples of empirical microcredit groups.
We considered alternative approaches for calculating a group's spatial structure, but found the EMST to be both parsimonious and appropriate for the context. The average group EMST was 1.06 kilometers, with a range from 0 meters (though it is rare in the dataset, it reflects groups that are residually co-located) to 5.24 kilometers. As stated previously, the policy of the microfinance institution does not allow direct kin to be members of the same group. The average EMST branch length was 299 meters. To put the distances in context, the city is roughly 4 kilometers in diameter.

The structural cohesion proxy was constructed by using a group's average EMST branch length and reversing the sign so that a positive value signifies cohesion rather than dispersion. The variable was mean-centered with a standard deviation of one.

**Disconnected Subgroups.** We follow a similar procedure for quantifying the second feature of a group’s structural embeddedness: the existence of disconnected subgroups. This has been characterized structurally as having subsets of actors which have greater connection density within the subset than across subsets (Festinger et al. 1950; Frank and Yasumoto 1998). Again, we use spatial structure as a proxy and assume that subgroups that are spatially distant are more likely to be socially disconnected. We have already examined social affiliation data and found that spatial proximity between individual clients is negatively correlated with the probability of a multiplex tie. However, it is useful to further probe our construct validity by empirically questioning whether an increase in physical distance from a spatial subgroup exhibits a systematic relationship with the likelihood of being socially disconnected from that subgroup.

We test the assumption by using the same social affiliation data with the subset of 378 clients discussed previously. To define a clear subgroup we used a standard approach for distinguishing the main component of the social network (Wasserman and Faust 1994). We then fitted a binary logistic regression model to the likelihood of being disconnected from the main social component. Table 4 summarizes the regression results for models without and with spatial proximity. We found that as the physical distance to the nearest member of the main component increases, the probability of being socially disconnected from the component also increases as expected. The coefficient of spatial distance is positive and significant with a p-value < 0.001. Figure 5 displays both the functional form.
fit by the regression model and the empirical deviation around the functional form. The analysis indicates that spatially distant subgroups may effectively function as a proxy for socially disconnected subgroups.

[Table 4]
[Figure 5]

We defined the proxy for groups consisting of socially disconnected subgroups as a binary variable with one representing groups consisting of spatially fragmented subgroups; zero otherwise. A spatial subgroup was defined as two or more borrowers living within less than 100 meters of each other. Subgroups were considered to be spatially fragmented if there was a distance of more than 100 meters between their nearest members. One would expect that the relevant threshold distance for defining a subgroup is context dependent. Our use of 100 meters was derived from the fieldwork in Sierra Leone as a critical distance for frequent interaction. For individuals living less than 100 meters apart, there is substantial social interaction on a daily basis that occurs unintentionally, i.e. without prior planning. Such situations are known to correlate with tie formation and ongoing interaction (Festinger et al. 1950; Feld 1981). Furthermore, we examined the robustness of the results to different values of the distance threshold, ranging from 50 meters to 200 meters. In Appendix C, data on alternative cut-off points are presented. The results are robust to variation in the distance threshold; disconnected subgroups based on alternative cutoff points produce the same substantive effect on a group’s cooperative outcome.

**Control Variables**

Having defined the dependent and independent variables of interest, the next primary concern is dealing with potential unobserved confounders, i.e. in this case, factors correlated with group structure that may affect repayment behavior. If unaccounted for, their role could be misinterpreted as resulting from the hypothesized variables (Hill, Griffiths, and Lim 2018). In this context, there are three primary categories of potential confounders that should be considered: (1) individual characteristics, (2) financial factors, and (3) organizational or loan-specific factors.
Individual characteristics may influence social dynamics of the group, as well as individual propensities to repay. For example, substantial research has indicated that the gender of clients is related to microcredit repayment. Studies have found higher repayment from female microcredit clients (e.g. Khandker, Khalily, and Khan 1995), linked to mechanisms based on responsiveness to social pressure, reduced mobility, and more responsible use of funds (Kevane and Wydick 2001; Armendáriz and Morduch 2010). Horne and Anthony (2003) suggest that higher repayment in groups with a greater proportion of women is a result of social expectations for cooperation rather than inherent gender differences. We used the individual characteristics to construct group-level controls, appropriate to the level of the regression analysis. Resulting group composition controls include: 

*proportion female, proportion married, and average number of children.*

Second, we took several steps to ensure that a group’s spatial structure is not confounded with financial factors affecting the ability to repay the loan. In this context, the primary source of income for clients results from their microbusinesses. To control for client variation in their ability to pay, we considered monthly sales and business equity. As with the social controls, we constructed group-level variables from the individual characteristics. In addition to *average monthly sales* and *average business equity* for each group, we also included *standard deviation monthly sales* to control for the possibility that within-group differences in financial strength affect cooperative behavior.

Another concern is that the ability to pay may be affected by a client’s type of business, for example affecting the seasonality of their income or its correlation with the incomes of other group members. To account for this, we include control variables concerning business types. Based on information gathered by the loan officer, each borrower’s business was categorized into one of six types: Food, Clothing, Service, Petty Trading, Single Item Trading, and Other. The predominant business type of borrowers in this dataset is Petty Trading at 64 percent. Using the business type data, we constructed two group-level controls: *proportion petty traders* and *business type diversity.*

Proportion petty traders captured the group’s focus on the predominant business type. Business type diversity was calculated as the number of different business types within the group, divided by the number of group members. This value was then normalized with a mean of zero and a standard
deviation of one. Business type diversity is a particularly important control because one could question whether the effects of structural cohesion are actually driven by correlation of business types (an undiversified portfolio) rather than social mechanisms.

Finally, we considered organizational and loan-specific factors that may affect group repayment. Through interviews with the staff and management of the MFI, we learned of the primary organizational factors that may produce unwanted artefacts in the data. Characteristics of the loan that we controlled for included group size, loan amount, loan officer (dummy variables for nine loan officers), and loan cycle (the number loan taken by the group, i.e. first, second, third, etc.).

**Statistical Model**

We modeled the effects of structural cohesion and disconnected subgroups on loan repayment using a hierarchical linear model for repeated measures (Snijders and Bosker 2012). As groups may take multiple loans and their performance may not be independent, we included random intercepts for each microcredit group. We estimated a model of the following form:

\[
Y_{ij} = \gamma_{00} + \gamma_{10} x_{1ij} + \ldots + \gamma_{p0} x_{pij} + \gamma_{01} z_{1j} + \ldots + \gamma_{q0} z_{qj} + U_{0j} + R_{ij}
\]

(1)

where \(Y_{ij}\) denotes days overdue for loan \(i\) for microcredit group \(j\); \(\gamma_{00}\) is the intercept; \(\gamma_{p0}\) is the coefficient for the loan-level variables, \(x_{pij}\); \(\gamma_{q0}\) is the coefficient for the group-level variables, \(z_{qj}\); \(U_{0j}\) is the residual at the group level; and \(R_{ij}\) is the residual at the loan level (ibid). In the results section, we consider alternative approaches to modeling the data and find the results to be robust.

**STATISTICAL RESULTS**

Table 5 summarizes four models testing our hypotheses derived from existing theory on group social structure and economic cooperation. Model 1 serves as a baseline control model accounting for group composition, financial indicators, and loan characteristics. Model 2 relates to Hypothesis 1 regarding the effects of structural cohesion on economic cooperation. Model 3 relates to Hypothesis 2, the effect of disconnected subgroups. Model 4, the complete specification, also tests the interaction effect of structural cohesion with the existence of disconnected subgroups, Hypothesis 3.
Structural Cohesion

Model 2 includes variables for a group’s structural cohesion and structural cohesion squared. The coefficient of structural cohesion is negative and significant with p-value < 0.01, indicating that as a group's structural cohesion increases its performance declines (i.e. more days overdue). The coefficient of structural cohesion squared is also negative and significant, with a p-value < 0.05, indicating that the relationship between cohesion and cooperation is nonlinear. The F-statistic for improvement in fit over a linear model is significant with a p-value < 0.02. We also validated statistically that a second degree polynomial provides the best fit to the empirical data, testing first, second, and third degree polynomials. It indicates that groups of moderate structural cohesion perform better than those groups with very high or very low levels of cohesion. The results of Model 2 provide support for Hypothesis 1.

To test the robustness of the empirical findings to our model selection we considered alternative statistical models: Tobit regression (considering early repayment and default to be censored data) and discrete-time event history models (based on risk of delinquency and default). The results are substantively the same. We also performed additional analyses to verify that the models are correctly specified. Appendix A contains further detail on log transformation of the dependent variable, variance inflation factors, and tests on the effects of loan officers.

