Multiplexity and Information Transmission: Evidence from Rural India

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Abstract

This study evaluates how having multiple kinds of relations – multiplexity – affects diffusion by word-of-mouth information transmission. The study uses data from a field experiment in 49 remote villages in Karnataka, India. The experiment used "leaders" in each community tasked with raising awareness and promoting microfinance participation among their contacts. The article develops and tests the idea that multiplex ties encouraged microfinance participation through social learning (Hypothesis 1), but that multiplex ties negatively moderated the benefits of word-of-mouth information through experimentally seeded leaders (Hypothesis 2). The results support these hypotheses and suggest that multiplexity created conflicting interests among leaders to recommend microfinance. The article concludes with implications for how multiplexity affects learning and information transmission within communities and organizations.

Keywords: Multiplexity; Information Transmission; Social Diffusion

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1 Introduction

Socially connected people are often assumed to be the best individuals to spread word-of-mouth information about new practices, technologies, and ideas. The diffusion literature (for reviews, see Wejnert, 2002; Strang and Soule, 1998) posits that highly connected individuals increase information flows at the stage of awareness and promote diffusion through social influence at the evaluation stage of adoption (Rogers, 1983; Coleman et al., 1957; Mahajan et al., 1984). The duality of being highly connected, however, often comes with a multiplicity of relationships and identities. This property, called multiplexity or relational pluralism (Verbrugge, 1979; Shipilov et al., 2014), affects a variety of processes within and among organizations, including communication (Lee and Monge, 2011; White et al., 1976; Baker, 1984; Uzzi and Gillespie, 2002), economic exchange (Granovetter, 1985; Uzzi, 1996; Kenis and Knoke, 2002), and coordination through alliances and board interlock (Mizruchi and Stearns, 1988; Galaskiewicz et al., 1986; Ahmadjian and Lincoln, 2001).

While having multiple kinds of ties and identities enables boundary-spanning and relational continuity (Rosenkopf et al., 2001; Rogan, 2014; Beckman et al., 2014) across various networks, it also creates conflicts of interest and allows strategic behavior (Ranganathan and Rosenkopf, 2014; Shipilov, 2012). Being connected across multiple ties, therefore, gives actors more pathways for coordination and communication to promote diffusion (Centola, 2015; Davis and Greve, 1997; Raffaelli and Glynn, 2014). However, having multiple relationships and identities could also encourage actors to be more strategic and selective in their communication and potentially impede diffusion (Padgett and Ansell, 1993; Abrahamson and Rosenkopf, 1997; Shipilov et al., 2014; Ranganathan and Rosenkopf, 2014).

This study, therefore, poses the following question: How does multiplexity affect diffusion through word-of-mouth communication? This question is essential for understanding information spread within and across communities and organizations for several reasons. First, the structures of social interaction in many collectivities involve multiple kinds of relations and identities among individuals, for example, work and friendship (Lincoln and Miller, 1979;

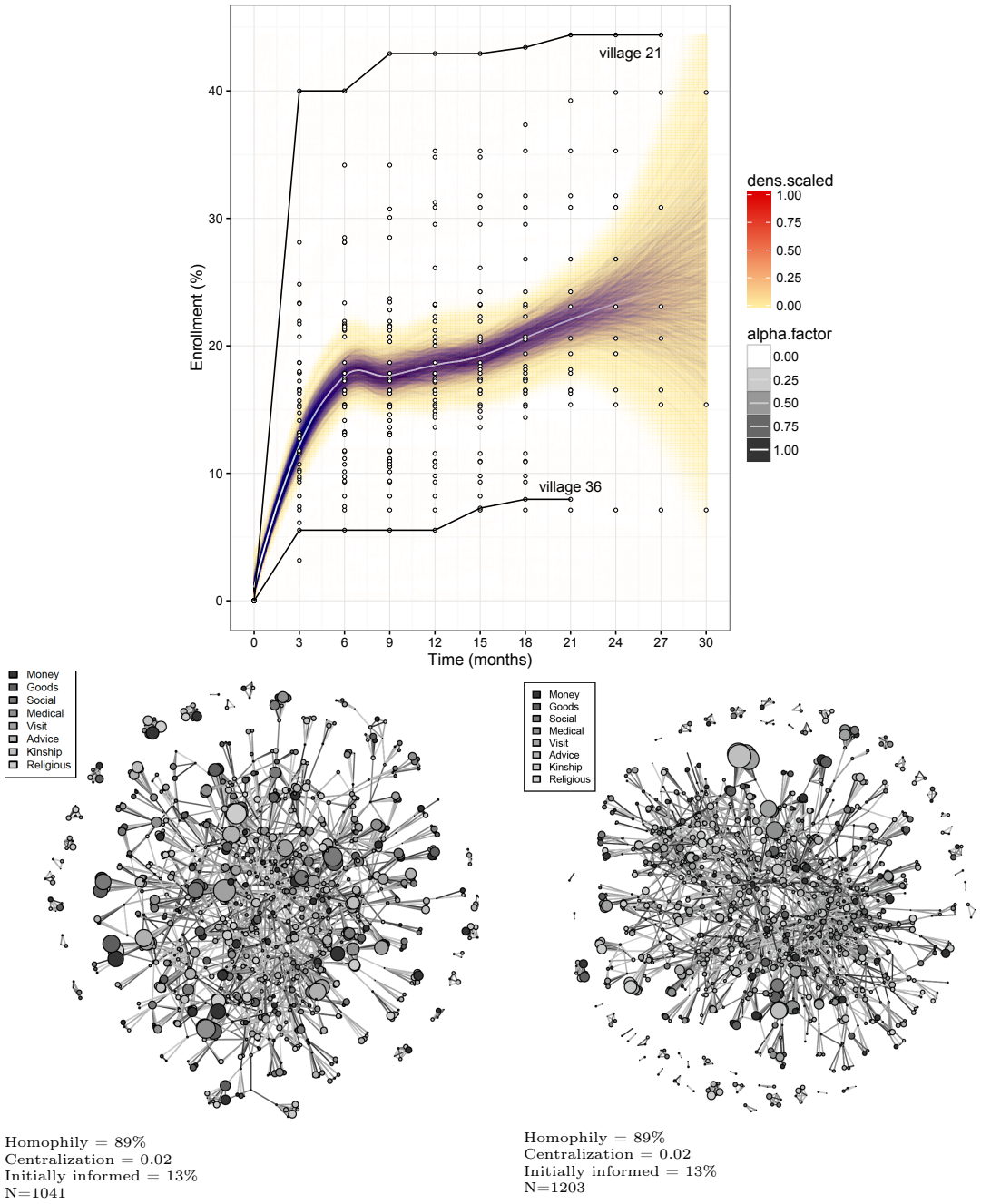
McPherson et al., 2001; Uzzi, 1996). Organizational theories of diffusion, therefore, need to account for multiplexity and how it affects word-of-mouth communication. Second, information sharing – unlike the spread of infectious diseases on contact – involves strategic behavior and cognitive information processing. This behavior entails managing conflicts of interests and multiple identities and engaging in selective information disclosure, such as skewing, biasing, and withholding information (Padgett and Ansell, 1993; Shipilov, 2012; Ranganathan and Rosenkopf, 2014). Thus, providing information through individuals embedded in dense and multiplex networks may not be sufficient to promote diffusion. Existing models assume that word-of-mouth information spreads like infectious diseases (Young, 2009; Mahajan and Peterson, 1978; Wejnert, 2002). But real human communication involves agency and cognition, which affect word-of-mouth information spread. Third, evaluating how multiplexity affects diffusion through the dissemination of word-of-mouth information is vital for understanding why potentially beneficial practices, knowledge, and technologies fail to diffuse.

This study aims to advance new theory and evidence about the consequences of multiplexity for social diffusion through word-of-mouth. It does so by connecting prior research on multiplexity and relational pluralism (e.g., Beckman et al., 2014; Rogan, 2014; Ranganathan and Rosenkopf, 2014) to theories of social diffusion (e.g., Mahajan et al., 1984; Davis and Greve, 1997; Davis, 1991; Chu and Davis, 2016). The study develops and tests two hypotheses. First, multiplexity increases individuals' opportunities for contact and enables social learning. As individuals become exposed to more contacts through a diverse set of ties, they become more likely to gain awareness and learn about new practices, ideas, or technologies. This mechanism increases the likelihood of social diffusion. Second, multiplexity enables strategic communication and more selective information disclosure by creating conflicts of interest. The presence of multiple ties and identities, therefore, negatively moderates the benefits of word-of-mouth information and undermines social diffusion. This theory explains limited social diffusion despite dense social connectivity in close-knit communities and organizations.

Methodologically, I draw on data from a field study in 49 remote villages in Karnataka, India, to evaluate these hypotheses. The study introduced information about the benefits of microfinance using experimentally seeded "leaders" in each village. A local non-governmental organization (NGO) tasked these leaders with raising awareness and promoting microfinance through word-of-mouth (Banerjee et al., 2013). The experiment aimed to encourage participation in microfinance among women. While nearly all women in these villages met the eligibility criteria to receive microfinance, only 20 percent signed up to receive loans, on average. Figure 1 shows the cumulative percent of participants who participated (enrolled) in microfinance across the villages over 30 months following the experiment. The two communities that were outliers with the highest participation (village 21) and the lowest (village 36) had similar network density and proportion of seeded leaders. The analyses evaluate the reasons for these divergent curves by looking at the role of multiplexity.

This study contributes to three different literature streams within management: research on relational pluralism, social diffusion, and economic empowerment through microfinance. First, this study contributes to the growing literature on relational pluralism (e.g., Beckman et al., 2014; Rogan, 2014; Ranganathan and Rosenkopf, 2014), by showing that multiplexity can both expand the number of social pathways through which individuals learn but limit information sharing and diffusion. Second, this study contributes to the diffusion literature (e.g., Mahajan et al., 1984; Davis and Greve, 1997; Davis, 1991; Chu and Davis, 2016) by placing scope conditions on the idea that having more network ties promotes broad and rapid diffusion (Wejnert, 2002). Therefore, the benefits of selecting socially connected individuals to promote diffusion depend on whether individuals communicate more selectively and have a higher capacity to skew, bias, and withhold information. Third, and finally, this study contributes to the literature on microfinance and economic empowerment (Cobb et al., 2016; Zhao and Wry, 2016; Canales, 2013). It does so by turning attention towards understanding when and why network ties impede microfinance participation. These findings demonstrate the downsides to social embeddedness and multiplexity for the uptake of microfinance.

Figure 1: Microfinance Enrollment in 49 Villages, 2007-2010



(a) Village 21

(b) Village 36

Note: Enrollment (scaled by data density) in microfinance across the 49 villages over 30 months (top) and social pathways for obtaining information in two of the villages (bottom). Homophily measured as proportion of all social interactions that occurred within in-groups (e.g. Caste, language, religion). Graph centralization captures the concentration of information flows.

2 Theoretical Background

2.1 What is Multiplexity?

Multiplexity is generally defined as "the overlap of roles, exchanges, or affiliations in a social relationship" (Verbrugge, 1979, 1286). Gluckman (1962) coined the term to refer to the superimposition of multiple sets of norms within the same relationship. Organizational scholars have since used the term multiplexity to refer to relational pluralism, or the state of having multiple types of relations and identities within a dyad (e.g., Shipilov, 2012; Gimeno and Woo, 1996; Rogan, 2014). Multiplexity arises through individuals' membership in multiple networks (White et al., 1976), such as when individuals interact in more than one group, organization, or field and thereby have more than one identities, for example as colleagues and friends (Shipilov et al., 2014; Tasselli et al., 2015; Kilduff and Tsai, 2012).