Disconnected Subgroups

Model 3 (Table 5) introduces the binary variable for groups with disconnected subgroups. The coefficient is negative and significant with p-value < 0.01. This provides support for Hypothesis 2 that groups consisting of disconnected subgroups perform worse than groups without disconnected subgroups. The size of the effect is substantial; the difference in means is 28.3 days overdue.

Model 4 is the full model including the interaction effect between structural cohesion and disconnected subgroups. The coefficient of the interaction effect is positive and significant with p-
value < 0.05. This indicates that if a group consists of disconnected subgroups, the higher the level of average structural cohesion for the group, the higher the level of economic cooperation. This provides support for Hypothesis 3 that overall cohesion mitigates the risk of disconnected subgroups. Figure 6 provides a graphical summary of the empirical relationships.

In contrast to a social interpretation, one might question whether the effects of structural embeddedness result from financial performance covariance associated with spatially proximate clients. As a first step, we included control variables in the statistical analysis for business type diversity, or lack thereof, and found that business type diversity does not have a significant effect on group repayment. We tested this issue further by considering spatial autocorrelation of performance regardless of business type. For example, perhaps negative financial shocks have occurred to certain spatial areas of the city over time. Cohesive groups or disconnected subgroups that are spatially concentrated would be at greater risk of members simultaneously unable to pay. We test this possibility by analyzing the spatial autocorrelation of the performance of all 741 loans in the principal dataset. We use a standard measure of spatial autocorrelation, Moran's I (Moran 1950). The statistic is applied to year-long performance windows from 2006 to 2011. The Moran's I statistic is consistently insignificant with a mean p-value of 0.73 over the six years, indicating that loan performance in this city is not spatially autocorrelated. See Appendix D for additional detail.

ETHNOGRAPHIC ANALYSIS

We have shown that different measures of a microcredit group’s structural embeddedness are correlated with their economic cooperation. The statistical results supported the three hypothesized relationships: (1) Groups with low levels of structural cohesion, as well as those with very high levels of cohesion, perform worse than those with moderate levels. (2) The existence of disconnected subgroups is correlated with worse economic cooperation. (3) Overall group cohesion moderates the effect of disconnected subgroups on cooperation. Each of the hypothesized relationships was based on propositions developed from existing literature regarding the effect of social structure on the ability
and willingness to sanction group members. The ethnographic fieldwork provides an opportunity to
gauge the veracity of the underlying propositions and investigate the causal mechanisms in greater
depth (King, Keohane, and Verba 1994).

The ethnographic analysis involves the most granular data sample of our nested design,
valued for the ability to penetrate deeper into the workings of individual units and strengthen a study’s
internal validity (Small 2011). This methodological approach is particularly relevant for attempting to
understand willingness to enforce on members of a microcredit group for two reasons. First, how one
may go about socially punishing a friend or work colleague is a sensitive topic. Different data
collection methods may affect the respondents trust in the research method, for example the likelihood
of data confidentiality (Berg and Lune 2011). We invested effort in building trust with the
interviewees, answering their questions, and giving them a better sense of the research motivation and
use of the information. Second, the mechanisms of informal enforcement are highly context
dependent, particular to the personal relationship and situation. How one may apply a motivating
pressure to a friend versus a work colleague may occur in significantly different ways and could
easily be lost in more coarse-grained data-collection techniques.

Our qualitative data consists of semi-structured interviews with microcredit group members
and microfinance institution staff in Sierra Leone. Client interviewees were drawn from the same
microfinance institution as in the quantititative datasets. Groups were randomly selected from those
that had been engaged in borrowing within the last six months (as of April 2011). We conducted
interviews with 64 microfinance clients. Interview time totaled 42 hours. Ninety four percent of the
clients were female, reflective of the organization's focus on women (84 percent). All names in the
text are pseudonyms for client confidentiality.

We also conducted nine interviews with staff of the organization, including two executive
directors, two loan portfolio managers, and five loan officers. Four of the nine staff interviewees were
women. Interview time of microfinance staff totaled 14 hours. This provides a critical understanding
of how the organization's practices shape the observed group behavior and also informs the
interpretation of the recorded loan portfolio data in our statistical analyses. We conducted additional
interviews with executives and loan officers at three other microfinance organizations in Sierra Leone to verify whether the organizational practices and general group behavior experienced at the principal organization were typical; the organizational practices and reported group dynamics were highly similar.

Each of the hypotheses in this study were based on two underlying propositions regarding a group’s (a) ability to sanction and (b) willingness to sanction. We investigate these propositions by using the ethnographic data to answer the following questions. First, does the qualitative data indicate that there are relationships between a microcredit group’s social structure and its ability or willingness to enforce economic cooperation? Second, if so, what are the specific mechanisms underlying the behavior? Third, what are the consequences of these behaviors on collective outcomes?

**Structural Cohesion and Enforcement Ability**

Even though all the groups were formed for the same primary purpose of joint-liability loan repayment, we found substantial variation in the groups’ social structures. To better understand the relationships that are front-of-mind in this context, we asked clients open-ended questions regarding how they knew their other group members. As noted previously in the statistical analysis section, clients typically reported social connections based on personal relationships (e.g. long-term neighbors, friends), interaction in community organizations (e.g. mosques, churches, savings groups), and business contexts (e.g. selling side-by-side in the market). These connections produced groups with notably different levels of structural cohesion as typically theorized in the literature. The concept of multiplicity of tie type was frequently expressed in terms of layers of different shared activities (Feld 1981). Here a borrower description from a highly cohesive group illustrates both high tie density among members and multiplicity of tie type:

> Every day we see each other. Day and night we see. . . . This one, she is my sister-in-law. This one, she is a neighbor to me. . . . We used to discuss issues for our businesses, things that can make us really prosper. We have plans to put things in place that will help us in our progression. . . . We cook, we share food together. . . . We go to the same mosque. The mosque is very close to us. . . . We take care of each other’s children. . . . That’s why we form a group.
In contrast, we also encountered many groups that were only weakly cohesive by comparison. Such groups were often formed through an informal referral process. A borrower describes how she was invited to join a group in which she did not previously know the other members:

I knew her because we are doing the same business, while I was doing my business in the Big Market. She met me there, and talked to me about business. And then I accept and I joined her in the group. We went together to the office [microfinance organization] . . . . then we met everyone [other group members].

In such groups, instead of a multiplicity of tie types and reinforcing connections, members may only have a single connection to the others through the marketplace. While these examples illustrate the variation between highly cohesive and weakly cohesive groups, this is not to suggest that we only found cohesion existing at these extremes. Our ethnographic research indicated that there is a range of intermediate levels as well.

How does such variation in a microcredit group’s structural cohesion affect its ability to enforce economic cooperation? Our ethnographic analysis suggests that members use three main enforcement mechanisms: (1) social pressure, (2) reputation and embarrassment, and (3) ostracism.

**Social Pressure.** A widespread form of enforcement was colloquially referred to as “pressuring,” “cajoling,” or “pestering.” If we apply Hechter and Opp’s (2001) definition of sanctions, we should also include rewards for positive social behavior. Positive pressure was described by clients as “encouraging” or “supporting” other members. One client describes her attempt to elicit repayment using pressure:

I put pressure on her, I continue to pressure her so she would pay. It continues until when we went to her mother. . . . We meet her in her mother’s house. . . . We continue to go to her father, then to her mother’s house to pay. . . . Normally, I used to go with [another member]. At times I go there alone. . . . Then apply more pressure to pay. . . .

We found that structural cohesion increases the ability to apply social pressure to microcredit clients by increasing the frequency of interaction and the amount of sanctioning opportunities. Multiplex ties provide more opportunities between the same individuals in different contexts and greater tie density provides more opportunities between members. The combined difference in sanctioning opportunities across groups was substantial. Here a member of a highly cohesive group estimates the frequency of their interaction:
We sit down together and talk and laugh. We eat together. . . . We see each other every day. . . . We see [each other] more than 10 times a day.

This can be contrasted with the naturally occurring sanctioning opportunities in a weakly cohesive group. A borrower describes her typical interaction:

We see each other monthly. At times we see each other after every two weeks. When it’s time for me to pay, we meet as a group. And we select someone who will go back [to the microfinance organization] and pay.

Clients explained that social pressure it typically not a single event, but more like applying regular heat to boil water. Applying pressure sporadically often resulted in unsuccessful shifts in behavior. A client that attempted to visit group members twice a month noted that the “others are always grumbling” and “giving me problems.”

The interviews highlighted that successful enforcement is a function of required effort. If the effort required to pressure a member consumes more of the client’s limited time and energy, it is more likely to decline over time. The increased interaction resulting from structural cohesion requires less purposeful creation of enforcement opportunities. Clients in weakly cohesive groups were more likely to mention that “I grow tired” of pressuring or “I’m constantly chasing people.”

**Reputation and embarrassment.** Another common form of sanctioning in microcredit groups was public embarrassment and the resulting loss in reputation. Losing face in public poses both psychological costs to the borrower, for example “they brought shame to me,” as well as financial costs in terms of reputation damage, “we know that she is not a serious person.”

Borrower descriptions revealed a progression of public actions one would typically take to draw attention to a non-compliant member. Common examples with increasing severity were (1) informal discussion among community members, (2) requesting a local community elder to arbitrate the dispute, and (3) summoning the police to take a delinquent member to the local court. It is interesting that some of these methods appear to be relying on external enforcement, e.g. if you sue a member in court his or her assets might be repossessed and liquidated to compensate for the overdue balance. However, in this context, the limitations of the legal infrastructure does not allow for this to be practically implemented. Rather borrowers emphasize the role these events play in terms of public embarrassment and social stigma. Here a borrower describes her concern of being taken to court:
When we decided to take this loan, we are always afraid of embarrassment. We don’t want to be embarrassed, to go with the police from one point to another [from home to court]. We are always afraid. ... In fact, we see the embarrassment of others groups.

For microcredit clients concerned with public reputation, there are numerous reasons why these public sanctions are more salient in structurally cohesive groups: cohesion increases the flow of gossip (Merry 1984), public awareness of deviant behavior (Coleman 1988; Ostrom and Walker 2003), and the indirect value of reputation (Nowak and Sigmund 1998).

**Ostracism.** Exclusion was the other common threat (and implemented sanction) in microcredit groups. The ethnographic analysis revealed that ostracism takes on three different forms in this context and does not typically involve full exclusion from the community. Rather, ostracism occurs in terms of (1) microcredit group membership, (2) a business community, or (3) selected social groups.

The most common form of ostracism was expulsion from the formal microcredit group. Recall that microcredit loan cycles are typically short (i.e. less than one year in this context) and progressive, substantially increasing in loan amount. An ostracized member loses access to future loan cycles with this microfinance institution. Colloquially, members use phrasing such as “we decided to kick her out of the group.” More severely, a group may choose to shun a defaulting client not just from the credit group, but from the market community. For example, [Amina] belonged to a group consisting of members that ran petty trading stalls in one of the smaller markets. When she defaulted on the group, she was no longer welcome to do business in that market. [Amina] left and set up her stall in a different part of the city. Even though there are numerous local markets in this relatively small city, transitioning is burdensome and costly. In the most severe cases, a member may be ostracized from a social or friendship network. [Fatmata] was deemed by her group as a “trouble maker.” She was seen as having brought embarrassment to the group. Her default resulted in the severing of their personal friendships: “That’s why we are no more friends… it is because of the loan.” Later that year, [Fatmata] decided to move to another neighborhood.

Our fieldwork indicated that there was considerable awareness of the different forms of ostracism and that they were used discriminately. Borrowers often distinguished in which context the
relationship was affected. One client described, “I will not do business with her again, but it does not affect our friendship.” In extreme cases, a delinquent member may be excluded from all three of these group types.

The granularity of the ethnographic data indicated how social structure shapes the effectiveness of ostracism. Cross-verification of interviews indicated that there was considerable disagreement about who was at fault and who was ostracizing whom. Community consensus on expulsion was rare; more typically, a subset of borrowers chose to cut or weaken a particular type of tie. Consequently, the variation of social structure across microcredit groups determines the severity of consequences. A close-knit network is more difficult to recreate than a loosely-connected group of referrals. We found that the value of the threat of ostracism depends greatly on the social structure from which one would be potentially excluded.

**Structural Cohesion and Enforcement Willingness**

The detailed accounts of financial hardship and group choices illustrate that one’s ability to sanction does not consistently mirror one’s willingness to sanction. Moreover, willingness to enforce tended to be weakest in highly cohesive groups. Lack of enforcement was most often expressed through empathetic accounts of another member’s difficulties, for example health problems, family trouble, or slow business sales. Here a member of a cohesive group describes another borrower’s difficulty:

> It was unfortunate for her that we lost her husband. . . . She decided to come back from the funeral ceremony. After the funeral ceremony I met her. Then we tried to arrange the payment and give her a time. . . . She did not pay the remaining balance of 20,000. But I decided to leave her alone.

Other cohesive groups recounted similar experiences in which the group dynamic shifted to leniency. For example, a member of another group struggled with a sickness in which she had to visit the hospital regularly. Co-members described that enforcement was not socially appropriate. One member said, “Why so much embarrassment for such a small amount of money?”

However, these kinds of empathetic descriptions were much less common in weakly cohesive groups. It seems unlikely that lesser-known community members genuinely experience less difficult
life events than other members. Rather, structural cohesion increases communication and story verification, enhancing members’ trust and personal regard for each other. The extent of this change in interaction was evidenced by cohesive groups’ willingness to pardon delinquent behaviour even when it was not a result of external misfortune, suggesting that increased cohesion can go beyond an increased ability to audit to cause a more substantial shift in the accepted norms for enforcement. For example, a borrower of a cohesive group blatantly misused the money to buy a motorbike rather than invest it in her petty trading business as per the loan terms. A member described how “she ate the money” and “we were angry with her.” But they were “also sorry for her” and did not make her repay.

The ethnographic analysis revealed that highly cohesive groups are more likely to employ a social logic regarding enforcement decisions rather than an economic logic. In these groups the financial transaction is often deemed of secondary importance to the social relationships. The decisions incorporate the depth of personal history and multiplex nature of their relationships. A member of a cohesive group described why strict pressure was not appropriate:

    Our members of the group undergo the same constraints. So I don’t want them to strain. . . . You know business is a rise and fall. At times when you bring the business, it sells very fast. But when it happens that it goes very slow and we are about to go and pay, then we assist the individual.

The ethnographic data provided evidence of numerous groups engaging in trading social approval for approval, rather than approval for compliance (Flache and Macy 1996). This theoretical distinction helps clarify why cohesive microcredit groups may regularly fail to enforce repayment.

In contrast, willingness to punish delinquent members was much more prominent in moderately or weakly cohesive groups. Members were less hesitant to risk damaging the social relationships by sanctioning. The story of [Mabinty], a member of a weakly cohesive group, exemplifies this trend. Her group formed through loose business connections in the market. They came together “so we can work the money with each other.” [Mabinty] was described by other community members as having health problems. In a more cohesive microcredit group, this might have been viewed as grounds for non-enforcement. However, her group members aggressively pressured her to repay. One member described:
Some of them, they bring their money, they pay their money completely. Why should [Mabinty] not pay? I keep on chasing [her] just to pay this money. . . . We go to [her] house and place of business in the market place. . . . We cajole her, we keep talking to her, [but] she refuse.

The members further escalated the issue to a local community elder. Feeling the immensity of the social pressure, [Mabinty] decided to flee the community without telling the other group members. However, they heard of this through other social contacts:

Actually, she did not tell us anything. All of a sudden she decided to run away. She was preparing to go and we got the information. We are able to catch her at the [JJ] intersection.

They found her there with packed bags. She swore that she would get the money now, but the other members did not want the pressure to lighten:

She told us that she wants to go and collect the money. And we said, this is not our agreement. This is the day. . . .”

They would not allow her to physically leave their sight. Eventually, “She called someone [family member] to come and sign for her, so that she can pay the money.” Having finally been pressured into finding a way to repay her portion, she was removed from the group: “After we finished paying, we kicked her out.”

The experience of [Mabinty] illustrates a common finding in the data: groups consisting of loose, simplex connections are more likely to view the relationships as serving a functional purpose. Desmond (2012) theorizes the concept of ‘disposable ties,’ typically occurring between new acquaintances with an accelerated intimacy. In contrast to a predominantly economic transaction, resource exchange is interwoven with the social relationship, but they usually have a short life span. Once strained, the ties are typically burned and discarded. We saw ample evidence of this in the microcredit groups. Co-borrowers without multiplex or reinforcing relationships were more likely to aggressively pressure each other, squeeze payment, and then sever the connection. One borrower described how she made no attempt to maintain a relationship after pressuring the member to pay:

We used to see her in the market, but now she is not in the market anymore. It's been so many days without seeing her since she was embarrassed for this money. Just after when she completed paying, then she disappeared.
In contrast, members of highly cohesive groups often maintained strong personal relationship after the loan, even if it ended due to a member defecting. Such clients often said that they would not do business again with the defecting member, but that it did not disrupt the other personal ties between them. A member describes:

Even though she was late to pay . . . . we never asked her to leave the group. We only tried to cajole her so that she would pay this money. . . . It does not change our friendship, but it did disturb us in the office [microfinance organization].