While interest in multiplexity has resurfaced recently, this construct traces its roots to classical studies of the web of group affiliations (Simmel, 1964, 1950), and interpersonal attachment (Durkheim, 1984). Further, the concept of multiplexity has also been studied in the form of micro-social interactions that involve separating multiple roles, relations and identities (Collins, 2004; Galaskiewicz et al., 1986; Goffman, 1959). Organizational scholars have also long studied multiple relational structures and their effects on organizational outcomes including communication (e.g., Lee and Monge, 2011; Baker, 1984; Uzzi and Gillespie, 2002), economic exchange (Granovetter, 1985; Uzzi, 1996; Kenis and Knoke, 2002), and organizational alliances and board interlocks (e.g., Mizruchi and Stearns, 1988; Lincoln and Miller, 1979; Ahmadjian and Lincoln, 2001).

Prior research has shown that multiplexity increases over the course of life as individuals engage in more interactions and activities with more contacts (White et al., 1976; Verbrugge, 1979; Krohn et al., 1988). For example, each new organization in which a person is a member presents new opportunities for contact and tie formation (McPherson et al., 2001; McPherson, 1983; Gulati and Gargiulo, 1999). Multiplex social ties emerge from a

combination of (i) opportunities for contact with others, (ii) preferences for interacting with others who share special similarities (e.g., common activities or interests), and (iii) desires for deep and meaningful relations that extend across multiple aspects of work, social, and family life (Wasserman and Faust, 1994, 1989; McPherson and Smith-Lovin, 1987). Over time, individuals who have more opportunities for interaction, more diverse sets of activities and interests, and greater desire to form deep and meaningful relations are more likely to develop multiplex ties.

Further, the level of multiplexity depends on the economic configuration and embeddedness of a community or organization (Gimeno and Woo, 1996; Ferriani et al., 2013; Padgett and Ansell, 1993). The stronger the division of labor, for instance, and the more compartmentalized the domain of work by departments, buildings, or functions, the more that individuals will interact within separate and non-overlapping spheres (Durkheim, 1984; Lincoln and Miller, 1979; Merton, 1957). In such instances, multiplex relationships enable network resilience and opportunities for brokers and bridge-builders that provide different resources within and across organizations (Kuwabara et al., 2010; Shipilov and Li, 2012; Rogan, 2014). Conversely, multiplexity can also create opportunities for strategic behavior and network change (Sytch and Tatarynowicz, 2014; Ranganathan and Rosenkopf, 2014; Rosenkopf and Tushman, 1998).

2.2 Multiplexity in Communities and Organizations

Multiplexity in communities and organizations entails both more – and different forms of –interaction (Lincoln and Miller, 1979; Collins, 2004; Shipilov et al., 2014). Individuals in their daily course of life, for example, interact with many different contacts – family members, co-workers, friends and social acquaintances. These different contacts provide different bases for identity formation, culture, sense-making, cognition, and attachment (Kilduff and Krackhardt, 2008; Kilduff and Tsai, 2012; Tasselli et al., 2015), for instance as members of the same family, organization, or community. They also provide different resources (Padgett

and Ansell, 1993; Gould, 1991; Smith and Papachristos, 2016), including information, tangible goods, emotional support, and social legitimacy. Thus, having more types of relations in a dyad creates more pathways through which individuals can obtain resources. This property of multiplex relations renders them more resilient in the face of change and disruption (Rogan, 2014; Simpson, 2015; Ferriani et al., 2013).

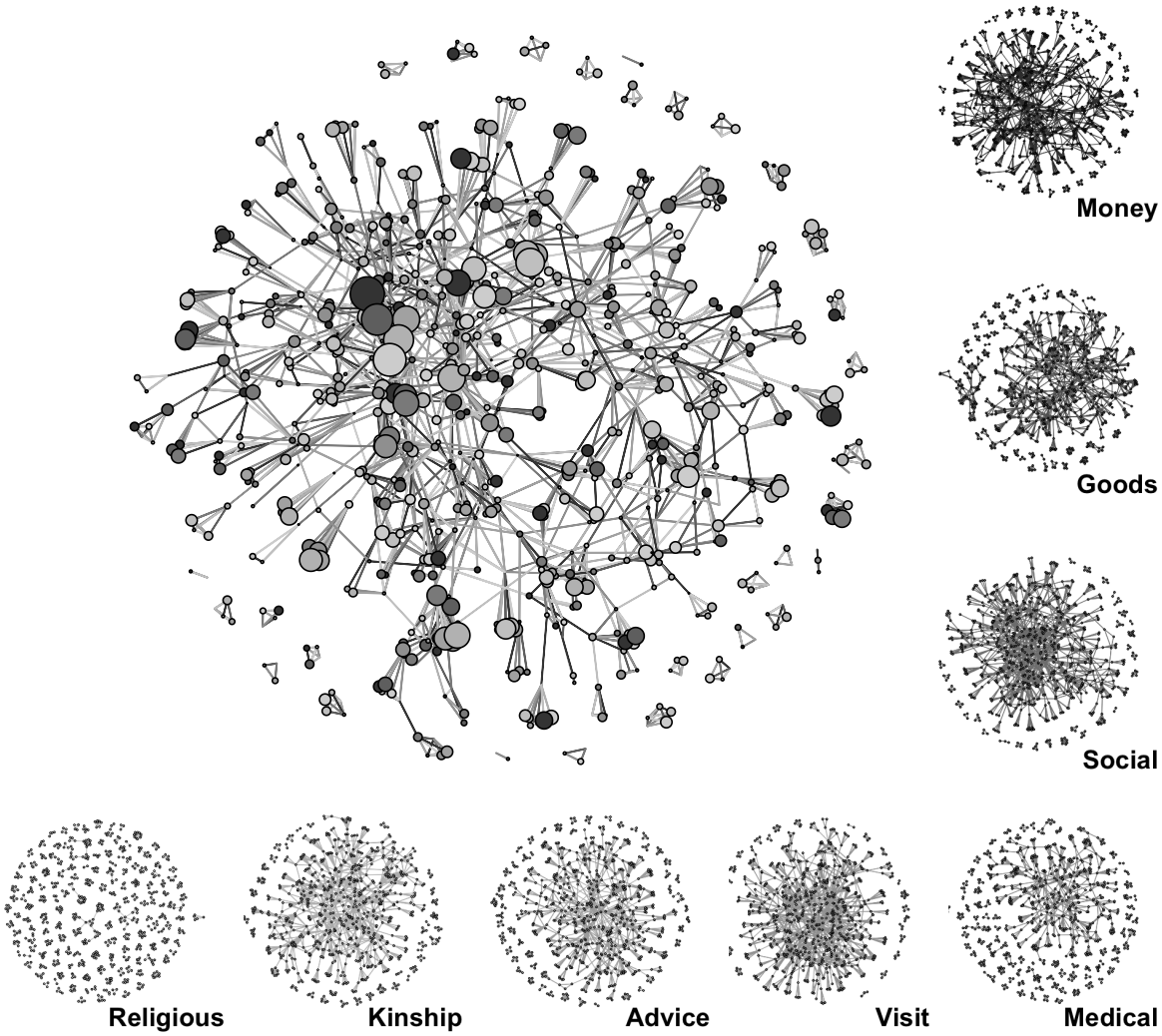
Further, the presence of multiple relations and identities that guide behavior requires individuals to segment their activities and behave differently at different places and times (Coser, 1975, 237). Individuals' actions and behaviors, therefore, become situational and conditional on their roles, relations, and identities (Goffman, 1961; Collins, 2004; Padgett and Ansell, 1993). This strategic adaptation of behavior enables individuals to advance their private interests and navigate relational complexity (Shipilov, 2012; Ranganathan and Rosenkopf, 2014; Rosenkopf et al., 2001). Figure 2, for example, illustrates multiplexity in a rural community in India. In this community, individuals shared multiple relations, roles, and identities (e.g., as advice-givers, friends, kin, goods traders, and money lenders). The most significant individuals in this community had many different relations spanning these networks.

3 Hypothesis Development

3.1 Multiplexity as a Catalyst for Diffusion

The network property of multiplexity has several implications for diffusion through network ties. First, multiplexity creates more opportunities for contact (Verbrugge, 1979; McPherson, 1983; Ferriani et al., 2013). Unlike ties in simplex networks, ties in multiplex networks involve multiple kinds of interactions across different domains (Collins, 2004; Lincoln and Miller, 1979; McPherson, 1983). These interactions facilitate tie formation in other networks and increase overall network density and cohesion (Kenis and Knoke, 2002; McPherson et al., 2001; White et al., 1976).

Figure 2: Multiplexity in an Indian Village



Note: Multiplexity in an Indian village (main) and its components (inset). Gray shading based on the type of interaction. Larger nodes denote higher multiplexity (role overlap). The Money exchange network denotes the structure of money lending. The Goods network denotes the structure of goods exchange (e.g., kerosene and rice). The Social network denotes the structure of social relationships (e.g., attending marriages and festivals). The Medical network denotes the structure of advice-giving and receiving about medical emergencies. The Visit network denotes the structure of home visits. The Advice network denotes the structure of general advice-giving and receiving. The Kinship network denotes the structure of kinship (relations by blood or marriage). The Religious network denotes the structure of praying together in the village.

The literature on relational pluralism (Shipilov et al., 2014; Brass et al., 2004) has noted that the presence of multiple kinds of relationships and identities among actors shape individual, group-level, and organizational outcomes. Multiplexity within and across organizations, for example, affects patterns of communication (Lee and Monge, 2011; Baker, 1984; Uzzi and Gillespie, 2002), economic exchange (Granovetter, 1985; Uzzi, 1996; Kenis and Knoke, 2002), and coordination among organizations through alliances and board interlocks (Mizruchi and Stearns, 1988; Gulati and Gargiulo, 1999; Galaskiewicz et al., 1986). The dynamics of communication in one network influence communication in other networks at both dyadic, triadic, and macro-structural levels (Lee and Monge, 2011; Baker, 1984; Uzzi and Gillespie, 2002). Further, multiplexity facilitates inter-organizational collaboration and learning through board interlock, strategic alliances, and joint ventures (Kenis and Knoke, 2002; Ahmadjian and Lincoln, 2001; Beckman et al., 2014). It also enables embedded exchange that ensures survival and continuity of buyer-supplier ties, especially during periods of organizational change and economic uncertainty (Granovetter, 1985; Uzzi, 1996; Rogan, 2014). The findings from this literature suggest that multiplex network ties, including through interlocking directorates, serve as critical conduits for learning within and between organizations and for the diffusion of new ideas, practices, and technologies (Davis and Greve, 1997; Abrahamson and Rosenkopf, 1997; Raffaelli and Glynn, 2014).