Consequently, the same structural group features that often enhance the ability to effectively sanction – i.e. tie multiplicity, density, closure – consistently reduce members willingness to use them.

**Compliance Enforcement with Disconnected Subgroups**

As hypothesized, the fieldwork provided evidence that another structural feature heightens the tension between ability and willingness to enforce: the disconnected subgroup. It was common to find microcredit groups with non-homogeneous cohesion such that subgroups were connected more strongly internally than to the other subgroup. We found these structures arising from neighborhood cliques, friendships spanning multiple social groups, and business connections between multiple markets.

We found that microcredit clients were more willing to sanction members of the out-subgroup. They would often try to use the same enforcement mechanisms as discussed previously: social pressure, reputation and embarrassment, and ostracism. For example, one group included a disconnected subgroup of two women living in a different neighborhood on the same street. They had not paid on time, complaining of “slow business sales.” The rest of the group typically referred to them collectively as “stubborn old women” and went to their homes as a group to “threaten them.” To avoid the embarrassment of being escorted by the police to court, they complied and paid their shares. Numerous cases in the ethnographic data supported the theory that relatively minor differences may result in the development of an out-group bias and increase the willingness to punish (Brewer 1979; Frank and Yasumato 1998).
However, it was more common for attempts at sanctioning another subgroup to fail. The lack of social connectivity across subgroups posed several enforcement limitations. First, the reduced interaction and communication across subgroups made it more difficult to track and sanction minor deviations from compliance. Issues that could be resolved by consistent social pressure in other groups were more likely to grow into substantial repayment problems. For example, one borrower described how the limited information flow from the other subgroup made it easier for them to be deceived. Ultimately the group fractured and one subgroup fully defected. A member of the remaining subgroup described:

That was the same plan they took. They used the same plan to make an excuse. They said they were going out to buy business [items out of town]. We said, ‘No problem, you can go out.’ But then . . . after a while, we do not see them back . . . After three months, they dissolved. You can’t see any of them.

Second, disconnected subgroups limit the effectiveness of embarrassment and public shaming as a punishment mechanism. The structural gap between subgroups makes the transmission of reputation effects less likely and the interviews indicated that clients weight the rebuke of outgroup members more lightly. One borrower, [Ibrahim], described how he had attempted to pressure members of a different community in the same way he had done with his neighbouring members: “I tried to influence . . . I tried to cajole . . . but no way.” The pressure persisted for months and was often purposely administered in public. Ultimately [Ibrahim] was unable to convince them to cooperate.

Third, the threat of social ostracism is less powerful to members of an out-subgroup. While it is true that members of an out-subgroup can still be threatened with ostracism from the formal microcredit group (and frequently were), social exclusion from a distant group or the severing of weak market relationships was less concerning. The result is that groups with disconnected subgroups lack some of the enforcement tools. [Memuna] described how her loan involved a disconnected subgroup. She did not know their names, but could recognize them if she saw them in the market. When the subgroup members were unwilling to pay she “kicked them out” of the group and stopped visiting them. [Memuna] wanted to “show grievance towards the group,” but believes that “they don’t feel bad about it . . . they deliberately did not want to pay.” This example illustrates a trend in the
data that though often eager to do so, members of one subgroup are not able to effectively sanction those of another subgroup.

In sum, the ethnographic analysis provided confirmatory evidence that the tension between ability and willingness to punish is influenced by dimensions of a group’s social structure. The personal descriptions brought to life the underlying sanctioning mechanisms. Specifically, we found evidence supporting the directionality of the propositions in this study. Though ability and willingness are often in conflict, the nature of the underlying social mechanisms suggest that there are systematic tendencies. The consistency with which a group member grants an ‘enforcement exception,’ or lack thereof, allows one to form more accurate expectations for aggregate cooperative outcomes.

**DISCUSSION**

The importance of cooperation in human societies has motivated substantial research and we are now equipped with an extensive and illuminating set of factors known to affect cooperative behavior (Dawes 1980; Kollock 1998; Ostrom 2000; Pletzer et al 2018). However, researchers have noted that in order to advance this line of research, we need to address our limited ability to integrate potentially conflicting factors in order to predict which mechanisms are most likely to dominate the collective outcome (Fehr and Gintis 2007; Hedström and Bearman 2009; Baldassarri 2015).

This study has argued that a group’s social structure often produces conflicting enforcement behaviors, but when accounted for, the collective outcome exhibits systematic trends. A known dilemma in cooperative research is that ultimately actors must contribute on at least two levels for sustained collective benefit: the first level, contribution to the original good, and the second level, contribution to enforcement (Heckathorn 1993). A challenge that arises when attempting to map social structure to cooperative outcomes is that changes in social structure tends to have inverse effects on these two levels. A key source of this conflict is that the same social mechanisms that naturally increase the ability to sanction, e.g. increased social interaction and multiplex relationships, simultaneously decrease the willingness to sanction the defector. In this closing section, we will discuss how a greater understanding of these relationships: (1) expands our existing knowledge on
First, this study confirms substantial prior research suggesting that social connectedness enhances the ability to sanction through an increase in opportunities and effectiveness (Homans 1950; Hechter 1988; Coleman 1990). However, effective opportunities in themselves, are functionally different from credible threats or implemented actions. This distinction between ability and willingness has been noted in the cooperative literature, suggesting, either explicitly or implicitly, that both are necessary components of effective enforcement (e.g. Ostrom 2000; Fehr and Gächter, 2000; Reuben and Riedl 2013). Specifically, we have advanced the idea that social structure is a key determinant of these two tendencies and a change in one is likely to accompany a change in the other. Accounting for this interdependence substantially shifts our expectations for collective outcomes. The ability-willingness tension induces cooperative trends that are non-monotonic and highly sensitive to interaction effects. We expect that this theoretical distinction may reconcile numerous empirical studies that appear to produce conflicting results (e.g. Wydick 1999; Paxton, Graham, and Thraen 2000; Hermes, Lensink, and Mehrteab 2005; Al-Azzam, Hill, and Sarangi 2012).

To take make use of this theoretical distinction, another important question is raised. When a group structure exhibits ability and willingness tendencies that are not reinforcing, what logic should we follow to form specific expectations for the collective outcome? In this study, we found it beneficial to start by explicitly considering how a characteristic of a group’s structure separately affects ability and willingness to sanction. However, when combining the two, we note that they should not be viewed as additive factors in relation to the cooperative outcome. Rather, as they are both necessary, the lesser of the two limits the extent to which social sanctioning can enhance cooperation in a group. This approach allows one to derive testable hypotheses that better reflect our understanding of the interdependence of ability and willingness. We suggest that this method may be fruitfully applied to other dimensions of a group’s social structure.

In this study, we took first steps towards exploring this possibility by deriving expectations for two dimensions of a group’s social structure: structural cohesion, disconnected subgroups, and
their interaction. In the context of group lending in Sierra Leone, these dimensions both exhibited a tension between ability and willingness and the variety of collective outcomes confirmed the importance of not assuming additive linear relationships. The data showed that optimal group structure in terms of repayment consists of moderately cohesive groups without disconnected subgroups. Notably, we did not find peak performance correlated with highly cohesive groups, suggesting that moderate cohesion provides a beneficial level of both ability and willingness to sanction. However, if a group can be characterized as consisting of disconnected subgroups, the baseline ability to sanction is so much lower that an incremental increase in overall group cohesion offers a more strongly positive effect. As a result, the worst group structure on average can be characterized as having disconnected subgroups and low overall structural cohesion.

To what extent do we expect that these relationships are generalizable beyond their observed context? The theoretical foundation suggests that the tension between ability and willingness to enforce naturally arises from underlying social mechanisms and that variation in social structure predictably shifts the balance. However, if and at what point the tipping point is reached is highly context driven: dependent on the group setting, the nature of the good itself, the relative tradeoffs between the future relationship and cooperative benefit, etc. It would be inappropriate to expect that a model of such a complex phenomenon as collective action can be stripped of its basic contextual assumptions and still provide insight (Oliver 1980). Rather, the tension to enforce should be interpreted in relation to these contextual factors. For example, imagine a cooperative setting in which the baseline level of structural cohesion is comparatively low and does not frequently reach levels at which the value of the relationships outweigh the good. In this case, one might expect a linearly increasing relationship between structural cohesion and economic cooperation. A study by Karlan (2007) provides a good example of this in the microcredit context. Members are quasi-randomly assigned to joint-liability groups rather than self-selected, resulting in less extreme values of social cohesion and overall increasing returns to spatial propinquity.

In regards to practical implications, one might look at the observed trends and be left with the idea that moderation should be the goal because moderately cohesive groups without a structural
cleavage demonstrated the best performance. While this point is observed in the data, attempting to manipulate group structure to reach that point may not be a trivial task in practice. For example, microfinance institutions often equip loan officers with simple heuristics, such as ‘the better group members know each other, the better the group.’ We see that such a heuristic immediately places the organization in a safe space, i.e. high structural cohesion narrows down the average propensities to moderate performance. This occurs because the risks associated with overembeddedness and underembeddedness are not symmetrical relative to the peak. The downside of low cohesion groups poses significantly greater economic risk. Certainly, it is a much more difficult search task for loan officers to identify moderately cohesive groups without disconnected subgroups than to simply identify highly cohesive groups. In this case, MFI’s may be setting appropriate practices given their limited resources. However, these findings do suggest that there is incremental room for improvement in group selection if appropriate resources are available.

The observed cooperative behaviors in this study also offers insight to group formation and member preferences for enforcement. Substantial research has suggested that selective interaction is one of the key mechanisms supporting the evolution of cooperation (Nowak 2006; Santos, Pacheco, and Lenaerts 2006). In the microfinance context, group members often have substantial flexibility in whom they choose as group members. When the data is statistically analyzed we see a tendency for groups to be overembebedded, i.e. levels of structural cohesion above the threshold which improves economic performance. This may partially derive from the MFI’s hueristics as noted above, but may also stem from the preferences of whom members wish to partner with. Do members prefer to join a group in which there is some expectation for soft enforcement? One may be aware that group norms for rigid enforcement are equally likely to be applied to themselves. Is the inferred ability to back out of a group agreement a preferred feature, even though it may reduce the likelihood of maximizing the economic outcome? Member selection in relation to compliance enforcement is an open question deserving further research. Bryan, Karlan, and Zinman (2015) have expanded a group selection model to include preferences for a partner’s malleability type, i.e. their susceptibility to social pressure.

Understanding the selection criteria in relation to compliance enforcement offers wide application to
alternative collective-action settings such as self-selection into school systems, neighborhoods, and working groups.

This study’s external validity has benefited from the focus on field data, but has also posed some limitations deserving further research. First, we note that the causal linkage between structure and the ability-willingness tension should be further examined. Though this study examined longitudinal data, we were limited in treating variation in group structure as variation across groups, rather than variation within groups over time. Alternative methods could probe the effect of shifts in group structure among the same members through evolving panel data or experimentally manipulated groups. Second, we have empirically focused on collective behavior in small groups. Group size is a key contextual variable in cooperative research (Dawes 1980). Large groups may exhibit different relationships between social structure and enforcement behavior. For example, though we found disconnected subgroups produce a consistently negative effect on the collective outcome, other research has suggested that social fragmentation may offer benefits for norm enforcement, dependent on the interaction of network structure and group size (Macy 1991; Kim and Bearman 1997; Hanaki et al. 2007).

In closing, this study encourages a fertile area of research in which exceptions in compliance enforcement are being better understood as systematic behaviors. Consider the behavior variation in highly cohesive groups (Flache and Macy 1996; Horne 2007), the substantial role of ‘conditional cooperators’ (Fehr and Gintis 2007; Fehr and Schurtenberger 2018), or member selection based on their susceptibility to social pressure (Bryan, Karlan, and Zinman 2015). In this vein, researchers are uncovering the causal basis for what initially appears to be noise in cooperative behavior. In the case of group lending, leniency in not punishing a member struggling to contribute financially, may seem like an outlier in the data. However, we suggest that there are consistent structural conditions which promote a logic of aggressive enforcement, “I keep on chasing [her] just to pay this money” over one of prosocial leniency, “. . . . but I decided to leave her alone.” Research which delves deeper into the structured component of social preferences and enforcement variability, offers continued advancement in our understanding of collective behavior.
REFERENCES


NOTES

1 Social dilemmas possess two characteristics: (1) the pay-off to individuals for defecting behavior is greater than the payoff for cooperative behavior, regardless of what other group members do; and, (2) all individuals receive a lesser payoff if all defect than if all cooperate (Dawes, 1980).

2 One could formally model the difference between sanction opportunities and their efficacy (e.g. Heckathorn 1990). For the purpose of this paper, we focus on the distinction between ability (both in terms of opportunity and potential effectiveness) versus the willingness to act.

3 Moody and White (2003) note two types of cohesive subgroups: (1) ‘Side by side’ subgroups and (2) hierarchically nested subgroups, e.g. core and periphery. In this study, we focus on the social implications of the former structure.

4 Taken to the extreme, subgroups which become highly connected are structurally equivalent to highly cohesive groups discussed in Hypothesis 1.

5 This research was approved by the Central University Research Ethics Committee (CUREC) at the University of Oxford.

6 From the outset of the research project, the researchers limited the study to the clients located in the primary city. Defining the sample criteria was necessary for the collection of the GPS data. Focusing on clients located in the main city versus rural villages served two primary purposes: (1) efficiency of data collection allowed us to maximize our sample size and (2) the city provides more consistent spatial data, i.e. clients are not separated by rivers, mountains, etc., which makes the use of spatial proximity a more valid proxy for social proximity. Regarding the time window criteria, pre-2006 the organization had not standardized its group lending practices. The usable data (2006-2011) represents the vast majority of the organization’s records: 96.1%.

7 The basic unit of analysis for the regressions is the loan-level. The primary reason that we collapse monthly payments to a single measure of loan performance is that there is no variation in the explanatory and control variables below the loan-level. Our primary research question is addressed in variation across group loans, rather than within loans.

8 Appendix B addresses concerns regarding the effects of communication and transport technology on the relationship between spatial and social proximity.

9 We examined the likelihood of a multiplex tie rather than a single affiliation as it serves as a stronger measure of structural embeddedness. Single affiliations to such groups may represent a relatively weak tie (Feld 1981). Further, we do not use ethnic tribe as a social affiliation in this analysis. With 72.5 percent of the respondents belonging to the largest tribe (Temne), it does not represent a meaningful social affiliation. Instead, it is used in the analysis as a control variable.

10 It is possible that clients with the same residential address (i.e. a spatial distance of zero) represent a categorically different type of social relationship. We explored this by including a binary variable in our analysis (1 = co-location) and found that it had no effect.

11 The level of educational attainment could also affect repayment behavior, particularly regarding a client’s financial ability to contribute to loan repayment. However, MFI staff emphasized reliability issues with such data in this context. The self-selection process of individuals interested in microcredit naturally reduces the variation in education levels and social desirability bias compounds the problem, i.e. potential clients are likely to misrepresent their educational level, thinking that it affects the loan
approval process. We prefer to use measures related to a client’s business as a more direct measure of his or her financial ability to repay.

12 Ideally, controls for financial ability to pay would extend beyond the individual’s income, e.g. household income. However, in this context, the MFI focuses on female empowerment and restricts requesting a spouse’s income. As such, we use measures related to the client’s business as a proxy for financial ability to repay.

13 Additional models were built controlling for exogenous factors using dummy variables for time periods: six month periods based on the primary rainy and dry seasons in Sierra Leone. The substantive results were unchanged.