Second, higher contact, density, and cohesion through multiplex ties facilitate learning and diffusion (Wang and Soule, 2012; Beckman et al., 2014; Uzzi and Lancaster, 2003). Relationships that enable interaction across multiple domains, such as multiplex ties, are generally associated with a higher frequency of communication and more relational resources, including trust, rapport, and support (Tasselli et al., 2015; Kilduff and Tsai, 2012; Kilduff and Krackhardt, 2008). Individuals connected through multiplex ties are more likely to interact frequently and to share these relational resources (Lincoln and Miller, 1979; Sparrowe and Liden, 2005; Tasselli et al., 2015). These relational resources enable individuals to observe each other, coordinate and create shared understandings of the situation (Kilduff

and Krackhardt, 2008; Ahmadjian and Lincoln, 2001; Beckman and Haunschild, 2002). The combination of higher contact and more relational resources enables learning through multiplex ties (Simpson, 2015; Lee and Monge, 2011; Beckman and Haunschild, 2002). Learning involves interacting, communicating, and taking stock of the varied experiences of others (Pentland, 2004; Logan and Pepper, 2007; Uzzi and Lancaster, 2003). This learning facilitates the diffusion of new ideas, knowledge, and technologies (Singh, 2005; Centola, 2015).

Further, learning enables individuals to form expectations about others' behaviors, which facilitate information processing and communication to build shared understandings of the situation. These expectations create cognitive boundaries between trusted insiders and distrusted outsiders that facilitate interpretation of the facts, sense-making, and social inference (Tasselli et al., 2015; Kilduff and Krackhardt, 2008; Merton, 1972). Information from contacts connected through multiplex ties, therefore, becomes more credible and trustworthy, and thus more potent at affecting interpretation, sense-making, and social inference (Vedres and Stark, 2010; Dodson and Muller, 1978; Chu and Davis, 2016). These factors together imply that individuals with multiplex ties will have more opportunities to engage in social learning and cognitive information processing from the heterogeneity of experiences across their contacts. Increased learning will, therefore, act as a powerful catalyst for diffusion through multiplex network ties. These arguments lead to the following hypothesis:

Hypothesis 1. *Multiplex ties will promote diffusion through social learning.*

3.2 Multiplexity as a Deterrent to Diffusion

At the same time, multiplexity also has a dark side. Beginning with Simmel'sSimmel's study of conflict and the web of group affiliations (Simmel, 1964, 1950), and Durkheim's investigation of the basis for interpersonal attachment (Durkheim, 1984), scholars of networks and social interaction have noted the potential for multiplexity to facilitate strategic behavior. Heterogeneity in individuals' relations and identities enables autonomy and agency to deploy different social personas and communications (Collins, 2004; Goffman, 1961, 1959; Padgett

and Ansell, 1993). Having more – and more diverse – relations and identities also creates conflicting demands and interests for individuals and limits information disclosure (Loewenstein et al., 2012, 2011; Hayward and Boeker, 1998). This conflict arises from the need to balance multiple interests across identities and relations. For example, an individual who is a dual citizen of two countries faces a difficult choice of which country to side with if both countries go to war with each other. Even in daily life, individuals often have to choose how to balance their work and family responsibilities along with many different organizational and civic roles they occupy (e.g., Hecht, 2001; Coverman, 1989).

Multiplexity, therefore, necessitates that individuals set priorities about which relations and identities to prioritize and how to communicate and interact across multiple sets of contacts (McPherson et al., 2001; Marks, 1977; Burt, 2012). While multiple personas and relationships can lend greater individual autonomy (Burt, 1980; Coser, 1975; Merton, 1957), they can also require individuals to be selective and strategic about when and how they convey information about their interests and identity to others (Padgett and Ansell, 1993; Zuckerman et al., 2003; Fernandez and Gould, 1994). For instance, a conflict of interest can arise when an individual's interests interfere with judgments on another's behalf, (Davis, 2012; Moore and Loewenstein, 2004). Conflicts of identities and loyalties can also occur when individuals have multiple identity claims, such as being a boundary-spanner or an insider into various groups (Fernandez and Gould, 1994; Padgett and Ansell, 1993; Vedres and Stark, 2010). These conflicts involve situations in which individuals face incompatible demands because of their identities and relations with two or more individuals, groups, or organizations, creating tensions about which needs and interests to prioritize (Stouffer and Toby, 1951; Rizzo et al., 1970; Fernandez and Gould, 1994).

When relationships and identities create conflicts of interest and involve conflicting interests, they develop motives for selective disclosure and more limited information sharing (Loewenstein et al., 2012; Hayward and Boeker, 1998). Individuals with conflicts of interest, for instance, can fail to share information that is not in their interests to disclose (Loewen-

stein et al., 2011; Cain et al., 2005). Further, having different types of relations increases individuals'individuals' agency to deploy multivocality, a style of communication in which an actor conveys different messages to different audiences (Padgett and Ansell, 1993). Actors in multiplex positions can also communicate strategically, withholding, biasing, or manipulating information to fit their interests (Hayward and Boeker, 1998; Cain et al., 2005). For example, undisclosed ties between physicians and pharmaceutical companies can prevent physicians from putting patients'patients' interests first (Loewenstein et al., 2012). Disclosing these conflicts, however, could worsen the problem of information bias by freeing agents to behave more opportunistically (Moore et al., 2010; Loewenstein et al., 2012).

Most theories of diffusion, however, have assumed that information conveyed through social ties is uniform and unbiased. If news indeed spreads on contact like infectious diseases, rather than involving selective disclosure and cognitive processing, then the standard predictions of our existing models are correct. Having more social ties – such as through multiplexity – should facilitate the spread of word-of-mouth information and diffusion. Evidence suggests, however, that individuals do not share the same information with everyone; they share information selectively and opportunistically. Studies of criminal and political networks, for example, have shown that multiplexity enables strategic and opportunistic communication. Padgett and Ansell (1993) demonstrated that Cosimo de' Medici's ties in the marriage, banking, and patronage networks of Florence enabled him to wield significant influence over international trade and state affairs. Smith and Papachristos (2016) showed that Al Capone's involvement in multiplex networks with bootleggers and criminals in Prohibition-Era Chicago enabled him to conduct underground activities for decades, despite police crackdowns.

Therefore, unlike infectious diseases, communication and information do not appear to spread on contact. Rather, information sharing among individuals involves strategic behavior, driven in part by conflicts of interest. These studies suggest that multiplexity enables secrecy and selective information sharing that confers advantages for individuals with mul-

tiple relations and identities. Thus, multiplexity could deter individuals from spreading truthful and unbiased information, even when this information is potentially beneficial for their contacts. More limited, and potentially more biased, information disclosure will undermine awareness and lead to more limited diffusion. Based on these arguments, individuals with multiple relations and identities, and those who have private interests not to spread information, will be less likely to share information broadly and objectively, and will thereby limit diffusion. These arguments imply the following moderating hypothesis about how multiplexity affects diffusion through the spread of word-of-mouth information:

Hypothesis 2. *Multiplex ties will negatively moderate the benefits of word-of-mouth information for diffusion.*

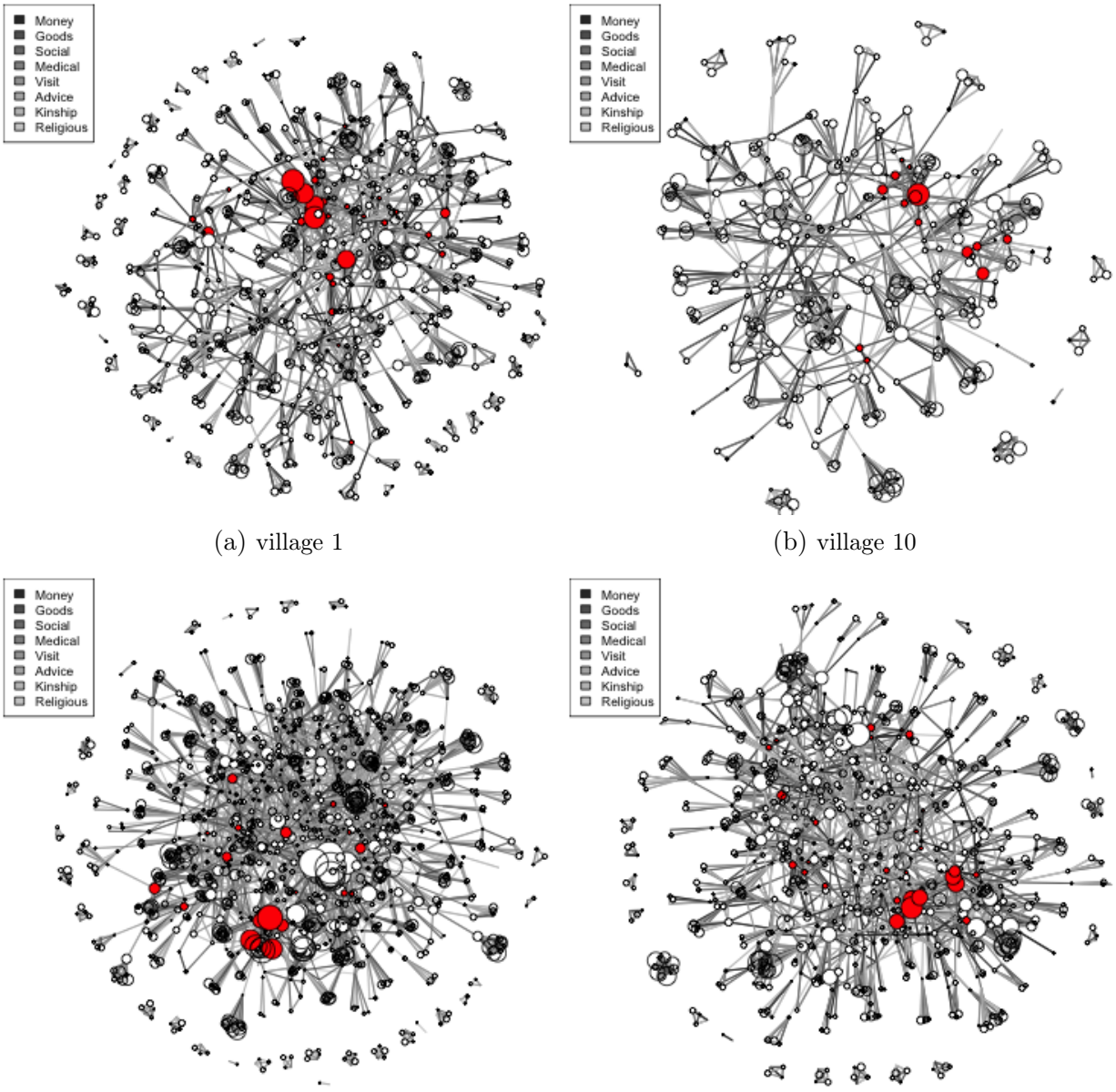
4 Methodology

4.1 Setting and Intervention

The setting for this study is rural India. In June 2006, an independent non-profit non-governmental (NGO) microfinance organization identified 49 villages in Karnataka, India to conduct an informational intervention about the benefits of microfinance. The objective of this intervention was to raise awareness about the benefits of microfinance by experimentally seeding a small group of individuals in each community ("leaders") with private information and tasking them to spread this information to their contacts by word-of-mouth. Fig. 3 illustrates the structural positions of leaders in these communities.

The informational intervention in each village was a private meeting between the NGO's credit officers and these leaders. At this meeting, the NGO's staff explained how microfinance worked, described its benefits, and asked leaders to tell their contacts who were eligible to participate. In February 2007, the NGO introduced microfinance in the villages and began to collect participation data within each community until September 2010.

Figure 3: Leaders' Network Positions in Select Villages



(a) village 1

(b) village 10

(c) village 25

(d) village 43

Note: Node size increasing with multiplexity. Informants shown in black.