14 We are using the term ‘ethnographic’ as characterized and demonstrated by Geertz (1973), Huberman and Miles (2002) and Uzzi (1996; 1997).
FIGURES

Figure 1. Spatial Distribution of Microcredit Clients in Sierra Leone, 2006-2011

Note: \( N = 1,884 \) residential coordinates. Data gathered by GPS in city of study, Sierra Leone.
Figure 2. Social Affiliation Network: Microcredit Clients in Sierra Leone, 2011

Note: N = 378 microcredit clients (subset surveyed for social affiliations). Incidence matrix of affiliations converted to one-mode network. Layout algorithm: Fruchterman Reingold. Network Density: 0.048. Average Path Length: 3.1. See Table 2 for detail on social affiliation types: Religious Organization; Place of Business; Educational Organization; Informal Lending Group.
Figure 3. Multiplex Social Tie Probability Spline: Microcredit Clients in Sierra Leone, 2011

Note: N = 71,253 potential ties. The solid line shows the implied relationship of the functional form produced by logistic regression, holding other variables at their means (see Table 3); the dotted line shows a 20-piece spline of the empirical likelihood of a multiplex social tie.
Figure 4. Euclidian Minimum Spanning Trees: Microcredit Groups in Sierra Leone, 2006-2011

Note: 10 microcredit groups illustrating different spatial configurations from the empirical city of study, Sierra Leone. Full dataset: 1,884 borrowers constituting 406 EMSTs.
Figure 5. Disconnect from Main Social Component Probability Spline: Microcredit Clients in Sierra Leone, 2011

Note: Note: N = 378 clients. The solid line shows the implied relationship of the function form produced by logistic regression, holding other variables at their means (see Table 4); the dotted line shows a 10-piece spline of the empirical likelihood of a client disconnected from the main social component of the affiliation network.
Figure 6. Empirical Relationship of Structural Embeddedness and Microcredit Economic Cooperation in Sierra Leone, 2006-2011

Note: N = 741 loan observations nested in 406 borrowing groups (comprising 1,884 unique members). X-axis values denote a group’s standardized Euclidian Minimum Spanning Tree. Y-axis values indicate a group’s average days overdue; negative values indicate worse performance. Curves fitted with hierarchical linear regression model (see Table 5 Model 4). Control variables held constant at mean values.
Table 1
Descriptive Statistics: Microcredit Groups in Sierra Leone, 2006-2011

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrowers</td>
<td>1,844</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groups</td>
<td>406</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loans</td>
<td>741</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Structural Embeddedness Proxies**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Cohesion</td>
<td>.00</td>
<td>1.00</td>
<td>-4.25</td>
<td>1.05</td>
</tr>
<tr>
<td>(-Euclidian Minimum Spanning Tree)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disconnected Subgroups</td>
<td>.11</td>
<td>.31</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>(1=Disconnected)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Group Characteristics**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Size</td>
<td>4.58</td>
<td>.49</td>
<td>4.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Proportion Female</td>
<td>.84</td>
<td>.22</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Proportion Married</td>
<td>.93</td>
<td>.14</td>
<td>.25</td>
<td>1.00</td>
</tr>
<tr>
<td>Average Number of Children</td>
<td>3.16</td>
<td>.86</td>
<td>1.00</td>
<td>6.50</td>
</tr>
</tbody>
</table>

**Financial Characteristics**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Monthly Sales</td>
<td>.82</td>
<td>.35</td>
<td>.20</td>
<td>4.85</td>
</tr>
<tr>
<td>Standard Deviation Monthly Sales</td>
<td>.22</td>
<td>.41</td>
<td>.00</td>
<td>6.77</td>
</tr>
<tr>
<td>Average Business Equity</td>
<td>.95</td>
<td>.38</td>
<td>.24</td>
<td>3.98</td>
</tr>
<tr>
<td>Proportion Petty Traders</td>
<td>.64</td>
<td>.29</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Business Type Diversity</td>
<td>.00</td>
<td>1.00</td>
<td>-1.50</td>
<td>3.12</td>
</tr>
</tbody>
</table>

**Loan Characteristics**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Loan Amount</td>
<td>2.43</td>
<td>1.14</td>
<td>1.20</td>
<td>7.50</td>
</tr>
<tr>
<td>Loan Cycle</td>
<td>2.14</td>
<td>1.43</td>
<td>1.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Loan Officer 1</td>
<td>.05</td>
<td>.22</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Loan Officer 2</td>
<td>.01</td>
<td>.12</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Loan Officer 3</td>
<td>.16</td>
<td>.37</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Loan Officer 4</td>
<td>.21</td>
<td>.41</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Loan Officer 5</td>
<td>.20</td>
<td>.40</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Loan Officer 6</td>
<td>.11</td>
<td>.31</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Loan Officer 7</td>
<td>.07</td>
<td>.25</td>
<td>.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Loan Officer 8</td>
<td>.01</td>
<td>.09</td>
<td>.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Dependent Variable**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Repayment (Days Late coded negative)</td>
<td>-35.08</td>
<td>85.58</td>
<td>-536.0</td>
<td>4.00</td>
</tr>
</tbody>
</table>

*Note: All descriptive statistics are loan-level. Financial Amounts in Millions of Leones (SLL).*
Table 2
Summary of Social Affiliation Survey: Microcredit Clients in Sierra Leone, 2011

<table>
<thead>
<tr>
<th>Social Foci</th>
<th>Religious Organization</th>
<th>Place of Business</th>
<th>Educational Organization</th>
<th>Informal Lending Group</th>
<th>Tribe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveyed Clients</td>
<td>410</td>
<td>410</td>
<td>410</td>
<td>410</td>
<td>410</td>
</tr>
<tr>
<td>Completed Surveys</td>
<td>378</td>
<td>378</td>
<td>378</td>
<td>378</td>
<td>378</td>
</tr>
<tr>
<td>Reported Affiliations</td>
<td>355</td>
<td>310</td>
<td>153</td>
<td>198</td>
<td>372</td>
</tr>
<tr>
<td>Reported Distinct Foci</td>
<td>82</td>
<td>127</td>
<td>43</td>
<td>136</td>
<td>13</td>
</tr>
<tr>
<td>Mean Affil/Focus</td>
<td>4.3</td>
<td>2.4</td>
<td>3.6</td>
<td>1.5</td>
<td>28.6</td>
</tr>
<tr>
<td>Std Dev Affil/Focus</td>
<td>5.5</td>
<td>4.2</td>
<td>3.5</td>
<td>.8</td>
<td>74.3</td>
</tr>
<tr>
<td>Min Affil/Focus</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Max Affil/Focus</td>
<td>34</td>
<td>33</td>
<td>13</td>
<td>5</td>
<td>274</td>
</tr>
</tbody>
</table>
Table 3
Binary Logistic Regression Predicting the Effect of Spatial Proximity on Multiplex Social Tie Probability in Sierra Leone, 2011

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>S.E.</td>
<td>Coefficient</td>
<td>S.E.</td>
</tr>
<tr>
<td>Spatial Distance</td>
<td>–</td>
<td>–</td>
<td>–2.716***</td>
<td>(.160)</td>
</tr>
<tr>
<td>Tribe (1 = Match)</td>
<td>.418***</td>
<td>(.121)</td>
<td>.258*</td>
<td>(.131)</td>
</tr>
<tr>
<td>Gender (1 = Match)</td>
<td>.451*</td>
<td>(.175)</td>
<td>.380*</td>
<td>(.192)</td>
</tr>
<tr>
<td>Marital Status (1 = Match)</td>
<td>.602**</td>
<td>(.214)</td>
<td>.540*</td>
<td>(.237)</td>
</tr>
<tr>
<td>Group Leader (1 = Match)</td>
<td>-.328**</td>
<td>(.118)</td>
<td>-.288*</td>
<td>(.128)</td>
</tr>
<tr>
<td>Business Type (1 = Match)</td>
<td>.378**</td>
<td>(.120)</td>
<td>.440***</td>
<td>(.130)</td>
</tr>
<tr>
<td>Monthly Sales Difference</td>
<td>-.726***</td>
<td>(.170)</td>
<td>-.570**</td>
<td>(.182)</td>
</tr>
<tr>
<td>Number Child Difference</td>
<td>-.192***</td>
<td>(.050)</td>
<td>-.141**</td>
<td>(.054)</td>
</tr>
<tr>
<td>Number Dependents Difference</td>
<td>-.098</td>
<td>(.064)</td>
<td>-.099</td>
<td>(.074)</td>
</tr>
<tr>
<td>Constant</td>
<td>-.6.138***</td>
<td>(.300)</td>
<td>-3.752***</td>
<td>(.334)</td>
</tr>
<tr>
<td>Deviance</td>
<td>3819.0</td>
<td>2837.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: N = 71, 253 potential ties;
Distance in kilometers; Financial amounts in millions of Leones (SLL);
*p<.05   **p<.01   ***p<.001 (two-tailed tests)
Table 4
Binary Logistic Regression Predicting the Effect of Spatial Proximity on Disconnect from Main Social Component, Sierra Leone 2011