4.1.1 Microfinance Participation

The aim of the intervention was to conduct large-scale poverty alleviation by promoting microfinance participation among poor women in these communities as part of a broader anti-poverty agenda. The microfinance model that the NGO introduced in each village was a joint-liability group-based lending model. This model is similar to group lending methods used widely among other microfinance organizations around the world (Armendariz and Morduch, 2005). This method allows eligible individuals (more on this below) to participate in microfinance (by joining a lending group) when it becomes available. Eligible participants had to be women aged between 18 and 57, able to work, qualified for food subsidies, permanent residents of their village, and allowed to participate by their husbands or male relatives. Only one woman from each household could join a lending group and receive loans.

Microfinance clients could borrow loans from the NGO by joining a lending group. The NGO placed clients in lending groups of five borrowers, who became jointly liable for repaying loans. The loans were uncollateralized and without any form of security deposit. To be placed into a lending group, clients had to confirm that they knew each other and were willing to take responsibility for the loans of the other members in their group. Lending group members were not allowed to be blood relatives or kin and were also barred from being members of more than one group to prevent exploitation of the joint-liability model.

Compared to other sources of money, the NGO provided loans at lower interest rates and larger principal. The maximal loan amount that each client was eligible to receive initially was 10,000 rupees (about $200). This loan was repayable over 50 weeks in small weekly installments, with an interest rate of about 28 percent per year. By comparison, money lenders offered loans that carried interest rates ranging from 40 to 200 percent per year (Banerjee and Duflo, 2011, 160). For purely economic reasons, microfinance offered better financial terms for borrowing money, especially among impoverished individuals who qualified to receive loans.

4.2 Data Collection

Data collection proceeded in two stages. The first stage involved conducting a complete census of all households in each village. The census collected demographic information about individuals in each household, the locations of their homes, and data about the types of amenities to which they had access (e.g., latrine, electricity). The second stage involved detailed individual demographic and sociometric surveys administered to a random sample of individuals in each village, stratified by religion and geographic location. More than half of all individuals that were eligible to receive microfinance completed this questionnaire. Respondents had to name individuals in their community with whom they interacted in different domains, including money exchange (borrowing and lending), goods exchange such as kerosene and rice, home visits, advice exchange, kinship relations (by blood and marriage), help with medical emergencies, attendance of weddings and festivals, and praying together.

The sociometric data from these surveys enabled the construction of the social interaction networks in each village. These networks formed the various social pathways by which individuals could have obtained word-of-mouth information about microfinance. These data were matched to demographic and enrollment data to gain a complete picture of how the experimentally seeded leaders affected microfinance participation. The final dataset used in the analyses contains dyadic observations for 22,788 eligible individuals and their contacts, including experimentally seeded leaders, from 49 different communities.

4.3 Measures

4.3.1 Dependent Variable

MF Participation: The main outcome of interest in this study is whether an eligible individual participated in microfinance (MF) during the observation period, between 2007 and 2010. I examine how the probability of this outcome varied with individuals' exposure to experimentally seeded leaders (treatment) and with the multiplexity in leaders' ties to

eligible individuals.

4.3.2 Independent Variables

Leader: The variable "leader" codes for whether the direct contact of an eligible individual was an experimentally seeded leader. The treatment in this study was word-of-mouth in the networks of each village through these leaders.

Multiplexity: Multiplexity refers to the number of different relations between two individuals in a dyad. For example, if two individuals shared only a kinship tie, this variable would take on a value of one. If they shared a kinship and a social tie, their multiplexity would be two, and so on.

4.3.3 Control Variables

The control variables included respondents' and their contacts' gender, age, self-help group participation status, caste group, economic status (above-poverty-line, APL), mother tongue, religion, education level, access to electricity and a latrine, household ownership status, and house size (number of rooms). The analyses also controlled for the types of relations that individuals shared with their contacts, including kinship, religious, social, come visit, go visit, medical help, get goods, give goods, get advice, give advice, borrow money and lend money.

4.4 Models

4.4.1 Baseline Models

Hierarchical Logistic Models. The first set of analyses use hierarchical logistic models (HLMs) (Wong and Mason, 1985) to investigate relationship between microfinance participation and the treatment effect of the informational intervention. HLMs account for the nested structure of the data, with individual outcomes depending on both personal contacts

and village-specific factors. The treatment effect in these models is being exposed to an experimentally seeded leader tasked with spreading information. Word-of-mouth information within the experiment could have only originated with these leaders and spread through their direct social contacts in the villages. The functional form of these models is:

$$Pr(y_{ijk,m} = 1|x_{ijk,m}) = H(\underbrace{\beta_0 Leader_{jk,m}}_{\text{TREATED}} + \sum_{p=1}^{P} \beta_p x_{ijk,m} + u_k + \varepsilon_{ijk,m})$$

where $Pr(y_{ijk,m} = 1|x_{ijk,m})$ is the conditional probability of individual i connected to individual j in village k participating in microfinance as a function of model covariates. The variable $Leader_{jk,m}$ is an indicator for whether contact j of individual i was an experimentally seeded leader tasked with spreading information about microfinance. In the model, $k = 1, ..., N$ is a set of villages with village-level random effects u_k. The village-level random effects are realizations from a multivariate normal distribution with mean 0 and variance $var(u_k) = \sigma^2$. Each village contains $i = 1, \ldots, N_k$ individuals and $j = 1, \ldots, M_k$ contacts of these individuals in the village. The row vector $x_{ijk,m}$ contains the covariates for each individual i, including personal characteristics, contact characteristics, and household characteristics. The term ε_{ijk} denotes the residual error, and the β's are the estimated regression coefficients. The logistic cumulative distribution function $H(x) = \exp(x)/\{1+\exp(x)\}$ maps the covariates to the probability of observing a positive outcome. I estimated these models using the `melogit` routine in Stata 15 SE.

Linear Social Interaction Models. The second set of analyses use linear social interaction models (LSIM) to explore the role of social interaction on observed outcomes. LSIM models are a method for identifying the effects of exposure to social contacts on individual outcomes (Bramoullé et al., 2009; Blume et al., 2015; Fafchamps, 2015). The functional form

of these models is:

$$y_{ijk,m} = \alpha + \underbrace{\beta \left[g_{ijk,m} / \sum_j g_{ijk,m} \right] Leader_{jk,m}}_{\text{TREATED}} + \mathbf{Z}'\phi + \mathbf{V}' + \varepsilon_{ijk,m}$$

where $y_{ijk,m}$ is an indicator if a person i connected to person j in network m of village k enrolled in microfinance during the observation period. The variable $Leader_{jk,m}$ is an indicator for whether contact j of individual i was an experimentally seeded leader tasked with spreading information about microfinance. The variable $g_{ijk,m}$ is an indicator that takes on a value of one if this individual had a tie with another individual in the same village ($g_{ijk,m} = 1$). These ties form an adjacency matrix $G_{k,m}$ comprising all dyadic interactions in each village k for each type of network m in the village ($g_{ijk,m} \in G_{k,m}$). The term $\left[g_{ijk,m} / \sum_j g_{ijk,m} \right]$ represents the weight of individual j on individual i's behavior in network m of village k. In this model, β is the effect of information from experimentally-seeded leaders in the village. The models include a vector of individual controls, $\mathbf{Z}$, and village intercepts, $\mathbf{V}$.

4.4.2 Models with Multiplexity

Hierarchical Logistic Models. The hierarchical logistic models that account for multiplexity follow a similar form to the baseline models, but include coefficients for the main and moderating effects of multiplexity. The functional form of these models is:

$$\begin{aligned} Pr(y_{ijk,m} = 1 | x_{ijk,m}) = H(& \underbrace{\beta_1 Leader_{jk,m}}_{\text{TREATED}} + \underbrace{\beta_2 M_{ijk}}_{\text{MULTIPLEXITY}} + \underbrace{\beta_3 M_{ijk} \times Leader_{jk,m}}_{\text{TREATED x MULTIPLEXITY}} \\ & + \sum_{p=1}^{P} \beta_p x_{ijk,m} + u_k + \varepsilon_{ijk,m}) \end{aligned}$$

where $Pr(y_{ijk,m} = 1 | x_{ijk,m})$ is the conditional probability of individual i connected to individual j in village k participating in microfinance ($y_{ijk,m} = 1$). The term M_{ijk} de-

notes the number of ties in the dyad between individuals i and j in village k, and the β's are the estimated regression coefficients. The logistic cumulative distribution function $H(x) = \exp(x)/\{1 + \exp(x)\}$ maps the covariates to the probability of MF participation. These models were again estimated using the `melogit` routine in Stata 15 SE.

Linear Social Interaction Models. Further, the baseline LSIM models can be expanded to account for multiplexity by adding a variable that measures the number of relations in a dyad across different types of networks in the villages. This modification enables analysis of how multiplexity affected microfinance participation through social contacts, both leaders and non-leaders. The functional form of the LSIM models with multiplexity is:

$$
\begin{aligned}
y_{ijk,m} = \alpha + \underbrace{\beta_1 \left[g_{ijk,m} / \sum_j g_{ijk,m} \right] Leader_{jk,m}}_{\text{TREATED}} + \underbrace{\beta_2 \left[\sum_m g_{ijk,m} \right]}_{\text{MULTIPLEXITY}} \\
+ \underbrace{\beta_3 \left[\sum_m g_{ijk,m} \right] \times \left[g_{ijk,m} / \sum_j g_{ijk,m} \right] Leader_{jk,m}}_{\text{TREATED x MULTIPLEXITY}} \\
+ \mathbf{Z}'\phi + \mathbf{V}' + \varepsilon_{ijk,m}
\end{aligned}
$$

The model above is similar to the baseline LSIM models, but include a variable measuring the multiplexity between individuals i and j. The coefficient β_1 captures the main effect of exposure to seeded leaders (treated). The coefficient β_2 captures the main effect of multiplexity, and the coefficient β_3 captures the interaction effect.

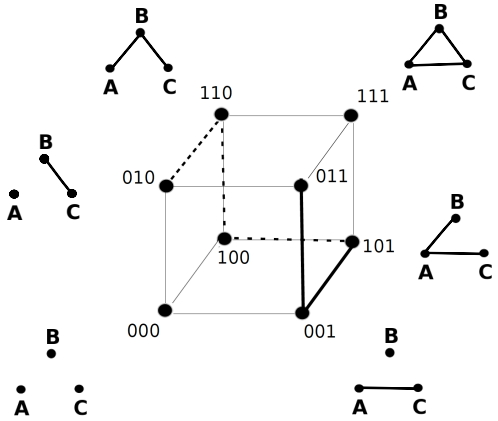
4.5 Construct Validity

To assess the validity of the multiplexity construct, I examined the extent of structural overlap between different relational structures in each community (e.g., kinship, home visits). The idea was to see how much relational pluralism there was overall within these communities and to what extend these different relations represented distinct spheres that involved

multiple identities and interests.

Relational pluralism in the villages was measured using a standard method for multivariate network analysis called the Hamming distance (Butts and Carley, 2001; Hamming, 1950). This distance captures the extent of structural difference between the adjacency matrices of different sets of interactions among agents in Euclidean space, as shown in Figure 4.

Figure 4: Graphical Representation of the Hamming Distance



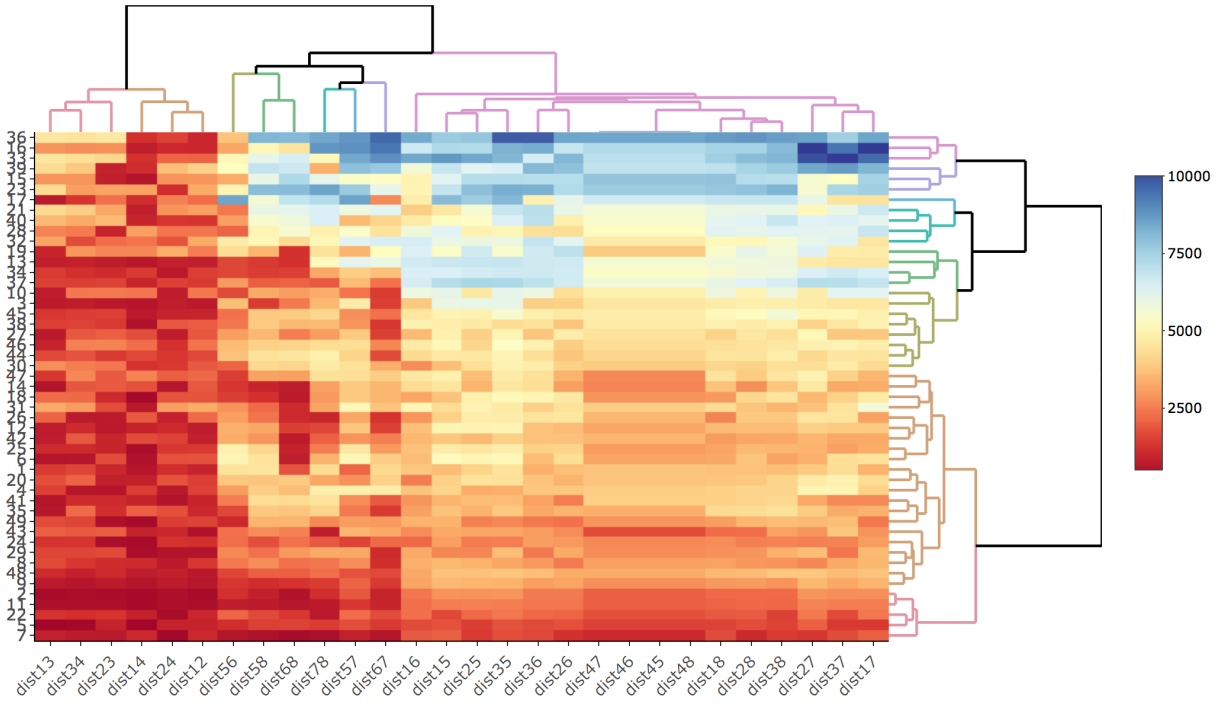
To understand intuitively how this measure works, consider the path 010→101, for example. The Hamming distance measures the minimal number of coordinate changes in Euclidean space needed to transform the binary string 010 into the binary string 101. In this example, the distance between the network connecting actors B and C, and the network connecting A and B and B and C, is three. More generally, the Hamming distance between the elements of two graphs g_1 and g_2 with adjacency matrices $\mathbf{A^{(1)}}$ and $\mathbf{A^{(2)}}$ is:

$$d_H(g_1, g_2) = \sum_{i \neq j}^{N} \left[A_{ij}^{(1)} \neq A_{ij}^{(2)} \right]$$

To illustrate how this measure works, suppose that A,B, and C are three individuals: Apurva, Bharat, and Chanda. Apurva shares different relations with Bharat and Chanda – exchanging money, visiting each other at home, and sharing advice. Suppose that Apurva borrows money only from Chanda, but visits both Bharat and Chanda at home. Then, Apurva's interactions with Bharat and Chanda can be represented as two binary strings

010 (money) and 101 (visits). The structural distances between these networks can then be computed as the number of coordinate changes in Euclidean space, or equivalently the path length from 010 to 101 in Euclidean space, in this case, three. The lower the Hamming distance between two networks, the greater the relational pluralism between them. That is, in highly overlapping networks, individuals have more inter-dependent roles and relations.

Figure 5: Relational Pluralism in the Villages



Note: Red shading denotes lower structural (Hamming) distance, i.e., greater multiplexity. Y-axis: village ID number; X-axis: pairwise distances of networks. Legend: 1= BORROW/LEND MONEY; 2= GIVE/GET GOODS; 3=COME/GO VISIT; 4=GIVE/SEEK ADVICE; 5=KINSHIP; 6=MEDICAL; 7=SOCIAL; 8=RELIGIOUS. For example, dist13= distance between BORROW/LEND MONEY and COME/GO VISIT.

Figure 5 plots a heatmap of these Hamming distances, with warmer colors (reds, yellows) showing pairs of networks that were more structurally similar, while cool colors (blues) show structurally different pairs. The x-axis shows the pairwise distances between networks of different types in each village, while the y-axis plots the village ID number. Hierarchical analysis of the Hamming distances between the networks of each village supports the presence of relational pluralism. These analyses reveal two main clusters of networks. The first, on

the left-hand side, comprises money borrowing and lending ties, goods exchange, visits, and advice. The second cluster comprises other network types, including kinship, medical help, and religious worship. Table A1 in the Appendix shows the correlations between these different types of ties, and Table A4 shows the average Hamming distances across villages. These figures and tables support the presence of relational pluralism within the villages and show that the extent of pluralism varied across villages. These patterns suggest that multiplexity was a vital feature of these communities. The networks of most of these villages were characterized by a high level of multiplexity in individuals' relations and identities. This structural feature could have influenced information transmission by word-of-mouth.

5 Results

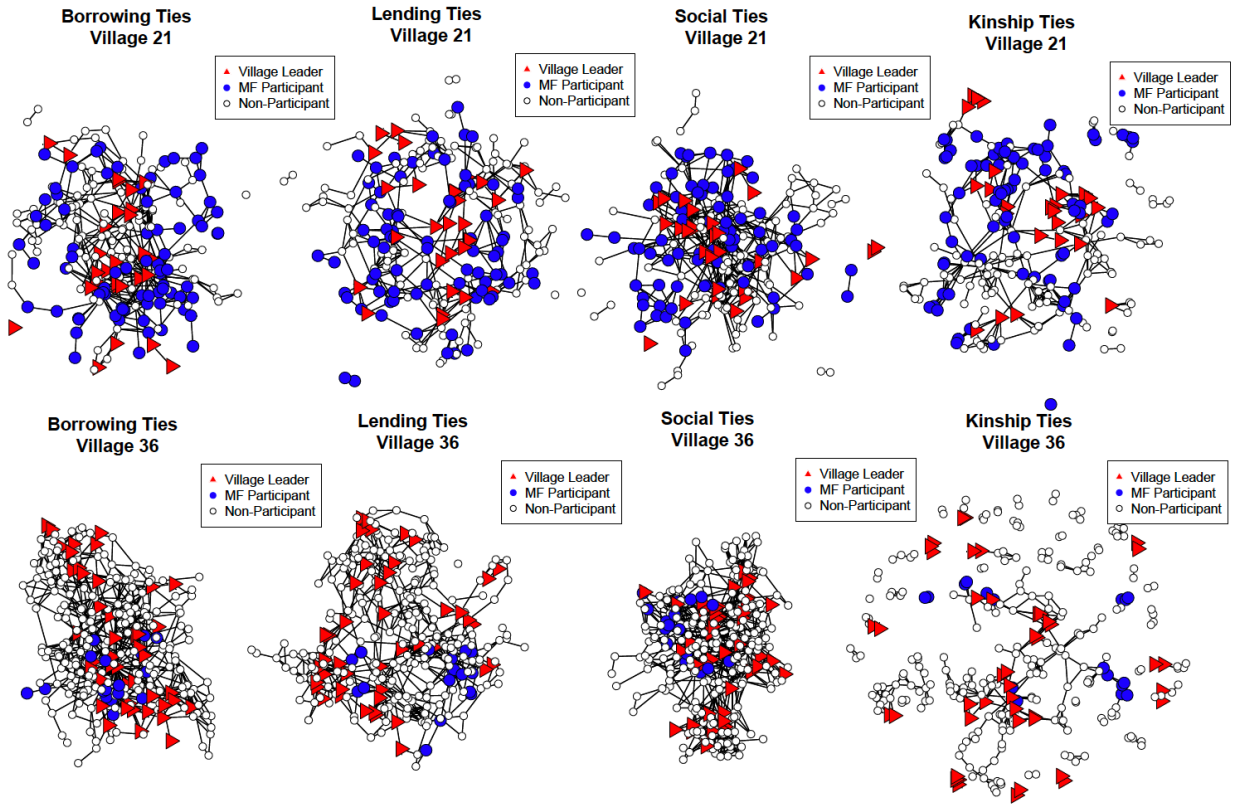
5.1 Descriptive Statistics

Table A1 in the Appendix provides the descriptive statistics and correlations matrix for microfinance-eligible individuals in the risk set of potential participants. Among these eligible individuals, about 19 percent on average participated in microfinance. These individuals were 40 years old on average at the time of the intervention. The majority had no education at the primary school level or beyond. Eligible participants lived in communities with about 238 households and about 1,118 residents on average. The average household size in these villages was about five people. The villages were relatively religiously homogeneous (mostly Hindu) but had substantial linguistic and caste heterogeneity.

The majority of eligible villagers (58 percent) came from Other Backward Class (OBC) castes, a designation used by the Indian government to denote the most socially and educationally disadvantaged groups. Other disadvantaged groups include scheduled castes (26 percent), and scheduled tribes (4.8 percent), which qualify for affirmative action and reservation benefits in India. The majority of these individuals (87.7 percent) received food rations from the government as part of famine relief programs.

Most of the interactions that existed in the villages were highly multiplex. For example, 71 percent of all religious interactions involved kinship ties in the village, as did 60 percent of all advice giving and receiving, and 50 percent of all money borrowing and lending. Further, 73 percent of all the medical help ties coincided with religious ties, and 70 percent coincided with the giving and receiving of advice and money. These high proportions of relational pluralism, whereby individuals played multiple social and economic roles as lenders, co-worshipers, and advice givers, and shared multiple ties with others in their village, show the importance of social cohesion and trust in these close-knit communities.

Figure 6: Network Positions of Experimentally Seeded Village Leaders



Note: The graphs show the network positions of experimentally seeded village leaders (red triangles), and MF participants (blue circles) in two sample villages.

Figure 6 shows the network positions of experimentally seeded leaders (red triangles) and microfinance participants (blue circles) in two of the villages in the sample. These villages are the two outliers in terms of cumulative microfinance participation. By the end of the experiment, village 21 had cumulative participation at just over 40 percent. Over the same

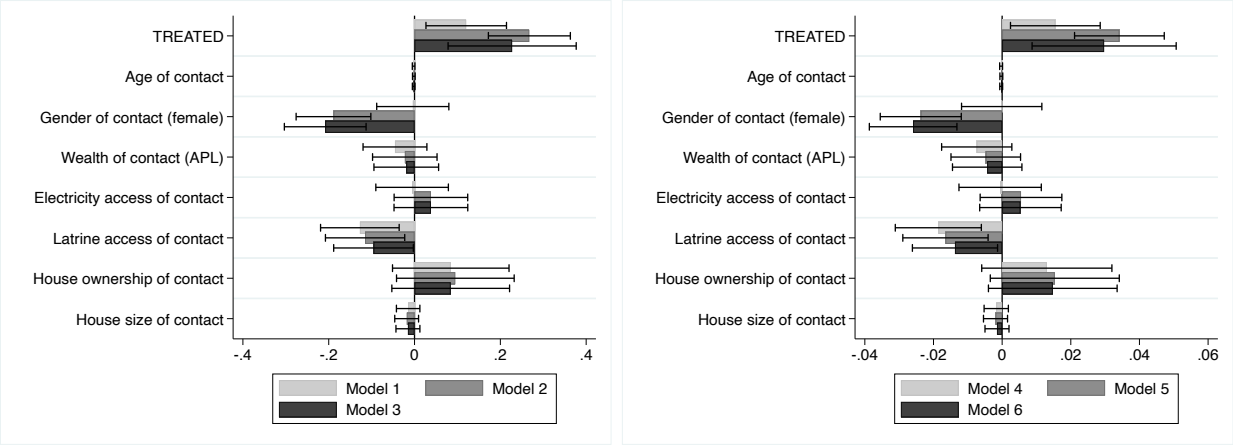
period, village 36 had the lowest participation at just under 10 percent. As these network plots show, even though the social and economic networks of village 36 were much denser and more interconnected than those of village 21, fewer individuals in village 36 participated than in village 21. These results appear to counter conventional wisdom, which would say that information should spread more broadly in dense communities.