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>S.E.</td>
<td>Coefficient</td>
<td>S.E.</td>
</tr>
<tr>
<td>Spatial Distance</td>
<td></td>
<td>.007*** (.001)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tribe (1 = Temne)</td>
<td>.049 (.370)</td>
<td>.073 (.412)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (1 = Female)</td>
<td>-.158 (.570)</td>
<td>.229 (.622)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital Status (1 = Married)</td>
<td>.156 (.579)</td>
<td>.524 (.682)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Leader (1 = Leader)</td>
<td>-.072 (.397)</td>
<td>-.167 (.432)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business Type (1 = Petty Trading)</td>
<td>-.300 (.368)</td>
<td>-.554 (.398)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly Sales</td>
<td>.319 (.420)</td>
<td>.376 (.450)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number Child</td>
<td>.086 (.122)</td>
<td>.036 (.138)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number Dependents</td>
<td>.247 (.261)</td>
<td>.061 (.304)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.568 (.958)</td>
<td>-.301 (1.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviance</td>
<td>260.49</td>
<td>202.14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: N = 378 clients
Distance in kilometers; Financial amounts in millions of Leones (SLL);
*p<.05   **p<.01   ***p<.001 (two-tailed tests)
Table 5
Hierarchical Linear Regression Predicting the Effect of Structural Embeddedness on Economic Cooperation in Microcredit Groups, Sierra Leone 2006-2011

<table>
<thead>
<tr>
<th>Structural Embeddedness Proxies</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Cohesion (-EMST)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Structural Cohesion Squared</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Disconnected Subgroups (1 = Disconn)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Structural Cohesion x Disconn Subgroups</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group Characteristics</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Size</td>
<td>-3.505</td>
<td>(7.324)</td>
</tr>
<tr>
<td></td>
<td>-3.064</td>
<td>(7.326)</td>
</tr>
<tr>
<td>Proportion Female</td>
<td>-13.069</td>
<td>(14.282)</td>
</tr>
<tr>
<td></td>
<td>-8.401</td>
<td>(14.361)</td>
</tr>
<tr>
<td>Proportion Married</td>
<td>-25.499</td>
<td>(22.038)</td>
</tr>
<tr>
<td></td>
<td>-28.397</td>
<td>(21.963)</td>
</tr>
<tr>
<td>Average Children</td>
<td>.414</td>
<td>(3.528)</td>
</tr>
<tr>
<td></td>
<td>1.349</td>
<td>(3.542)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Financial Characteristics</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Monthly Sales</td>
<td>-5.614</td>
<td>(18.910)</td>
</tr>
<tr>
<td>Standard Deviation Monthly Sales</td>
<td>-8.518</td>
<td>(11.771)</td>
</tr>
<tr>
<td>Average Business Equity</td>
<td>16.972</td>
<td>(13.272)</td>
</tr>
<tr>
<td>Proportion Petty Traders</td>
<td>13.309</td>
<td>(14.225)</td>
</tr>
<tr>
<td>Business Type Diversity</td>
<td>-5.721</td>
<td>(6.219)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Loan Characteristics</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan Amount</td>
<td>-10.489</td>
<td>(5.918)</td>
</tr>
<tr>
<td></td>
<td>-11.208</td>
<td>(5.898)</td>
</tr>
<tr>
<td>Loan Officer 1</td>
<td>-4.330</td>
<td>(4.556)</td>
</tr>
<tr>
<td></td>
<td>-4.730</td>
<td>(4.538)</td>
</tr>
<tr>
<td>Loan Officer 2</td>
<td>-10.434</td>
<td>(16.914)</td>
</tr>
<tr>
<td></td>
<td>-12.674</td>
<td>(16.871)</td>
</tr>
<tr>
<td>Loan Officer 3</td>
<td>-85.363***</td>
<td>(25.105)</td>
</tr>
<tr>
<td></td>
<td>-84.921***</td>
<td>(25.021)</td>
</tr>
<tr>
<td>Loan Officer 4</td>
<td>-12.206</td>
<td>(11.098)</td>
</tr>
<tr>
<td></td>
<td>-15.096</td>
<td>(11.102)</td>
</tr>
<tr>
<td>Loan Officer 5</td>
<td>-83.893***</td>
<td>(10.231)</td>
</tr>
<tr>
<td></td>
<td>-85.927***</td>
<td>(10.265)</td>
</tr>
<tr>
<td>Loan Officer 6</td>
<td>6.113</td>
<td>(9.722)</td>
</tr>
<tr>
<td></td>
<td>6.629</td>
<td>(9.718)</td>
</tr>
<tr>
<td>Loan Officer 7</td>
<td>-2.443</td>
<td>(13.949)</td>
</tr>
<tr>
<td></td>
<td>.074</td>
<td>(13.944)</td>
</tr>
<tr>
<td>Loan Officer 8</td>
<td>2.626</td>
<td>(14.839)</td>
</tr>
<tr>
<td></td>
<td>1.620</td>
<td>(14.803)</td>
</tr>
<tr>
<td>Loan Officer 9</td>
<td>-5.814</td>
<td>(34.334)</td>
</tr>
<tr>
<td></td>
<td>-5.614</td>
<td>(34.178)</td>
</tr>
</tbody>
</table>

| Constant              | 50.172  | (41.894) |
|                       | 52.206  | (42.002) |

| Deviance              | 8553    | 8546    |

Note: N = 741 loan observations nested in 406 borrowing groups (comprising 1,884 unique members)
*p<.05   **p<.01   ***p<.001 (two-tailed tests)
<table>
<thead>
<tr>
<th></th>
<th>Model 3</th>
<th></th>
<th>Model 4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>S.E.</td>
<td>Coefficient</td>
<td>S.E.</td>
</tr>
<tr>
<td><strong>Structural Embeddedness Proxies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural Cohesion (-EMST)</td>
<td>–</td>
<td>–</td>
<td>-12.197**</td>
<td>(4.194)</td>
</tr>
<tr>
<td>Structural Cohesion Squared</td>
<td>–</td>
<td>–</td>
<td>-5.147*</td>
<td>(2.165)</td>
</tr>
<tr>
<td>Disconnected Subgroups (1 = Disconn)</td>
<td>-18.656**</td>
<td>(9.387)</td>
<td>-36.689**</td>
<td>(12.545)</td>
</tr>
<tr>
<td>Structural Cohesion x Disconn Subgroups</td>
<td>–</td>
<td>–</td>
<td>47.416*</td>
<td>(19.994)</td>
</tr>
<tr>
<td><strong>Group Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Size</td>
<td>-1.219</td>
<td>(7.395)</td>
<td>-1.176</td>
<td>(7.360)</td>
</tr>
<tr>
<td>Proportion Female</td>
<td>-12.112</td>
<td>(14.252)</td>
<td>-9.512</td>
<td>(14.292)</td>
</tr>
<tr>
<td>Average Children</td>
<td>.430</td>
<td>(3.519)</td>
<td>1.080</td>
<td>(3.523)</td>
</tr>
<tr>
<td><strong>Financial Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Monthly Sales</td>
<td>-4.517</td>
<td>(18.868)</td>
<td>-3.700</td>
<td>-18.75</td>
</tr>
<tr>
<td>Standard Deviation Monthly Sales</td>
<td>-8.154</td>
<td>(11.742)</td>
<td>-8.493</td>
<td>(11.674)</td>
</tr>
<tr>
<td>Average Business Equity</td>
<td>15.995</td>
<td>(13.246)</td>
<td>12.833</td>
<td>(13.194)</td>
</tr>
<tr>
<td>Proportion Petty Traders</td>
<td>13.816</td>
<td>(14.189)</td>
<td>15.144</td>
<td>(14.104)</td>
</tr>
<tr>
<td>Business Type Diversity</td>
<td>-5.090</td>
<td>(6.211)</td>
<td>-4.067</td>
<td>(6.174)</td>
</tr>
<tr>
<td><strong>Loan Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loan Amount</td>
<td>-10.911</td>
<td>(5.906)</td>
<td>-11.714*</td>
<td>(5.866)</td>
</tr>
<tr>
<td>Loan Cycle</td>
<td>-4.015</td>
<td>(4.546)</td>
<td>-4.038</td>
<td>(4.517)</td>
</tr>
<tr>
<td>Loan Officer 1</td>
<td>-10.026</td>
<td>(16.870)</td>
<td>-11.382</td>
<td>(16.776)</td>
</tr>
<tr>
<td>Loan Officer 2</td>
<td>-82.511***</td>
<td>(25.079)</td>
<td>-86.669***</td>
<td>(24.966)</td>
</tr>
<tr>
<td>Loan Officer 3</td>
<td>-12.265</td>
<td>(11.068)</td>
<td>-13.031</td>
<td>(11.068)</td>
</tr>
<tr>
<td>Loan Officer 4</td>
<td>-83.908***</td>
<td>(10.204)</td>
<td>-85.420***</td>
<td>(10.207)</td>
</tr>
<tr>
<td>Loan Officer 5</td>
<td>6.129</td>
<td>(9.697)</td>
<td>6.420</td>
<td>(9.661)</td>
</tr>
<tr>
<td>Loan Officer 6</td>
<td>-2.112</td>
<td>(13.913)</td>
<td>.524</td>
<td>(13.862)</td>
</tr>
<tr>
<td>Loan Officer 7</td>
<td>2.834</td>
<td>(14.800)</td>
<td>2.908</td>
<td>(14.724)</td>
</tr>
<tr>
<td>Loan Officer 8</td>
<td>-7.198</td>
<td>(34.250)</td>
<td>-5.667</td>
<td>(33.984)</td>
</tr>
<tr>
<td>Constant</td>
<td>41.552</td>
<td>(42.008)</td>
<td>46.453</td>
<td>(41.939)</td>
</tr>
<tr>
<td>Deviance</td>
<td>8549</td>
<td></td>
<td>8537</td>
<td></td>
</tr>
</tbody>
</table>

*Note: N = 741 loan observations nested in 406 borrowing groups (comprising 1,884 unique members)*

*p<.05  **p<.01  ***p<.001 (two-tailed tests)
### APPENDICES

**Appendix A**

#### Table A1

Robustness of Model Selection

<table>
<thead>
<tr>
<th></th>
<th>Model A1</th>
<th>Model A2</th>
<th>Model A3</th>
<th>Model A4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Days Overdue</td>
<td>Log Days Overdue</td>
<td>Censored Days Overdue</td>
<td>Hazard Loan Default</td>
</tr>
<tr>
<td></td>
<td>Coefficient</td>
<td>S.E.</td>
<td>Coefficient</td>
<td>S.E.</td>
</tr>
<tr>
<td><strong>Structural Embeddedness Proxies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural Cohesion (-EMST)</td>
<td>-12.197** (4.194)</td>
<td>-.178*** (.052)</td>
<td>-8.995*** (2.635)</td>
<td>-.632** (.258)</td>
</tr>
<tr>
<td>Structural Cohesion Squared</td>
<td>-5.147*  (2.165)</td>
<td>-.071** (.027)</td>
<td>-.478* (1.371)</td>
<td>-.276† (.136)</td>
</tr>
<tr>
<td>Disconnected Subgroups (1 = Disconn)</td>
<td>-36.689** (12.545)</td>
<td>-.371* (.154)</td>
<td>-25.205** (7.908)</td>
<td>-1.440*** (.421)</td>
</tr>
<tr>
<td>Structural Cohesion x Disconn Subgroups</td>
<td>47.416*  (19.994)</td>
<td>.484* (.246)</td>
<td>37.269** (12.643)</td>
<td>2.060** (.680)</td>
</tr>
<tr>
<td><strong>Group Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group Size</td>
<td>-1.176 (7.360)</td>
<td>.129 (.090)</td>
<td>2.903 (4.609)</td>
<td>-.518 (.536)</td>
</tr>
<tr>
<td>Proportion Female</td>
<td>-9.512 (14.292)</td>
<td>-.175 (.176)</td>
<td>-7.582 (9.047)</td>
<td>-1.240 (.986)</td>
</tr>
<tr>
<td>Average Children</td>
<td>1.080 (3.523)</td>
<td>.060 (.043)</td>
<td>2.276 (2.206)</td>
<td>-.028 (.194)</td>
</tr>
<tr>
<td><strong>Financial and Loan Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>46.453 (41.939)</td>
<td>-2.140 (.515)</td>
<td>31.535 (26.244)</td>
<td>-</td>
</tr>
</tbody>
</table>

*Note: N = 741 loan observations nested in 406 borrowing groups (comprising 1,884 unique members)*

†p<.10  *p<.05  **p<.01  ***p<.001   (two-tailed tests)
Appendix A (continued)

In this appendix we summarize additional analyses verifying whether the selection of the statistical model is robust and appropriately specified. We summarize analysis related to (1) distribution of the dependent variable, (2) alternative statistical models, and (3) model specification.

**Distribution of the dependent variable.** In the principal analysis, we used maximum days overdue for each group loan as the dependent variable, lateness coded as negative (see Model A1 for a summary). The distribution has a negative skew with a higher frequency of groups paying on time. We took several steps to verify that the skewness of the distribution was not adversely affecting the model results. We calculated Cook's distance and reran the analysis without the observations with potential high influence; the results were not significantly changed. We performed a log transformation on days overdue to reduce the skewness of the distribution. See Model A2 for regression results using log days overdue. The results are substantively the same.

**Alternative statistical models.** In the principal analysis, we treated the dependent variable as a continuous measure. One could question whether early payment and default should be treated differently from "ordinary" days overdue. To account for this we considered two different models. We modeled days overdue as censored data, right censored at 0 (early) and left censored at -180 (default). Model A3 presents the results of the Tobit model. The results are substantively the same. Alternatively, one could disregard days overdue and focus on the risk of default as the key indicator of economic performance. We modeled this alternative with the Cox proportional model for discrete-time survival (the hazard rate of default over each loan cycle.) Model A4 indicates that the effects of the explanatory variables are not substantively different. Of the alternative models in this appendix, we prefer Model A1 for its theoretical motivation (i.e. interest in days overdue) and ease of interpretation.

**Model specification.** We note additional tests to verify that Model A1 is appropriately specified. Calculation of generalized variance inflation factors (maximum value 5.63) for the principal model indicates that multicollinearity is not a significant concern. However, we do see from the empirical results (Table 5) that the controls for some loan officers are highly significant; notably,
Loan Officers 2 and 4 are associated with worse performing groups. To test whether loan officers were influencing our results, we divided the dataset into two subsets (one with Loan Officers 2 and 4, and one with the others). Rerunning the principal model on the subsets did not significantly affect the results.
Appendix B: Effects of Communication and Transport Technology on the Relationship between Spatial and Social Proximity

This appendix addresses potential limitations of using spatial proxies for structural embeddedness. The most significant concern relates to the softening of the relationship between social and spatial proximity as a result of changes in communication technology. Technological advances such as the mobile phone, e-mail, and social media, have made it easier to form and maintain social relationships at greater physical distances (Wellman and Hampton 2001; Lin and Atkin 2007). Though this trend in technology is undoubtable, research has found that spatial proximity still plays a fundamental role in shaping social networks. It appears that enhanced communication is most commonly directed towards maintaining local social ties (Levy and Goldenberg 2014) and tends to reinforce existing socio-spatial patterns, rather than inventing completely new ones (Stephens and Poorthuis 2015). For example, college students are more likely to email their peers living in the same dormitory hall (Marmaros and Sacerdote 2006), employees at Google are more likely to communicate with and influence their physically proximate coworkers (Cowgill, Wolfers, and Zitzewitz 2009), and Twitter users are more likely to follow their neighbors (Stephens and Poorthius 2015). These examples focus on contexts in which individuals are using the latest communication technology. Most microfinance clients in Sierra Leone will not use such technology to the same extent. However, the implication is that if spatial proximity is still a basic determinant of social networks in more extreme cases of technology use, one can be more confident using a spatial proxy in the Sierra Leone context.

A second concern is the trend in increased spatial mobility (Kellerman 2012; Wegener 2013), e.g. greater likelihood of long work commutes or moving residential addresses. Sampson (1988) notes that there is significant variation in spatial mobility across cultural contexts and the role of spatial proximity in social behavior is more potent in contexts with lower mobility. Microfinance institutions, particularly group lending programs, are typically based in developing countries with lower spatial mobility of its clients (Wenner 1995; Cassar and Wydick 2010). In this study, the concern of spatial mobility is mitigated by the geographical context of Sierra Leone, providing a stronger relationship between physical space and structural embeddedness.
Appendix C

Figure C1. Robustness of Disconnected Subgroup Threshold

Note: N = 741 loan observations nested in 406 borrowing groups (comprising 1,884 unique members). The threshold distance for defining disconnected subgroups is varied, X-axis. The Y-axis values indicate a group’s average days overdue; negative values indicate worse performance. Error bars reflect ± SEM.

This figure displays the relationship between economic cooperation and the existence of disconnected subgroups. By varying the distance threshold used to define a disconnected subgroup, we can examine the robustness of the results. Across different thresholds, groups with disconnected subgroups perform consistently worse than those without disconnected subgroups.
Figure D1. Spatial Autocorrelation of Microcredit Economic Performance in Sierra Leone, 2006-2011

Note: N = 741 loan observations nested in 406 borrowing groups (comprising 1,884 unique members). Colors designate group loan repayment performance.

In the text of the article we applied the Moran’s I statistic for spatial autocorrelation. We found loan performance in our dataset was not spatially autocorrelated. This figure presents the results graphically, each point representing the repayment performance on a group loan. For visual purposes, we apply five repayment categories: early, on-time, late, delinquent (30+ days overdue), and default (180+ days overdue).