5.2 Treatment Effects of Seeded Leaders

Figure 7 shows the main effects of the intervention. It plots the coefficient point estimates and their 95 percent confidence intervals for individuals who were TREATED (i.e., directly exposed to experimentally seeded leaders in their networks). Panel (a) shows the results from the HLM models, while Panel (b) shows the results from the LSIM models. The x-axis represents the magnitude of the estimated effect. The grayscale is darker for more saturated models with additional controls. As this figure shows, the main effect of the treatment was positive. Individuals who were exposed to experimentally seeded leaders were subsequently more likely to participate in microfinance. The magnitude of the effect of treatment ranges between an increase of 2-3.4 percent (LSIM Models 4-6) and an increase of 11-21 percent (HLM, Models 1-3) in the probability of microfinance participation among eligible individuals.

The results also show that contact characteristics also affected participation outcomes. Specifically, older contacts were less effective at encouraging eligible individuals to participate, as were women. Other characteristics, such as contacts' wealth, and household characteristics do not appear to have affected the probability of participating in microfinance. All models also control for individuals' personal and household characteristics, which had similar effects on outcomes as those for direct contacts and are omitted for brevity and clarity of presentation.

Figure 7: Treatment Effect of Leaders on Microfinance Participation



(a) Hierarchical Logistic Models (HLM) (b) Linear Social Interaction Models (LSIM)

Note: Coefficient estimates with 95% confidence intervals (lines). Darker shading denotes estimates from more saturated models inclusive of social influence and endorsement effects. Figures based on estimates reported in Table A2 (HLM) and Table A3 (LSIM).

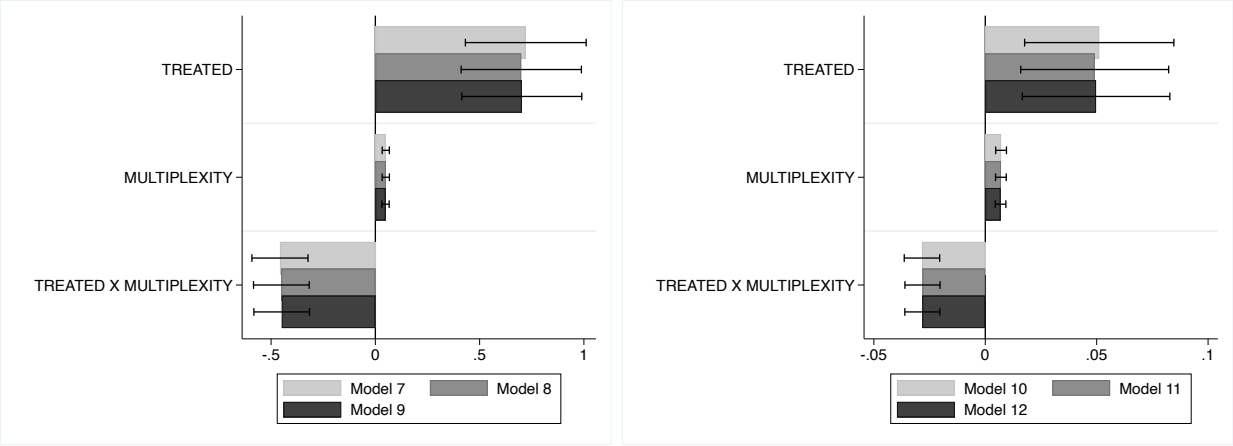
5.3 Main and Moderating Effects of Multiplexity

Figure 8 plots the main and the moderating effects of multiplexity on microfinance participation. Panel (a) shows the results from the HLM models, while Panel (b) shows the results from the LSIM models. The x-axis represents the magnitude of the estimated effect. The grayscale is darker for more saturated models with additional controls. These results reveal several patterns. First, they confirm the positive main effects of exposure to experimentally seeded leaders (treatment). These effects range between an increase of 5 percent (LSIM, Models 10-12) and an increase of 42 percent (HLM, Models 7-9) in the probability of participating in microfinance among eligible individuals.

These models also show that the main effect of multiplexity was positive. That is, eligible individuals who had more relations within dyads with their contacts were more likely to participate in microfinance. This effect ranged between an increase of 1 percent (LSIM, Models 10-12) and 4.8 percent (HLM, Models 7-9). This result supports Hypothesis 1.

The moderating effect of multiplexity, however, was negative. That is, eligible individuals who had more relations within dyads with contacts who were experimentally seeded leaders

Figure 8: Moderating Effect of Multiplexity on Microfinance Participation



(a) Hierarchical Logistic Models (HLM) (b) Linear Social Interaction Models (LSIM)

Note: Coefficient estimates with 95% confidence intervals (lines). Darker shading denotes estimates from more saturated models inclusive of social influence and endorsement effects. Figures based on estimates reported in Table A4 (HLM) and Table A5 (LSIM).

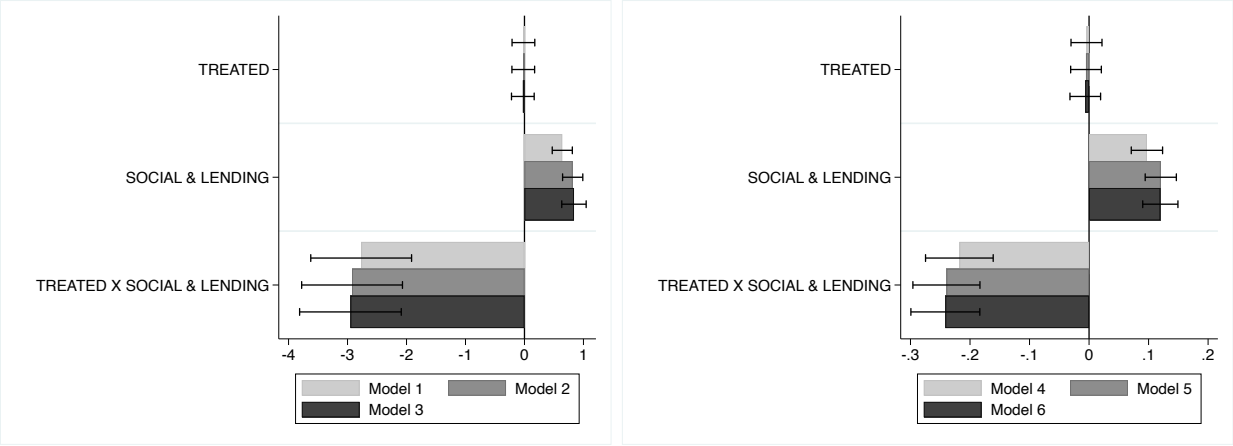
were less likely to participate in microfinance. This effect ranged between a decrease of 3 percent (LSIM, Models 10-12) and 84 percent (HLM, Models 7-9). This result supports Hypothesis 2.

5.4 Robustness Checks

Figure 9 plots the results from robustness checks looking at the effects of leaders with conflicts of interest to recommend microfinance: those who had prior social and lending ties to microfinance-eligible individuals. Panel (a) shows the results from the HLM models, while Panel (b) shows the results from the LSIM models. The x-axis represents the magnitude of the estimated effect. The grayscale is darker for more saturated models.

These results suggest several conclusions. First, they confirm the negative moderating effect of having multiple – social and exchange – ties. These effects range between a decrease of 5 percent (HLM, Models 1-3) and 24 percent (LSIM, Models 4-6) in the probability of participating in microfinance among eligible individuals. By contrast, the main effect of having non-leader contacts who had both social and lending ties is positive, ranging between an increase of 12 percent (LSIM, Models 4-6) and 70 percent (HLM, Models 1-3) in the

Figure 9: Moderating Effect of Multiplexity on Microfinance Participation



(a) Hierarchical Logistic Models (HLM) (b) Linear Social Interaction Models (LSIM)

Note: Coefficient estimates with 95% confidence intervals (lines). Darker shading denotes estimates from more saturated models inclusive of social influence and endorsement effects. Figures based on estimates reported in Table A6 (HLM) and Table A7 (LSIM).

probability of participating in microfinance among eligible individuals. These results suggest that experimentally-seeded leaders potentially skewed, withheld, or biased information that was not in their private interest to share, because they were informal lenders to eligible individuals.

6 Discussion

This study set out to understand how multiplexity affects diffusion by word-of-mouth information. It did so by analyzing data from an informational intervention conducted by a microfinance NGO in 49 villages in Karnataka, India. This intervention introduced private information about the benefits of microfinance through seeded leaders in these communities. An NGO tasked these leaders with raising awareness and encouraging microfinance participation among women. The findings showed that individuals exposed to these leaders were more likely to participate in microfinance. However, multiplexity in leaders' ties negatively moderated the benefits of word-of-mouth information.

These results offer several insights. First, they suggest that experimentally seeded lead-

ers raised awareness about microfinance and encouraged participation. Further, the results indicate that multiplexity in leaders' ties undermined the benefits of word-of-mouth. Consistent with this explanation, robustness checks showed that leaders with both social and money lending ties to eligible individuals exerted adverse effects on microfinance participation. By contrast, contacts who were not experimentally-seeded leaders but who shared social and money lending relations with qualified individuals promoted microfinance participation. These results suggest that multiplexity in leaders' ties limited information disclosure about microfinance.

6.1 Limitations

There are several limitations to this study. First, in this study, it was not possible to determine the content of the experimentally-seeded leaders' communications about microfinance. Thus, it is not easy to establish how their communications varied with their multiple relations and identities. Therefore, this is an important area for future work to examine. Second, in the scope of this study, it was not possible to ascertain whether the observed effects stem from leaders withholding or biasing information. The models estimate the effects of dyadic interactions. They are thus unable to distinguish between whether informants skewed information or their contacts filtered and discounted information in ways that made them less likely to take the leaders' recommendations. Either way, the results are the same, but the two mechanisms are distinct and merit further attention in future work. Third, this study pertains to a unique context – remote and relatively close-knit communities in rural India. Whether or how the results generalize to other contexts remains to be studied in other contexts. Future work on this topic should, therefore, address these gaps by collecting both more detailed data about communications and coupling that with additional surveys to understand how contacts interpreted this information. Future studies can also explore how the effects of multiplexity vary for other types of information sharing, and other types of decisions. Measuring the content of communications more precisely and further distin-

guishing how individuals' motives for sharing information vary across different types of ties and identities are important avenues for future research.

6.2 Contributions

This study contributes to three different literature streams within management: research on relational pluralism, social diffusion, and economic empowerment through microfinance. I discuss this study's contributions to each of these streams below.

6.2.1 Literature on Relational Pluralism

First, this study contributes to the growing literature on relational pluralism (Shipilov et al., 2014; Brass et al., 2004), which looks at how the presence of multiple kinds of relationships and identities among actors emerge and influence individual, group-level, and organizational outcomes. This literature has a long tradition rooted in Simmel's study of conflict and the web of group affiliations (Simmel, 1964, 1950), Durkheim's study of the basis for interpersonal attachment in society (Durkheim, 1984), and seminal studies of micro-social interactions (Collins, 2004; Goffman, 1961, 1959; McPherson, 1983). Organizational scholars working in this tradition have been interested in understanding how multiple role structures affect a variety of outcomes including communication within and across organizations (Lee and Monge, 2011; White et al., 1976; Baker, 1984; Uzzi and Gillespie, 2002), economic exchange (Granovetter, 1985; Uzzi, 1996; Kenis and Knoke, 2002), and organizational alliances and board interlocks (Mizruchi and Stearns, 1988; Gulati and Gargiulo, 1999; Burt, 1983; Galaskiewicz et al., 1986; Lincoln and Miller, 1979; Ahmadjian and Lincoln, 2001).

Recent work in this area has categorized the different forms that relational pluralism takes (Shipilov et al., 2014) and begun to examine its implications for organizations (e.g., Ranganathan and Rosenkopf, 2014; Rosenkopf et al., 2001; Rogan, 2014). Scholars in this area have evaluated both the positive and negative aspects of multiplexity for individuals and organizations. The findings from this literature suggest that these properties of networks

provide actors with greater flexibility and continuity in relations ties (Rogan, 2014; Beckman et al., 2014), enable more tailored innovation (Raffaelli and Glynn, 2014), create greater network segmentation (Sytch and Tatarynowicz, 2014), and enable strategic voting behavior (Ranganathan and Rosenkopf, 2014).

This study contributes to this rich literature, by showing that multiplexity can both expand the number of social pathways through which actors can obtain information and also create conflicting interests to share information and encourage social diffusion. Thus, this study suggests that multiplexity affects how constructs such as network density and centrality operate. For instance, higher density and centrality could promote information spread as long as social relations are single-stranded. High levels of multiplexity, however, could enable actors to be more strategic and opportunistic in their communications, owing to having more competing demands and interests. Thus, multiplexity could trump the benefits of network density for fine-grain information transfer and social diffusion.

6.2.2 Literature on Social Diffusion

Second, this study contributes to the literature on social diffusion. This rich and varied literature has studied the role that network ties play in the spread of information, knowledge, and innovations. From the first studies of the diffusion of hybrid corn (Ryan and Gross, 1943) and tetracycline (Coleman et al., 1966), scholars working in this area have been interested in how social ties act as pathways for information transmission and social influence. The findings from this literature show that social networks, including interlocking network ties, serve as critical conduits for the diffusion of knowledge and information, and thereby of new practices and technologies within and across individuals and organizations (Davis and Greve, 1997; Abrahamson and Rosenkopf, 1997; Davis, 1991; Teece, 1980). Recent work in this area has focused on processes of complex contagion and dynamic models to capture cascades across multiple types of ties (Goel et al., 2016; Chu and Davis, 2016; Centola, 2015).

These findings from this study contribute to this literature in several ways. First, they

suggest that multiplexity undermines social diffusion through word-of-mouth information. These findings place scope conditions on the idea that having more network ties promotes broad and rapid diffusion (Wejnert, 2002). Extant theories predict that informing socially central individuals should help diffusion by creating more pathways to information spread and social influence. The fundamental assumption behind these arguments, however, is that information spreads on social contact like infectious diseases, whereby the most connected individuals are most contagious. But this conceptualization misses a critical consideration concerning information spread: individuals communicate strategically and have many different kinds of relations and identities. This multiplicity of ties and identities, therefore, makes highly connected individuals highly conflicted in which identities to deploy and how (and which) information to convey. It also enables actors in multiplex positions to benefit strategically from their different ties and identities (Shipilov et al., 2014; Shipilov, 2012; Shipilov and Li, 2012). Relational pluralism both gives individuals greater autonomy and agency in how they share information (Padgett and Ansell, 1993; Coser, 1975; Merton, 1957). The potential for conflicts in interests and loyalties that accompany multiplexity explains why having more ties does not necessarily promote information diffusion.

Further, the prior literature has often portrayed highly connected individuals as well-positioned to diffuse new practices, technologies, and ideas. This study, however, shows that highly connected individuals could also undermine social diffusion when their ties are multiplex. These findings suggest that it is vital to select not only central actors but also unbiased actors to spread information. For example, if a manager who sits on the board of another organization learns about a new process that can radically improve her organization's performance, but jeopardizes her job, she may never propose this innovation despite its benefits. Who diffuses information and what interests they hold could affect whether a new idea, practice, or technology gains widespread adoption. This study brings these agency questions to the forefront in network models of diffusion by showing that the benefits of word-of-mouth depend on multiplexity.

6.2.3 Literature on Microfinance and Economic Empowerment

Third, and finally, this study contributes to the literature on microfinance and economic empowerment (e.g., Cobb et al., 2016; Zhao and Wry, 2016; Canales and Greenberg, 2016). This literature has focused on understanding how microfinance can be made more effective as a solution for economic empowerment, and what role organizations such as NGOs play in equalizing access to finance among the poor. Existing research in this area has advocated making microfinance more accessible and less costly, by mitigating tensions between organizations' mission and sustainability. Further, scholars have called for greater flexibility in lending practices to enable broader inclusion and more significant economic empowerment.

This study contributes to this literature by turning attention towards understanding when and why individuals that are eligible for microfinance do not participate. Specifically, the findings show that endogenous information transmission processes within rural communities in developing countries could undermine microfinance participation. In these contexts, economic exchanges are highly socially embedded and occur over many kinds of ties (e.g., kinship, friendship). Thus, programmatic solutions to poverty alleviation through informational interventions need to account for not only economic norms of exchange but also communal norms of cohesion and inter-dependence. These norms can sometimes conflict and undermine financial development.

The findings also demonstrate some of the downsides to multiplexity for economic empowerment. Although multiplexity can enable relational resilience and stability conducive to a variety of benefits for individuals, it can also impede the diffusion of new knowledge, practices, and ideas. This article shows that multiplexity could hinder the spread of information about microfinance. In this setting, the co-mingling of communal and exchange relations meant that leaders who were both lenders and friends to eligible individuals had conflicting interests to recommend microfinance. Further, socially-embedded lending ties could have been challenging to re-organize into microfinance groups. The reason is that pre-existing economic relations in the villages formed expansive networks of informal borrowing and lending.

In contrast, microfinance operated on a more centralized and formal organizational model. These findings suggest that it is vital to consider the social structures of the communities in which NGOs introduce microfinance to understand whether these communities will be receptive to participating.

7 Conclusion

This article has sought to explain how network multiplexity affects social diffusion through word-of-mouth information. The article proposed that multiplexity increases the number of social pathways to obtaining information from second-hand sources, but also enables opportunism in how individuals share information across their multiple relations and identities. The main effects of multiplexity on social diffusion were positive, but that the moderating effects were adverse. Thus, multiplexity in the ties between experimentally seeded leaders and their contacts appears to have deterred diffusion by word-of-mouth.

Future research can explore the audience-side and informant-side mechanisms that affect these outcomes and the boundary conditions on these effects to understand what factors affect information loss and distortion in the presence of conflicting interests and identities. Lab experiments can parse the audience-side and informer-side mechanisms, such as information discounting and opportunistic communication, that give rise to these outcomes. The key finding from this article that multiplexity undermines the benefits of word-of-mouth information for social diffusion by enabling opportunistic communication has ramifications for other types of socially influenced behavior, such as voting and insurgency. The proposed theory explains why potentially useful and novel ideas, practices, and technologies often fail to diffuse in dense and close-knit communities. Practically, this research calls into question standard diffusion models that assume that information spreads on contact like infectious diseases. Further, it suggests critical scope conditions on the benefits of network density and centrality for social diffusion, by noting that both constructs could involve relational plural-

ism that creates competing interests to share information widely and impartially. Thus, the best actors to target for spreading the word may not be the most connected, but rather the least conflicted.

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Table A1: Descriptive Statistics and Correlations Matrix

		Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
(1)	MF PARTICIPATE	0.19	0.392	1																								
(2)	CASTE: OBC	0.575	0.494	-0.07	1																							
(3)	CASTE: SCHEDULED CASTE	0.26	0.438	0.13	-0.69	1																						
(4)	CASTE: SCHEDULED TRIBE	0.048	0.215	0.03	-0.26	-0.13	1																					
(5)	SHG PARTICIPATE	0.2	0.4	0.06	-0.02	0.03	0.01	1																				
(6)	AGE	40.285	12.63	-0.04	0.03	-0.05	-0.01	-0.11	1																			
(7)	RATION CARD HOLDER	0.877	0.328	0.02	-0.03	0.04	0.02	0.06	0.15	1																		
(8)	NO ELECTRICITY	0.046	0.209	0.03	-0.08	0.12	0.04	0.01	-0.02	0.01	1																	
(9)	COMMON LATRINE	0.003	0.052	0	0	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	1																
(10)	HOUSE RENTER	0.033	0.18	0	0.02	-0.04	0.04	0	-0.05	-0.08	0.06	0.07	1															
(11)	HOUSE SIZE (ROOMS)	2.754	1.735	-0.1	0.12	-0.18	-0.07	-0.07	0.08	-0.05	-0.13	-0.02	-0.09	1														
(12)	MOTHER TONGUE: KANNADA	0.74	0.438	-0.08	0.06	-0.15	-0.11	0	0.05	-0.01	-0.01	-0.03	-0.05	0.12	1													
(13)	NO EDUCATION	0.37	0.483	0.03	-0.06	0.16	0.07	0.09	0.25	0.09	0.09	-0.02	-0.01	-0.14	-0.08	1												
(14)	KINSHIP	0.529	0.499	0.02	0.02	0	-0.01	-0.06	0.07	0	-0.01	-0.01	-0.02	0.05	-0.01	0.01	1											
(15)	SOCIAL	0.572	0.495	0.01	0.01	0	-0.01	-0.02	0.03	-0.01	-0.01	0	0	0.06	0	0	0.31	1										
(16)	COME VISIT	0.604	0.489	0.02	0.01	0	-0.01	-0.02	0.03	-0.01	-0.01	0	-0.01	0.05	-0.01	0.02	0.38	0.51	1									
(17)	GO VISIT	0.612	0.487	0.01	0.01	0	-0.01	-0.03	0.03	-0.01	-0.01	0	-0.01	0.05	-0.01	0.02	0.37	0.51	0.81	1								
(18)	MEDICAL	0.528	0.499	0.01	0.02	0	0	-0.03	0.04	-0.01	-0.01	0	-0.02	0.06	0	0.01	0.56	0.52	0.57	0.57	1							
(19)	GET GOODS	0.567	0.495	0.02	0.01	0	-0.01	-0.01	0.04	-0.01	-0.01	0	-0.01	0.05	0	0.02	0.47	0.46	0.55	0.55	0.64	1						
(20)	GIVE GOODS	0.563	0.496	0.02	0.02	0.01	-0.01	-0.01	0.03	-0.01	-0.01	0	-0.01	0.04	0	0.03	0.45	0.45	0.53	0.51	0.61	0.78	1					
(21)	GET ADVICE	0.486	0.5	0.01	0.02	0	-0.01	-0.04	0.07	-0.01	-0.01	0	-0.01	0.07	0	0.01	0.59	0.55	0.55	0.55	0.69	0.6	0.58	1				
(22)	GIVE ADVICE	0.47	0.499	0.02	0.02	0	-0.01	-0.03	0.05	-0.01	-0.01	0	-0.01	0.07	-0.01	0.01	0.58	0.6	0.59	0.59	0.69	0.63	0.63	0.78	1			
(23)	BORROW MONEY	0.543	0.498	0.01	0.02	0	-0.01	-0.03	0.04	-0.01	-0.01	0	-0.02	0.06	0	0	0.47	0.55	0.56	0.57	0.69	0.62	0.58	0.7	0.7	1		
(24)	LEND MONEY	0.525	0.499	0.02	0.02	0.01	-0.01	-0.02	0.03	-0.01	-0.01	0	-0.01	0.06	-0.01	0.01	0.49	0.56	0.59	0.57	0.67	0.61	0.63	0.68	0.74	0.77	1	
(25)	RELIGIOUS	0.391	0.488	0.02	0.02	0	-0.01	-0.04	0.05	-0.01	-0.01	0	-0.02	0.08	0	0.01	0.71	0.66	0.62	0.61	0.73	0.67	0.68	0.79	0.82	0.71	0.73	1

Table A2: Hierarchical Logistic Models: Baseline Treatment Effect

	(1) MF Participation	(2) MF Participation	(3) MF Participation
TREATED	0.120*	0.268***	0.227**
	(2.52)	(5.49)	(2.99)
Age of contact	-0.00214	-0.00165	-0.00195
	(-1.38)	(-1.05)	(-1.24)
Gender of contact (female)	-0.00411	-0.189***	-0.208***
	(-0.10)	(-4.25)	(-4.28)
Wealth of contact (APL)	-0.0456	-0.0227	-0.0193
	(-1.20)	(-0.59)	(-0.50)
Electricity access of contact	-0.00569	0.0382	0.0381
	(-0.13)	(0.87)	(0.87)
Latrine Access of contact	-0.127**	-0.115*	-0.0956*
	(-2.73)	(-2.45)	(-2.02)
House ownership of contact	0.0845	0.0951	0.0843
	-1.22	-1.36	-1.2
House size of contact	-0.0149	-0.0184	-0.0154
	(-1.07)	(-1.30)	(-1.08)
Intercept	-0.0591	-0.158	-0.109
	(-0.09)	(-0.23)	(-0.16)
Var(Village)	0.507***	0.451***	0.435***
	(4.72)	(4.68)	(4.67)
Controls:			
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Social influence	No	Yes	Yes
Positive endorsement	No	No	Yes
Negative endorsement	No	No	Yes
χ^2	728.63	1046.84	1128.21
p-value	0.000	0.000	0.000
N	22,788	22,788	22,788

Note: t-statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests)

Table A3: Linear Social Interaction Models: Baseline Treatment Effect

	(4) MF Participation	(5) MF Participation	(6) MF Participation
TREATED	0.0155*	0.0342***	0.0297**
	(2.32)	(5.12)	(2.77)
Age of contact	-0.000298	-0.000233	-0.000275
	(-1.39)	(-1.09)	(-1.29)
Gender of contact (female)	-0.00013	-0.0237***	-0.0259***
	(-0.02)	(-3.94)	(-3.98)
Wealth of contact (APL)	-0.0074	-0.00477	-0.00435
	(-1.42)	(-0.92)	(-0.84)
Electricity access of contact	-0.000584	0.00549	0.00533
	(-0.10)	(0.91)	(0.88)
Latrine Access of contact	-0.0186**	-0.0165**	-0.0137*
	(-2.91)	(-2.61)	(-2.17)
House ownership of contact	0.013	0.0153	0.0148
	(1.35)	(1.60)	(1.54)
House size of contact	-0.00172	-0.00193	-0.0015
	(-0.95)	(-1.08)	(-0.84)
Intercept	0.728***	0.689***	0.689***
	(6.86)	(6.55)	(6.57)
Controls:			
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Social influence	No	Yes	Yes
Positive endorsement	No	No	Yes
Negative endorsement	No	No	Yes
R-sq.	0.10	0.12	0.12
N	22,788	22,788	22,788

Note: t-statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests)

Table A4: Hierarchical Logistic Models: Effects of Multiplexity

	(7) MF Participation	(8) MF Participation	(9) MF Participation
TREATED	0.721***	0.700***	0.702***
	(4.88)	(4.76)	(4.78)
MULTIPLEXITY	0.0499***	0.0500***	0.0489***
	(5.72)	(5.67)	(5.53)
TREATED X MULTIPLEXITY	-0.457***	-0.451***	-0.449***
	(-6.67)	(-6.62)	(-6.61)
Age of contact	0.000447	0.000988	0.000653
	(0.28)	(0.60)	(0.40)
Gender of contact (female)	-0.0812	-0.261***	-0.320***
	(-1.70)	(-5.30)	(-6.31)
Wealth of contact (APL)	-0.0446	-0.018	-0.0175
	(-1.17)	(-0.47)	(-0.45)
Electricity access of contact	-0.00268	0.0418	0.0394
	(-0.06)	-0.95	(0.90)
Latrine Access of contact	-0.110*	-0.0909	-0.0759
	(-2.35)	(-1.92)	(-1.60)
House ownership of contact	0.0842	0.0992	0.0842
	(1.21)	(1.42)	(1.20)
House size of contact	-0.0131	-0.0117	-0.0138
	(-0.94)	(-0.83)	(-0.96)
Intercept	-0.111	-0.193	-0.116
	(-0.16)	(-0.28)	(-0.17)
Var(Village)	0.500***	0.447***	0.429***
	(4.71)	(4.68)	(4.67)
Controls:			
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Social influence	No	Yes	Yes
Positive endorsement	No	No	Yes
Negative endorsement	No	No	Yes
χ^2	783.29	1077.77	1175.39
p-value	0.000	0.000	0.000
N	22,788	22,788	22,788

Note: t-statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests)

Table A5: Linear Social Interaction Models: Effects of Multiplexity

	(10)	(11)	(12)
	MF Participation	MF Participation	MF Participation
TREATED	0.0512**	0.0491**	0.0497**
	(2.99)	(2.90)	(2.94)
MULTIPLEXITY	0.00709***	0.00701***	0.00686***
	(5.75)	(5.73)	(5.62)
TREATED X MULTIPLEXITY	-0.0284***	-0.0282***	-0.0282***
	(-7.00)	(-7.01)	(-7.04)
Age of contact	0.0000619	0.000124	0.0000835
	(0.27)	(0.56)	(0.37)
Gender of contact (female)	-0.0111	-0.0342***	-0.0412***
	(-1.66)	(-5.06)	(-5.97)
Wealth of contact (APL)	-0.00694	-0.00381	-0.00372
	(-1.33)	(-0.74)	(-0.72)
Electricity access of contact	-0.000189	0.00609	0.00544
	(-0.03)	(1.00)	(0.90)
Latrine Access of contact	-0.0171**	-0.0139*	-0.012
	(-2.67)	(-2.20)	(-1.90)
House ownership of contact	0.0128	0.0158	0.0146
	(1.33)	(1.65)	(1.53)
House size of contact	-0.0015	-0.00113	-0.00128
	(-0.83)	(-0.63)	(-0.71)
Intercept	0.722***	0.685***	0.687***
	(6.73)	(6.44)	(6.48)
Controls:			
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Social influence	No	Yes	Yes
Positive endorsement	No	No	Yes
Negative endorsement	No	No	Yes
R-sq.	0.11	0.12	0.13
N	22,788	22,788	22,788

Note: t-statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests)

Table A6: Robustness checks: Hierarchical Logistic Models

	(1) MF Participation	(2) MF Participation	(3) MF Participation
TREATED	-0.0179	-0.0204	-0.0278
	(-0.18)	(-0.21)	(-0.28)
SOCIAL & LENDING	0.641***	0.817***	0.839***
	(7.38)	(9.35)	(7.94)
TREATED X SOCIAL & LENDING	-2.769***	-2.923***	-2.951***
	(-6.35)	(-6.70)	(-6.71)
Age of contact	-0.00119	-0.000468	-0.000815
	(-0.75)	(-0.29)	(-0.51)
Gender of contact (female)	-0.093	-0.289***	-0.297***
	(-1.94)	(-5.82)	(-5.83)
Wealth of contact (APL)	-0.0436	-0.0168	-0.0131
	(-1.14)	(-0.44)	(-0.34)
Electricity access of contact	-0.000189	0.0468	0.0463
	(-0.00)	(1.07)	(1.05)
Latrine Access of contact	-0.120*	-0.101*	-0.082
	(-2.55)	(-2.13)	(-1.73)
House ownership of contact	0.0819	0.0962	0.0859
	(1.18)	(1.37)	(1.23)
House size of contact	-0.0149	-0.0147	-0.0113
	(-1.07)	(-1.04)	(-0.79)
Intercept	0.0678	-0.0277	0.0103
	(0.10)	(-0.04)	(0.01)
Var(Village)	0.503***	0.446***	0.430***
	(4.71)	(4.68)	(4.67)
Controls:			
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Social influence	No	Yes	Yes
Positive endorsement	No	No	Yes
Negative endorsement	No	No	Yes
χ^2	794.42	1116.07	1193.72
p-value	0.000	0.000	0.000
N	22,788	22,788	22,788

Note: t-statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests)

Table A7: Robustness Checks: Linear Social Interaction Models

	(4)	(5)	(6)
	MF Participation	MF Participation	MF Participation
TREATED	-0.00428	-0.00513	-0.00635
	(-0.32)	(-0.39)	(-0.48)
SOCIAL & LENDING	0.0972***	0.120***	0.120***
	(7.24)	(9.03)	(7.94)
TREATED X SOCIAL & LENDING	-0.218***	-0.240***	-0.241***
	(-7.51)	(-8.34)	(-8.17)
Age of contact	-0.000147	-0.0000631	-0.00011
	(-0.67)	(-0.29)	(-0.50)
Gender of contact (female)	-0.0131	-0.0378***	-0.0388***
	(-1.95)	(-5.58)	(-5.62)
Wealth of contact (APL)	-0.00685	-0.00377	-0.00338
	(-1.31)	(-0.73)	(-0.66)
Electricity access of contact	-0.0000668	0.00645	0.00633
	(-0.01)	(1.07)	(1.05)
Latrine Access of contact	-0.0177**	-0.0147*	-0.012
	(-2.77)	(-2.32)	(-1.89)
House ownership of contact	0.0126	0.0154	0.0148
	(1.31)	(1.61)	(1.55)
House size of contact	-0.00171	-0.0015	-0.00104
	(-0.95)	(-0.84)	(-0.58)
Intercept	0.745***	0.706***	0.705***
	(6.95)	(6.65)	(6.66)
Controls:			
Individual Characteristics	Yes	Yes	Yes
Household Characteristics	Yes	Yes	Yes
Social influence	No	Yes	Yes
Positive endorsement	No	No	Yes
Negative endorsement	No	No	Yes
R-sq.	0.11	0.12	0.13
N	22,788	22,788	22,788

Note: t-statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests)