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RE-VISITING COLLABORATIVE BEHAVIOR IN SUPPLY NETWORKS – STRUCTURAL EMBEDDEDNESS AND THE INFLUENCE OF CONTEXTUAL CHANGES AND SANCTIONS

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November 2017

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Abstract

This study considers decision making beyond a dyadic buyer-supplier context to the network context. Decisions made by firms are shaped by behavioral norms within the supply network as perceived by the decision makers. Firms can perceive themselves to be part of a collaborative regime or one in which the potential for non-cooperation is high. Further, the ability to put sanctions on non-cooperating firms could shape the overall behavioral patterns in the network. To gain further insights into these aspects and their interactive effects on firm behavior, our study investigates decision-making in supply network by means of behavioral experiments. By organizing practicing managers in a supply network, the study investigates the role of structural embeddedness, incentive structure, and sanctioning mechanisms on the level of collaboration. The results of this study confirm that while sanctions are detrimental for collaborative behavior in a supply network, they play an important role when the underlying norms of governance of such a network are perturbed. The results show that structural embeddedness provides a context that aids adaptive collaborative behavior by firms that are part of the supply network. Once the incentive structure is altered such that there is a higher payoff from defection, the adaptive collaborative behavior is replaced by a behavior in which firms try to maximize their returns and forego collaborative decision-making behavior.

Keywords: Supply Networks, Collaboration, Incentive Structure, Sanctions, Behavioral Experiments, Panel Data Analysis.

1. Introduction

Dyadic buyer–supplier relationships are part of extended networks that have come to bear influence on the nature of inter-organizational relationships. Buyer-supplier relationships could manifest themselves in terms of the direct link between a buyer and a supplier as well as indirect connections among firms that are part of the overall supply network. Dyads are embedded within a triadic network structure and triads, in turn, are embedded in a higher-order network structure (Choi and Kim, 2008). Each iteration of network evolution embeds the previous level. As such, structural embeddedness has been proposed as a useful conceptual foundation to examine the nature of collaborative behavior in supply relationships (Granovetter, 1985; Uzzi, 1997). It captures interconnections and the loose and tight coupling of relationships among firms as well as the interdependent nature of buyer-supplier relationships with the entities in the extended supply network (Ghoshal and Bartlett 1990; Gulati et al., 2000; Echols and Tsai, 2005).

The complexities associated with these extended networks make the examination of inter-organizational collaborative relationships more difficult than when these relationships are investigated in isolated dyadic settings. Studies have emphasized the need to consider such embedded nature of supply networks to gain a deeper understanding of buyer-supplier relationships (Uzzi, 1997; Choi et al., 2001; Pathak et al., 2007; Choi and Kim, 2008). Recently, the primary focus of studies on supply networks has moved from dyads to triads, to examine the dynamics of supply networks as a complex adaptive system (Wu and Choi, 2005; Dubois and Fredriksson, 2008; Choi and Wu, 2009a). For instance, Choi and Wu (2009b) emphasize that considering triads can help us understand the relationships of the supply chain from a network perspective, extending the theoretical lens beyond Transaction Cost Economics (TCE) which has been the tradition in supply chain management research. Meanwhile, many researchers have adopted various tools of social network analysis (SNA) through network and graph theories to broaden the scope of inter-

organizational relationships (Carter et al., 2007; Autry and Griffis, 2008; Borgatti and Li, 2009; Tate et al., 2013; Kim et al., 2015).

In this study, we build on the notion of progressive levels of structural embeddedness to illuminate the issue of collaborative relationships in supply networks. Structural embeddedness sets the context that is instrumental in determining the contingent economic actions of buyers and suppliers who are embedded in the larger supply network structure. In essence, the behavior is not an outcome of a series of buyer-supplier relationships but is based on a network of relations among members of the supply network. Thus, structural embeddedness focuses on the network architecture and the relational quality of inter-organizational exchanges (Uzzi 1997; Rowley et al., 2000) and informs that both direct and indirect network ties of a firm can facilitate or impede its decisions and outcomes (Gulati and Westphal, 1999; Moran, 2005). A focused examination of structural embeddedness in supply network enables an interpretation and analyses of individual firm decisions and collaborative buyer-supplier relationships within the larger relational context.

Given the salience of structural embeddedness in shaping firm behavior in supply networks, the underlying incentive structures need to be considered (Lazzarini et al., 2008). Incentive refers to "an event or object external to the individual which can incite action" (Locke 1968; p. 161) that can play an important role in developing relational norms such that a group of decision makers will have shared behavioral expectations (Thibaut and Kelley 1959; Heide and John 1992; Aulukh et al. 1996). Embeddedness creates a governance structure that is cognitively based on heuristics and mutual expectations of collaboration. Social processes and psychological mechanisms, therefore, foster the emergent nature of collaborative behavior in supply networks. Notwithstanding the enriched opportunities gained by firms, embeddedness can turn into a liability when "(1) there is an unforeseeable exit of a core network player, (2) institutional forces rationalize markets, or (3) overembeddedness characterizes the network" (Uzzi, 1997; p. 57). Our study focuses on the altered

incentive structure caused by contextual changes, such as a change in institutional forces impacting supply networks. Uzzi (1997) presents evidence from the apparel retail trade in the 1980s whereby the longstanding embedded relationships among clothing manufacturers were broken due to the acquisitions of many of the large retailers such as Macy's, Bullock's, and A&S by corporate conglomerates such as Federated, Inc. This resulted in a change in the norms of business such that retail buyers moved from "relationship buying" to "numbers buying" among the retail buyers. In this new context short-term gains, one-shot bidding, and competitive bidding replaced the long-term relationship regime. Another example can be traced to Toyota's move of dissolving or restructuring the U.S. joint ventures of three of its largest seat suppliers[1]. Toyota took this step to reduce overembeddedness and increase competition among its North American Suppliers. Specifically, Toyota Boshoku America Inc., a Toyota affiliate, bought out partner Lear Corp.'s share of Total Interior Systems-America, a joint venture that makes seats and components for the Sienna minivan. Similar actions were taken with regards to Trim Masters Inc., which was formed in 1987 as a joint venture 49%-owned by Johnson Controls (JCI) and 51%-owned by Toyota Boshoku and Toyota Tsusho. After Toyota realized they were getting too embedded with JCI, Toyota and JCI phased out the joint venture in 2008. Now Trim Masters, Inc. operates as a subsidiary of Toyota Tsusho America, Inc.

In this study we consider a similar contextual change to investigate how an altered incentive structure resulting in higher temptation to choose a non-cooperative stance (when others are cooperating) impacts the propensity of supply network members to collaborate with each other. Extending the relational issues born by incentive structures, this study investigates the role played by sanctions. Sanctions are obligations that are conditional on certain violations so as to make it possible for violations to be redeemed (Dignum et al. 2004). They provide a mechanism to

[1] http://www.autonews.com/article/20081208/OEM01/312089737/toyota-pushes-breakup-of-seat-suppliers-to-boost-competition

influence collaborative behavior among firms. They offer the means for reinforcing the desired behavior (Skinner, 1953) and form the basis for creating systems that can ensure compliant actions (Pfeffer, 1994). Despite the promise of sanctioning mechanisms in shaping cooperative behavior, their efficacy has been questioned by a growing number of skeptics (Pfeffer, 1994; Tenbrunsel and Messick, 1999; Mulder et al., 2006; Hartl et al., 2016). The use of sanctions has been argued to contribute to firm inefficiencies and failures (Walsh and Seward, 1990) as well as unethical behavior (Cialdini, 1996). In addition, sanctioning systems create an environment of mistrust, which promotes resentment and potentially forms the basis for non-cooperative behavior (Pfeffer, 1994; Cialdini, 1996). The potential outcome is an adverse impact on the core foundation of embedded network structures. The control exerted by sanctioning systems induces feelings of increased pressure and tension, and the intrinsic motivation to collaborate is replaced by an extrinsic pressure to engage in a pre-specified behavior (Pfeffer, 1994; Cialdini, 1996). In this study, we examine how a sanctioning mechanism performs when the incentive structure within the supply network changes.

To address the theoretical tension among structural embeddedness, incentives, and sanctions, we conduct two behavioral experiments administered to practicing managers in a leading pharmaceutical company in Western Europe. The two experiments differ such that in the second experiment the participants are able to sanction someone who did not contribute to the collaborative project. The results present evidence towards collaborative behavior in supply networks. Structural embeddedness of decision makers (i.e., firms) enables adaptive behavior in supply networks and fosters collaboration. A change in the incentive structure that offers greater return from non-cooperative behavior results in decision makers aiming to maximize their returns from each exchange, which compromises the collaborative behavior in the network. Interestingly, the results indicate that while sanctions are ineffective (and counter-productive) in a structurally

embedded supply network, it becomes effective once the network is subjected to an incentive structure with greater temptation to defect.

The remaining paper is organized as follows. In the next section, we develop our research hypotheses. In the following section, we present our research design along with details regarding the two experiments. The last two sections present the results and discuss the implications and directions for future research.

2. Theory and hypotheses development

2.1. Structural embeddedness, incentive structure, and contextual changes

Embeddedness is one of the most important concepts in network-related studies. Since Granovetter (1985) defined embeddedness as a contextualization of economic behaviors in social structures, there have been many discussions over the two key dimensions of the concept: structural embeddedness and relational embeddedness (Gulati and Gargiulo, 1999; Rowley et al., 2000; Moran, 2005). Structural embeddedness is defined as the structural configuration between actors (Granovetter, 1985; Nahapiet and Ghoshal, 1998), and it shows how the network is shaped and how the common ties between units, people, or firms are interconnected (Borgatti and Foster, 2003). Relational embeddedness, on the other hand, is defined as the personal relationships developed through a history of interactions (Granovetter, 1985; Nahapiet and Ghoshal, 1998). Rowley et al. (2000) suggest that relational embeddedness focuses on the collaboration, information and resource sharing, and social learning between the actors within the network.

In a supply network context, Choi and Kim (2008) emphasizes the importance of structural embeddedness, suggesting that the performance of a supplier is largely dependent on its structural relationships with other companies who are embedded together in the supply network. Additionally, Tate et al. (2013) introduce both dimensions of embeddedness and develop several propositions in the domain of environmental supply chain practices in a hypothetical supply chain network. This

study focuses on structural embeddedness to shed further light on its role in fostering collaborative behavior in a supply network.

To better understand the relational patterns in a supply network, one needs to delve deeper into the dynamics governing individual firms as members of the network. In particular, it is crucial to consider the mechanisms that lead to collective action in supply networks. Studies focusing on collective action in groups have identified two distinct sets of decision makers: rational egoists and conditional cooperators (Kreps et al., 1982; Ostrom, 2000). Rational egoists take rational individual action, whereas conditional cooperators are willing to cooperate and continue to do so when others reciprocate their action. These conditional cooperators make relatively higher contributions to the common good in a one-shot game as well as in the initial rounds of prisoner's dilemma and public goods games. These conditional cooperators typically have a higher level of trust for others and remain trustworthy as long as the proportion of others reciprocating the trust is relatively high. They also tend to restrain their disappointment with free riders and maintain moderate levels of cooperation as long as the number of repeated interactions is sufficiently high. To wit, structural embeddedness in a supply network presents the conditional cooperators with opportunities for repeated interactions. Even for rational egoists, the initial collaborative stance taken by conditional cooperators and their relational norms encourage them to contribute to common good so as to increase their own returns in the early rounds (Kreps et al., 1982). Repeated interactions contribute towards the development of "reciprocal altruism" (Trivers, 1971), which shapes collaborative behavior in supply networks.

Given the institutional role played by the embedded structure of supply networks and the presence of reciprocal altruism, we reason that even when the incentives from defection are high, the collaborative regime driven by structural embeddedness can sustain itself as long as there is repeated interaction in a network. This is due to the ability of decision makers to adapt to group

norms for sustaining collaborative behavior. The local structure provided by a supply network allows cooperation to be a stable outcome such that the structure enables players to copy successful strategies from their neighborhood (Kirchkamp and Nagel, 2007; Nair et al., 2009).

Notwithstanding the positive features of structural embeddedness, under certain circumstances, it can become a liability and adversely impact collaborative behavior. One such situation is the instability caused by the changed incentive structures that could potentially fracture social ties. Uzzi (1997; pp. 58) notes that, "If changes to the system rupture social ties, then the benefits of embeddedness generated by the ties can be lost. Ironically, this can place firms that invested heavily in networks at a higher risk of failure than market-oriented firms because the social relationships that created and supported competitive advantages no longer exist, and the distinctive competencies of managing network relationships may not translate well to other modes of exchange." New incentive structure governing network relationships can alter relational norms such that firms begin to emphasize one-shot relationships and short-term profit maximization as compared to a focus on collaborative actions. In essence, rationalized markets and fractured social ties reduce collaborative decision-making. With the changed incentive structure, the relative returns from collaboration diminish as compared to the returns from adopting a non-cooperative stance. Firms are incentivized to defect whenever possible to squeeze out margins, and this makes the payoff distribution explicitly inequitable, causing the non-cooperation strategy to become more pronounced (Rabin, 1993). Intuitively, one can reason that if a supply network is subjected to a changed incentive structure resulting from contextual changes, the robustness of structural embeddedness can be compromised and the level of collaboration will decrease. We offer the following hypothesis to establish the relational patterns in a supply network and to set the foundation for investigating the role of sanctions. The hypothesis highlights the impact of a change

in the incentive structure in a certain direction (i.e., moving to a context in which the temptation to defect is high) and thereby is capturing relational dynamics.

H1. When the temptation to defect increases in a supply network such that the underlying relational norms are altered, the level of collaboration in the network decreases.

2.2. Sanctions

Sanctions are originated from the dynamics of international politics between states. Galtung (1967) defined sanctions as "actions initiated by one or more international actors (the 'senders') against one or more others (the 'receivers') with either or both of two purposes: to punish the receivers by depriving them of some value and/or to make the receivers comply with certain norms the senders deem important." In a narrow definition, sanctions are "economic measures levied by 'a constitutionally authorized' international body seeking to compel the target nation to alter its policies in order that they no longer conflict with international norms (Doxey, 1980; Drury, 2005)." Also, Pape (1997) explains sanctions as one of the strategies of international economic pressure, an attempt to lower the economic welfare of a target state in order to coerce the target government to change its political behavior.

Sanctioning mechanisms are frequently used to foster collaboration since it changes the payoff structure and makes collaboration consistent with the self-interest of exchanging parties (Fehr and Rockenbach, 2003). Lack of trust among exchanging parties limits the ability to regulate exchanges without incorporating such mechanisms. Along with the direct impact on the payoff structure, sanctions also exert an indirect effect by reassuring reluctant cooperators that they would

not be exploited. This altering of expectations along with the direct effect of the payoff structure is expected to limit defection in supply networks (Tenbrunsel and Messick, 1999).

In spite of the positive features of sanctions, the effectiveness of sanctions has also been questioned (Titmuss, 1970). Studies have emphasized the detrimental effects of sanctions on the ability to collaborate (Fehr and Rockenbach, 2003). As noted earlier, structural embeddedness in supply networks allows repeated interactions and reciprocal altruism. This fosters collaboration without having to resort to sanctions (Trivers, 1971). However, externally induced incentives for cooperation or punishment for non-cooperation (e.g., sanctions) could result in aggravating the compliance problem, thereby undermining the intrinsic altruistic behavior (Titmuss, 1970; Deci and Ryan, 2000; Bohnet et al., 2001). Sanctioning undermines autonomy and intrinsic motivation to cooperate (Deci and Ryan, 2000). This reduces the persistence of cooperation (Lepper and Greene, 1978; Cardenas et al., 2002), induces resistance to comply (Brehm, 1966), evokes costly retaliation (Denant-Boemont et al., 2007), transforms an ethical decision into a business decision (Tenbrunsel and Messick, 1999), and even undermines trust in others (Chen et al., 2009; Mulder et al., 2006).

Sanctioning systems also impact the way the situation is perceived and understood by decision makers (Tenbrunsel and Messick, 1999). Messick (1999) asserts that decision makers determine the appropriateness of an action based on their perception of the underlying situation. According to Tenbrunsel and Messick (1999; p. 687), "…the judgment of appropriateness influences not only the perception of what type of behavior is proper but also expectations of what others will do, what norms are applicable, and what kinds of attributions about others are justified. The appropriate judgment thus determines a cluster of perceptions, including what behavior is called for in that specific situation." In addition, the introduction of a sanctioning system serves as an environmental cue that there is a lack of trust among interacting members. This alters the perception

of decision makers regarding the prevailing business norms within the network and influences future patterns of decision making.

In sum, in a supply network, "clan" structures based on collaborative governance emerge that eliminates the need for control and sanctioning mechanisms (Ouchi, 1980). In fact, the introduction of sanctions limits the ability of supply networks to develop collaborative relationships as trust, which is the basis for generating relational rents, might be driven out (Lazzarini et al., 2004). Similarly, the intense use of monitoring mechanisms might signal mistrust to other parties, which results in reducing collaborative investment due to reciprocal mistrust (Bohnet et al., 1999). Social norms have been shown to encourage collaborative behavior, but when subjected to contextual changes that increase the temptation to defect, there is evidence of a breakdown of cooperative regimes (Cardenas et al., 2000). Accordingly, we hypothesize:

H2a. The structural embeddedness in supply network enables decision makers to collaborate more intensively in the absence of sanctions as compared to the presence of sanctioning mechanisms.

In a recent meta-analysis, Balliet et al. (2011) use the interdependence perspective and assert that sanctions will be more effective when they are viewed as genuine tools for promoting collective interest. The study shows that when a firm expends higher costs towards sanctioning non-cooperators, there is a higher likelihood of promoting the belief that the firm is seeking to promote cooperation. This relates to the notion of strong reciprocity (Bowles and Gintis, 2002). A strong reciprocator co-operates with others and punishes non-cooperators in spite of the fact that this behavior cannot be justified in terms of self-interest (Fehr and Gächter, 2000). With an increase in the temptation to defect, punishment by strong reciprocators at a cost to themselves provides the only credible means to encourage cooperation in the network (Ostrom et al., 1992). In line with the

arguments, we hypothesize that in situations when the temptation to defect is high, sanctions placed on decision makers will be associated with their subsequent collaborative behavior (e.g., allocation of money for a group project).

H2b. When incentive to collaborate is lowered by contextual changes, decision makers will collaborate more intensively in the presence of sanctions as compared to its absence.

The previous two hypotheses compare the level of collaboration in the presence and absence of sanctions for two different contextual situations (i.e., two different payoffs). We posit that along with the difference in the level of collaboration between two contextual situations, sanctions are also expected to have a differential temporal effect on collaborative behavior within a context. In particular, we hypothesize that in a structurally embedded supply network, sanctions placed on a decision maker at a point in time will not result in an increase in collaborative behavior in the future. In contrast, when the underlying incentive mechanisms and, consequently, the relational norms are altered by contextual changes, sanctions are able to steer decision makers towards collaboration in the future time-period. Accordingly, we hypothesize:

H3a. In a structurally embedded supply network, the presence of sanctioning mechanisms does not temporally (over time) increase collaborative decision-making behavior.

H3b. When incentive to collaborate is lowered by contextual changes, the presence of sanctioning mechanisms temporally (over time) increases collaborative decision-making behavior as compared to its absence.

2.3. Satisficing vs. Maximizing Behavior

In his 'Primer on Decision Making,' March notes the tension between decision makers that behave in a "satisfying" manner and those that seek to "maximize" the return. He explains, "Maximizing involves choosing the best alternative. Satisficing involves choosing an alternative that exceeds some criteria or target" (March, 2009; p. 18). Subsequently, scholars have noted that managers often adopt a satisficing stance such that they look for a satisfactory (as against an optimum or maximum) outcome (Simon, 1959; Bourgeois and Eisenhardt, 1988). Yet, findings in social psychology (Festinger, 1954; Homans, 1961) and sociology (Runciman, 1966) literature qualify the satisficing behaviors. They suggest that once decision makers observe others adopting a non-cooperative stance, they forgo their collaborative behavior and engage in a more predictable and calculated decision-making pattern that puts greater emphasis on maximizing returns from the relationships.

In supply networks, this transition from satisficing to maximizing behavior as the dominant managerial decision making logic results in compromising the inherent collaborative governance capability of supply networks (Cyert and March, 1992; Sakhartov and Folta, 2013). This change of decision-making pattern also relates to the precepts of prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). Evaluations of options by decision makers are dependent on their risk aversion and whether the option is considered to be in a gain or a loss frame. Thus, preference reversal phenomena are typical for decision making, even in cases where reference points are uncertain such as under third generation prospect theory (Schmidt et al., 2008). In an early account of shift of maximizing and satisficing behavior, Mintz (1951; p 151) discusses the example of a theater fire and notes, "it is chiefly the reward structure of the situations which is responsible for non-adaptive behavior of groups at theater fires and similar situations. People are likely to recognize the threats to themselves, as they appear, and behave accordingly … cooperative behavior at a theater fire is likely to deteriorate progressively as soon as an initial disturbance occurs. If a few

individuals begin to push, the others are apt to recognize that their interests are threatened; they can expect to win through to their individual rewards only by pressing their personal advantages at the group's expense. Many of them react accordingly, a vicious circle is set up, and the disturbance spreads."

We reason that similar behavior results in supply networks that are subject to a changed incentive structure in which decision makers prefer non-cooperative stance as compared to collaboration. An incentive structure that presents increased the temptation to defect would change the behavioral pattern of decision makers such that they benchmark against those who have received the highest payoff. Non-adaptive behavior will ensue due to the behavioral disintegration and disorderly nature of decision making in supply network which makes it difficult to adapt effectively to group norms. The change in business norms results in group norms being crowded out by individual norms. Accordingly, we hypothesize:

H4a. Decision makers in a supply network engage in satisficing behavior by basing their group allocations on the deviation from average group allocations in the previous instance.

H4b. When incentive to collaborate is lowered by contextual changes, decision makers adopt maximizing behavior by basing their group allocations on the maximum payoff received in the previous instance.

3. Research design

We test the hypotheses by means of two experiments that focus on the role played by structural embeddedness, changed incentive structures, and sanctioning mechanisms. Hypothesis H1 is tested using the first experiment. The results from the second experiment together with the results

of the first experiment are used to test hypotheses H2, H3, and H4 (see Figure 1). The overall setting of our experiments closely corresponds to that of Fehr and Gächter (2000), except that decision making in our study occurs in a supply network. The network structure considered in this study is, therefore, different from the four-subject experimental game in Fehr and Gächter (2000).

[Figure 1 about here]

The data collection was carried out in 2012 by engaging managers from the supply chain department of an international pharmaceutical company in Belgium. All subjects had at least five years of work experience and had been involved in supply chain roles (e.g., procurement, supply chain, internal supply chain consultant) with varying levels of prior experience in other functions (e.g., sales, finance, marketing). We involved experienced managers for the experiment, as collaboration behavior in supply chains is complex and requires business experience and judgment. Even though studies have shown that student behavior might not be different from manager behavior (e.g., Scandura and Williams, 2000), understanding how practicing business managers would behave would likely provide a better understanding of decision-making patterns in complex situations.

Subjects were contacted before the experiment to register for their voluntary participation. As the participants were already compensated for their work time by the firm, no additional show-up fee was provided. Even though managers might have sufficient intrinsic motivation to decide thoroughly, it is preferable to implement real incentives (Abdellaoui et al., 2007). Hence, based on the performance of a participant in the experiment, they received a cash incentive. Each participant submitted a pre-experimental and a post-experimental survey. The pre-experimental survey captures aspects such as total work experience and psychological attributes of participants (e.g., general risk aversion), and post-experimental survey obtained responses regarding participants' perceived performance in the experiment.

There were 14 managers that agreed to participate in the study. Each manager as a decision-maker represented one out of five different roles in the supply network. Overall, we considered 14 linked supply chain members including raw material supplier (1), supplier of intellectual property (1), final assembler (1), intermediate supplier (4), and boundary-spanning suppliers and buyers who play both roles in different parts of the supply network (7). In experiment 1, the 14 decision makers do not have an option to apply sanctions, but they experience the change in payoff structure such that the new structure provides increases the temptation to defect. In experiment 2 we shuffle the decision makers so that they are now part of a different triad. Similar to experiment 1, the decision makers start with the context represented by the original payoff structure and move to a context with higher temptation to defect, but now with the option to apply sanctions. We collect decisions over the course of 20 rounds, and hence our analyses are based on 280 observations (14 participants X 20 rounds). Although participants were aware that the game would run for 20 rounds, we did not find any discernible bias in the final round decisions. We also conducted multivariate tests for the equality of means and the results suggest that the group allocation in different game scenarios is not significantly different for different time-steps.

The power levels of various roles in the supply network were different, and this was informed respectively to each participant. Specifically, final assembler, raw material supplier and intellectual property supplier were told that they are the more powerful members than other partners (intermediate supplier and boundary spanning suppliers/buyers) in the supply network by the experiment instructions. Figure 2 shows the supply network with 14 sub-groups each consisting of three decision-makers. These sub-groups (in-groups) are important as they determine the payoffs of individual members of the network during the experiment.

The decision makers play the Prisoner's Dilemma game within this network context. It is important to note that the prisoner's dilemma is not restricted to a dyadic analysis of strategic

behavior. Many scholars have broadened the scope and context of the prisoner's dilemma game. The model was evolved into a triadic setting (Marwell and Schmitt, 1972; Kahan, 1973) as well as a multi-person model (Weil, 1966; Kelley and Grzelak, 1972; Hamburger, 1973; Hamburger et al., 1975; Bonacich et al., 1976) to better investigate realistic behaviors of the agents. Fox and Guyer (1978) study the effect of "public choice" which encourages cooperation in an n-person setting in repeated trials. Yao and Darwen (1994), through a set of simulations on an n-person iterated prisoner's dilemma game, claim that the increase in group size makes it difficult to evolve cooperation from the iterated runs. Perc and Szolnoki (2008) suggest that diverse distribution of social status among players might play a significant role in evolving the cooperation amongst egoistic individuals in spatial prisoner's dilemma game. Presently, the scope of research has been further extended to a social network level to capture the complex dynamics of the real world (Thibert-Plante and Parrott, 2007; Fu et al., 2008; Cameron and Cintron-Arias, 2013).

[Figure 2 about here]

3.1. Experiments

The first experiment focuses on the change in payoff structure such that there is higher incentive for non-cooperative behavior due to exogenous forces and examines the impact on collaborative behavior. The general instructions for experiment 1 are listed in Appendix A. These general instructions were complemented by the description of the specific role. Subjects then played several practice rounds before the actual experiment. On completion of the experimental session, each subject was privately paid his or her earnings in cash. The experiment results were not disclosed to the participants. The experiment lasted approximately 90 minutes, and participants were told not to communicate with anyone during the experiment. The participants had to decide in each round of the experiment how much of their per-round budget of 5 experimental monetary units (EMUs) they want to invest in group allocation (representing collaboration) or in private allocation.

We first consider the base-case supply network to examine the role of structural embeddedness in supply network in fostering collaborative behavior (condition 1). The payoff matrix for the base-case supply network is presented in Figure 3. After completing 20 rounds of decision-making, the participants were informed about the change in the payoff structure such that there is a higher reward for defection (condition 2). This changed context captures the situation when institutional forces impact the inherent motivation of supply network members to collaborate (Uzzi, 1997). The increase in the temptation to defect in condition 2 was explicitly pointed to the participants. The revised payoff table is also presented in Figure 3.

[Figure 3 about here]

As shown in the two payoff matrices, the payoff for a defector when others cooperate increases from 4 to 5 in the revised version. It is important to note that as against the relative quantitative increase, our focus is on the behavioral change caused by the 'mere mention' of an increased temptation to defect. Prior studies have shown that mere mention of the situation has potential to trigger behavioral changes among participants (Malhotra and Murnighan, 2002). The mere mention is expected to prime the participants regarding the issues of defection and the potential possibility of non-reciprocity.

The second experiment focuses on the impact of sanctions on collaborative behavior. The general instructions for experiment 2 are listed in Appendix B. These general instructions were complemented by the description of the specific role. Similar to experiment 1, participants played several practice rounds before experiment 2 started. Upon completion of the experimental session, each participant was privately paid his or her earnings in cash. The experiment lasted approximately 90 minutes, and participants were told not to communicate with anyone during the experiment. In experiment 2, the participants had to decide in each round of the experiment how much of their per-round budget of 5 EMUs they want to invest in group allocation (representing collaboration) or

in private allocation as well as whether to punish non-cooperators. As detailed in Appendix B, in this experiment the participants are allowed to punish non-cooperators. In particular, after each round, participants are informed about the group allocation and private allocation of all members of the supply network and their corresponding payoffs. Based on this information, a participant representing a specific role in the supply network can decide to sanction a member (i.e., reduce the payoff of a member by 2 EMUs by incurring 1 EMU cost for administering the sanction). Participants first went through the experiment with condition 1 to make decisions regarding their group/private allocations as well as whether to sanction any participant in the network. Subsequently, the participants were informed about the change in the payoff matrix towards higher incentives for defection (condition 2). The participants went through 20 rounds of decisions with this changed payoff matrix as shown in Figure 3. The overall experimental protocol is summarized using a flowchart in Figure 4.

[Figure 4 about here]

We used a computerized version of the experiment to provide a controlled environment and allow real-time calculation of results. A large meeting room was arranged, and computers were set up to support the computerized experiment using ***z-tree*** software (Fischbacher, 2007). The instructions for the experiment were provided to each participant and read out aloud before each experiment. We used STATA 12.1 to test hypotheses H1 and H2 by means of Wilcoxon signed-rank tests (e.g., Croson and Donohue, 2006) and H3 and H4 using GLS random effects model with AR(1) disturbances.

4. Results

The general patterns observed in the experiments for condition 1 (base-case supply network) and condition 2 (with higher temptation to defect) are presented in Figure 5. Specifically, the figure

presents group allocations and payoffs for the fourteen participants with and without sanctions in the two conditions. In the absence of sanctions, the average group allocation in the base-case supply network is 1.91 EMUs, and the average group allocation in the supply network with higher temptation to defect is 1.23 EMUs. The corresponding average payoffs in the two scenarios are 9.6 EMUs and 9.48 EMUs, respectively. In the presence of sanctions, the average group allocation and payoff in the base-case supply network drop to 1.23 EMUs and 6.70 EMUs, respectively. Contrarily, in the presence of sanctions, the average group allocation in the supply network with higher temptation to defect increases to 1.39 EMUs, and the payoff decreases to 7.73 EMUs.

[Figure 5 about here]

To test H1, we compare group allocations made by the fourteen supply chain managers when they made decisions based on the payoff matrix in condition 1 versus condition 2 in the absence of sanctions. The change in payoff structure such that non-cooperative behavior receives a higher reward, as reflected in the two matrices, represents the impact of contextual changes. We average the amount of group allocation made by each manager over 20 rounds of decision making in the two settings. The results obtained from the Wilcoxon signed-rank test are presented in Table 1.

[Table 1 about here]

The results using 280 observations indicate that the group allocations are lower when the temptation to defect increases ($p<0.01$). Specifically, nine participants made higher average group allocations in condition 1 compared to condition 2, four participants made lower average group allocations in condition 1 compared to condition 2, and there was no difference in the average group allocations made by one participant in both conditions. The Wilcoxon signed-rank test for the average group allocation of the 14 participants lends further support for H1 ($p<0.10$).

For H2a, we compare group allocations made by managers in the absence of sanctions with the group allocations made in the presence of sanctions. The results obtained from the Wilcoxon

sign-rank test using 280 observations show that in base-case supply network (condition 1), group allocations are higher in the absence of sanctions than in the presence of sanctions ($p<0.01$). Next, we average the group allocations by the 14 participants over 20 rounds of decision-making without and with sanctions.

The results show that in base-case supply network (condition 1), ten participants made higher average group allocations in the absence of sanctions, whereas four participants increased their average group allocations in the presence of sanctions. Collectively, the results confirm that in condition 1 group allocation is higher in the absence of sanctions ($p<0.01$). This lends support for H2a. However, in the presence of higher temptation to defect (condition 2), group allocation in the absence of sanctions is not significantly lower than in the presence of sanctions ($z=0.9115$). The average group allocations in condition 2 indicate that nine participants made higher average group allocations in the absence of sanctions, four made higher group allocations in the presence of sanctions, and one manager made similar group allocations in the presence and absence of sanctions. The results of the Wilcoxon signed-rank test are not significant for condition 2 ($z=0.565$). Hence, we fail to find support for H2b.

To test H3 and H4, we use the panel data for conditions 1 and 2 in the presence of sanctions. Using 266 observations (decisions made by 14 supply chain managers during 19 rounds of the experiment), we examine the impact of sanctions placed on a participant at time *t-1*, deviation from average group allocation at time *t-1*, and deviation from maximum payoff at time *t-1* on the amount of group allocation at time *t* for the base case supply network (condition 1) and the supply network characterized by a payoff matrix with higher temptation to defect (condition 2). Several research studies have highlighted the role played by power, risk aversion, and other decision maker specific characteristics on inter-organizational relationships (Buchanan, 1992; Kumar et al., 1995). To clearly discern the impact of the variables of interest, we control for the role played by

participants (dummy variables) and group allocation made by the participant at time *t-1*. In addition, we also control for total work experience, general risk aversion, and the gender of the participant that were collected as a part of the pre-experimental survey. The general risk aversion score is the average score comprising of the following six items (Mandrik and Bao, 2005) measured on a 7-point Likert scale: (i) I do not feel comfortable about taking chances; (ii) I prefer situations that have foreseeable outcomes; (iii) Before making a decision, I like to be absolutely sure how things will turn out; (iv) I avoid situations that have uncertain outcomes; (v) I feel comfortable improvising in new situations; and (vi) I feel nervous when I have to make decisions in uncertain situations.

Given that the decisions made in every round are expected to be dependent on the decisions in the previous round, we first test for autocorrelation between residuals by undertaking Wooldridge test for autocorrelation in panel data (Wooldridge, 2002). The results of the test using the ***xtserial*** command in STATA 12.1 indicate that the residuals are autocorrelated, and we should account for autoregressive error term ($F(1,13)=5.104$, $p<0.05$). We use the ***xtregar*** command in STATA 12.1 to analyze the cross-sectional time-series regression model with disturbance terms that are AR(1) (first-order autoregressive). Since it is reasonable to believe that differences across participants will have some influence on the group allocation, an autoregressive regression model with random effects is theoretically more appropriate. The random effects model allows for the time-invariant characteristics of the participants (e.g., role played, gender, general risk aversion) to be explicitly included in the model, whereas in the fixed effects model these characteristics will be absorbed in the intercept. Specifically, we consider the following model:

$$y_{it+1} = \alpha + \mathbf{x}_{it}\beta + \nu_i + \varepsilon_{it} \qquad i = 1, \ldots, 14;\ t = 1, \ldots, 19 \qquad (1)$$

where $\varepsilon_{it} = \rho\varepsilon_{it-1} + \eta_{it}$ (2)

The dependent variable y_{it+1} is the group allocation by decision makers at time *t+1*. The vector of covariates that includes the explanatory variables and control variables listed above are

represented by $\mathbf{x}_{it}$. In the model, α is the intercept and $\nu_i + \varepsilon_{it}$ is the error term where ν_i is the unit-specific error term; it differs between units, but for any particular unit, its value is constant. ε_{it} is the usual error term expressed in equation (2). In equation (2), $|\rho| < 1$ and η_{it} is independent and identically distributed (i.i.d.) with mean 0 and variance σ_η^2. We consider the random effects model wherein ν_i are assumed to be realizations of an i.i.d. process with mean 0 and variance σ_ν^2.

Our preliminary checks indicate that multicollinearity is not a concern in our model. Endogeneity is a concern when there are possibilities of measurement error, autoregression with autocorrelated errors, simultaneous (or reverse) causality, and omitted variables. By means of our controlled laboratory experiments, we have eliminated other confounding variables and have spotlighted the attention of the participants as well as focused the experimental conditions on the variables of interest. Additionally, our variables are not complex psychometric constructs but capture the group allocation, sanction amount, and payoffs calculated using pre-defined logic. Hence, we do not believe that we encounter the issue of measurement errors. By using autoregressive panel regression model we address the potential endogeneity caused by autoregression with autocorrelated errors. The nature of our explanatory variables (i.e., lagged by one time step vis-à-vis the dependent variable) addresses the potential endogeneity concern of simultaneity or reverse causality. Finally, by taking into consideration aspects capturing individual characteristics (i.e., work experience, attitude towards risk, gender) and experimental contexts (i.e., the role played by participants), we account for the potential issue of omitted variables.

We undertake a stepwise regression analysis by first including the control variables in the regression equations. Next, we include the three variables of interest for the study - sanctioned cost incurred by a participant at time *t-1*, deviation from average group allocation at time *t-1*, and deviation from maximum payoff at time *t-1* that have been hypothesized to impact the group allocation behavior at time *t*. We run these regressions for the supply network facing condition 1 and

condition 2.

The results for condition 1 are presented in Table 2 in models 1 and 2, and the results for condition 2 are presented in Table 2 in models 3 and 4. As shown in Table 2, in the base-case supply network, we fail to find a statistically significant impact of sanctions on subsequent group allocation behavior (model 2: β=-0.039; p=0.354). However, in a supply network with higher temptation to defect, sanctions placed at time *t-1* increase group allocation at time *t* (model 4: β=0.093; p<0.05). The results lend support for hypotheses H3a and H3b. We find that the deviation from average group allocation at time *t-1* is significantly associated with group allocation at time *t* (model 2: β=-0.362; p<0.05). Specifically, when a participant makes lower group allocation than the average group allocation at time *t-1* (i.e., a negative deviation), s/he increases group allocation in the next time period. In contrast, the participant reduces group allocation at time *t* if s/he had made more group allocation compared to the average group allocation at time *t-1* (i.e., positive deviation from average group allocation at time *t-1*). We find that in condition 2, the deviation from the average group allocation at time *t-1* is not significantly associated with group allocation at time *t* (model 4: β=0.126; p<0.319). Finally, for condition 1 the deviation of a participant's payoff from maximum payoff at time *t-1* is not significantly associated with group allocation at time *t* (model 2: β=-0.029; p=0.0343). However, in a supply network with increased temptation to defect, the deviation of a participant's payoff from maximum payoff at time *t-1* is significantly associated with group allocation at time *t* (model 4: β=0.044; p<0.05). The results show that when a participant receives lower payoff than the maximum payoff in the supply network at time *t-1* (i.e., a negative deviation), s/he decreases group allocation in the next time period. The results lend support for hypotheses H4a and H4b.

[Table 2 about here]

The results pertaining to control variables show that in the presence of condition 1 participants playing the role of final assembler (role dummy 1), intellectual property supplier (role

dummy 2), raw material supplier (role dummy 3), and supplier (role dummy 4) made lower group investment than the boundary spanners who play the role of buyer in one supply network and the role of supplier in another supply network (role dummy 5). In contrast, for condition 2 we find that only the final assembler invested higher than the boundary spanner. Group investments made by other roles were not significantly different from the investments by boundary spanners. Previous period's group allocation is significantly positively associated with group allocation in the next period in condition 2 but not in condition 1. The results show that work experience is related to lower group allocation in condition 1 and higher group allocation when the participants are subjected to condition 2. General risk aversion is negatively related to group allocation only in condition 2. Gender does not seem to have any significant association with group allocation in both condition 1 and condition 2.

4.1. Robustness Check

We undertake several additional analyses to check for the robustness of our results. We use Somers' D with Fisher's z transformation to further examine the group allocations by participants in condition 1 and condition 2 (H1) as well as the group allocations in the absence and presence of sanctioning mechanisms in condition 1 and condition 2 (H2) (Somers, 1968; Newson, 2006). For H1, Somers' D provides the information (probability) regarding how often the difference between group allocation in condition 1 is expected to be greater than group allocation in condition 2. Similarly, for H2a(b), Somers' D provides the information regarding how often the difference between group allocation in the absence of sanctions is expected to be higher (lower) than group allocation in the presence of sanctions. In addition, as compared to a single estimate for the rank statistics (as obtained in a Wilcoxon signed-rank test), it also provides the confidence interval. We use the ***somersd*** command in STATA 12.1 to undertake the analyses. The results are presented in Table 3.

[Table 3 about here]

Somers' D analysis for the panel data comprising of 20 rounds of decisions made by 14 participants confirms that group allocation in condition 1 is higher than in condition 2 ($p<0.01$). The results indicate that if we choose a positive condition1–condition2 difference and a negative condition1–condition2 difference at random, then the positive difference is 22.9% more likely to be the larger of the two than to be the smaller of the two. The result for the averaged data for the fourteen participants over twenty rounds was slightly above the 0.10 significance level ($p=0.12$). Somers' D value for the averaged data suggests that if we choose a positive condition1–condition2 difference and a negative condition1–condition2 difference at random, then the positive difference is 58.3% more likely to be the larger of the two than to be the smaller of the two. Overall, this indicates that our results are reasonably robust.

For H2a and H2b, we compare the group allocations in the presence and absence of sanctions for conditions 1 and 2. Somers' D analysis for the panel data from condition 1 indicates that in the base-case supply network, participants invested higher in a group project in the absence of sanctions ($p<0.05$). There is 17.7% higher likelihood for the positive difference of group allocation (in the absence of sanction versus in the presence of sanctions) to be greater than the negative difference. This result was further confirmed by the averaged data ($p<0.001$) and the Somers' D for the averaged data indicates that the positive difference of the group allocation in the absence of sanction versus in the presence of sanction is 100% more likely to be greater than the negative difference. This lends additional support for H2a. As compared to the results from the Wilcoxon signed-rank test, Somers' D analysis lends support for H2b suggesting that in the presence of higher temptation to defect (condition 2), group allocation in the absence of sanctions is lower than the group allocation in the presence of sanctions ($p<0.01$). However, we fail to find support for H2b using average group allocation by the fourteen participants over the twenty rounds of decisions.

While we used the random effects model to test H3 and H4 since theoretically it can be reasoned that participant level differences will have some influence on the group allocation, the Hausman test indicates that the unique errors (u_i) are correlated with the regressors, and hence, from a technical standpoint, fixed effects model is preferable (Condition 1: X^2=34.36; d.f.=5; p<0.001 and Condition 2: X^2=24.89; d.f.=5; p<0.001). Hence, we also report the results obtained from the fixed effects model using the ***xtregar*** command in STATA 12.1 (see Table 4). The results confirm that in the base-case supply network (condition 1), sanctions are not significantly associated with subsequent group allocation behavior (model 1: β=-0.046; p=0.302). However, when the temptation to defect increases (condition 2), sanctions placed at time *t-1* increase group allocation at time *t* (model 2: β=0.076; p<0.10). The results lend further support for hypotheses H3a and H3b. The results obtained from the fixed effects model further show that in condition 1, the deviation from average group allocation at time *t-1* is significantly associated with group allocation at time *t* (model 1: β=-0.450; p<0.05). Hence, participants adapt their decision such that if their group allocation in the previous round is greater (smaller) than average group allocation, they reduce (increase) the group allocation in the next round. However, in condition 2, the deviation from average group allocation at time *t-1* is not significantly associated with group allocation at time *t* (model 2: β=-0.038; p=0.787). We also find that for condition 1, the deviation of a participant's payoff from maximum payoff at time *t-1* is not significantly associated with group allocation at time *t* (model 1: β=-0.052; p=0.102). However, in a supply network with increased temptation to defect, the deviation of a participant's payoff from maximum payoff at time *t-1* is significantly associated with group allocation at time *t* (model 2: β=0.045; p<0.05). Hence, the results confirm the support for hypotheses H4a and H4b.

[Table 4 about here]

5. Discussion

5.1. Theoretical Implications

The findings from this study establish the efficacy of structural embeddedness in supply network for fostering collaboration among constituent members. Uzzi (1997; p. 43) notes, "… in embedded ties, there was an absence of monitoring devices…the decision-making psychology of trust appeared to conform more closely to heuristic-based processing than to the calculativeness that underlies risk-based decision making…" Heuristics based decision-making that relies on group norms as its foundation economizes on cognition, attention, and time and still manages to deliver a collaborative outcome (Aumann and Sorin, 1989). Notwithstanding the role of norms in embedded supply networks, our study points to circumstances that make the structural embeddedness less effective. We operationalize the influence of contextual changes, such as external institutional forces, by changing the payoff matrix to one with higher returns from a non-cooperative decision, and explicitly informing the participants about this change. This shift in the payoff matrix triggers behavioral changes that move the network from a cooperative regime to non-cooperation. The results point to the importance of considering contingencies in shaping collaborative behavior in networks.

The results of our study provide a more nuanced understanding of how sanctions work (or do not work) in supply networks. In a sense, our study emphasizes the role of the moral legitimacy of sanctions. In an earlier study, Fehr and Gächter (2000) show that in a public goods experiment the group contribution of subjects tend to converge to a very low level in the absence of punishment opportunities. Their study finds that contribution rates in the presence of sanctions increase to about 50 to 95 percent of the endowment. In contrast, we find that when sanctions are presented in the base-case supply network, they can reduce collaboration. However, sanctions play an important role in a supply network in which the incentive structure is perturbed by institutional forces. In a

structurally embedded network, sanctions are incompatible with the underlying logic that supply network members follow to instill collaboration. Norms enable structural embeddedness to effectively operate in the supply network. In a network guided by a payoff structure that does not provide an undue advantage to someone who does not cooperate, putting sanctions can have an adverse effect on the norms. Sanctioning has been construed as serving self-interest and enforcing unfair payoff distribution in favor of the sanctioning participants (Fehr and Rockenbach, 2003). However, in a network that has an increased temptation to defect, sanctioning members who are not collaborating is morally legitimate, and hence the disciplining effect of sanctions does not undermine cooperative behavior among network members (Fehr and Rockenbach, 2003). In the presence of a temptation to defect, sanctions present a legitimate and effective mechanism to instill collaborative stance among network members.

Our study indicates that structural embeddedness assists in collaborative decision-making by supply network members. Relational orientation built on group norms shifts supply network members' focus from immediate economic gains to align more closely with the group norm, which we conceptualize in terms of the average group allocation in the supply network (Lincoln et al., 1996; Uzzi, 1997). There is an implicit understanding of what constitutes a 'fair' share in the network relationship. By basing their decision on the average group allocation in the network, structural embeddedness in supply network promotes reallocation of resources and creates parity among various constituents of the network. Decision makers pursue satisficing behavior whereby they change their group allocations only if they are either investing higher or lower than the average allocation in the entire network (Cyert and March, 1992). This is consistent with findings in extant research that show satisficing to be a descriptive alternative to normative maximizing (Simon, 1955); decision makers are more likely to search for something that is good enough (i.e., satisfice) than seeking something that is absolute best (i.e., maximize) (Jain et al., 2013). Participants using the

average group allocation as their aspiration level inadvertently lead to a decision pattern that results in a collusive (and collaborative) effect without an explicit intent for collaboration (Oechssler, 2003).

However, once the incentive structure is changed such that there is a higher temptation to defect, participants change their decision-making strategy from satisficing to maximizing. The changed incentive structure increases the aspiration level of decision makers, and they base their group allocation decision on the deviation of their payoff from the maximum payoff within the network. The results suggest that the choice of maximizing and satisficing may coexist and be applied by the decision maker based on the contextual environment. A noticeable switch from satisficing to maximizing is observed when the decision makers are facing an inherently biased incentive structure, which adversely impacts the foundation of cooperation within the supply networks.

5.2. Managerial Implications

As the study shows, collaboration behavior in embedded supply networks is far more complex than simple buyer-supplier dyads might have indicated in the past. Managers face the daunting task of reacting to this increasing complexity. Foremost, managers have to pay attention to the level of structural embeddedness present in supply networks as it fosters collaboration in the network. This means that managers must understand their behavior as part of a network and be aware of how interdependent and interconnected their sourcing network is. In the presence of high structural embeddedness, collaboration in the network is likely to be high even though the action of every single network member might not necessarily be collaborative. The results suggest that managers should not be myopic in terms of focusing on the actions of individual actors in the network even though these actors might be the ones with whom they are in a direct relationship in their supply network activities. The overall outcome in the network might turn out to be quite distinct from the observations at individual firm level.

The study's findings suggest that managers have to pay attention to the presence of institutional forces that change the incentive structure and thereby impact the level of collaboration in the supply network. It is necessary for managers to act quickly in order to sustain collaboration before the tipping point is reached and collaboration is driven out of the network. Collaboration in networks calls for great attention and continuous care by managing embedded structures and sanctioning options based on the circumstances.

The study provides managerial insights regarding the likelihood of supply chain members changing their behavior based on the alterations in the underlying incentive structure. When institutional factors diminish the incentives for collaboration by making private investments more attractive than group investments, as is observed in the case of industry consolidation (Uzzi, 1997), firms adopt maximizing behavior at the detriment of the overall collaborative environment in the supply network. In the presence of collaborative regime, managers tend to adopt a satisficing stance, whereas changed incentive structure towards defection results in a focus on maximizing the outcome of self. Thus, with changed incentive structures that provide higher rewards for non-cooperative behavior, sanctions become specifically necessary.

6. Conclusions and directions for future research

The results of this study confirm that the structural embeddedness of supply networks is instrumental in shaping collaborative behavior (condition 1). However, an increased temptation to defect compromises the effectiveness of embedded structures (condition 2). The results indicate that a change in incentive structures towards defection born by contextual changes play an important role in altering collaborative behavior in a supply network. They highlight that sanctions are not necessary to instill collaborative behavior in supply networks. In fact, decision makers collaborate more intensely in the absence of sanctions even when there is an incentive to defect as long as the

prevailing incentive structure is not altered to increase the temptation to defect. We find that sanctions increase the propensity of decision makers to invest higher amounts in-group allocation only when the incentive structure has changed to offer more returns from non-cooperation (condition 2).

In the absence of institutional forces impacting the incentive structure, supply networks have adaptive capabilities. Decision makers display satisficing behavior such that their group allocation is related to the deviation from the average allocation made by others in the previous time period. However, once the incentive structure is altered such that there is a higher temptation to defect, decision makers pursue maximizing behavior and make their group allocation based on their deviations from the maximum payoff that was received by a supply chain member in the previous time period.

There are a few limitations of the study that provide fruitful avenues for future research. Despite the use of executives and conducting the experiment at the company site to capture actual decision-making environment more closely, financial incentives provided in the experiment do not reflect sufficiently large investments, which are common in most business situations. Also, even though participants had various international, functional, educational, and organizational backgrounds, they still are only representing an experiment within a single firm. As group norms are highly contingent on context, future research might benefit from a replication in other firm(s) and cultural contexts. Further, the experimental setting was restricted to a specific supply network topology as shown in Figure 2. As the nature of supply chains is diverse, it needs to be tested how different supply network~~s~~ topologies influence collaboration behavior in the short and long run. Notwithstanding some of these limitations, we believe that we have contributed to the newly emerging field of testing collaboration behavior in supply networks alongside previous literature that has studied supply

networks using case studies as a primary tool (Danese et al., 2004; Camuffo et al., 2006; Dubois and Fredriksson, 2008; Caniëls et al., 2012).

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APPENDIX A: EXPERIMENT 1

Instructions for the Experiment

OVERVIEW:

The goal of this experiment is to study decision-making behavior within the network of supply networks, particularly in the pharmaceutical industry. Each supply network comprises of three companies. Several such supply networks are interlinked to form the overall supply network. The structure of the supply network is shown in the figure below.

If you have a question at any time, please raise your hand and the monitor will answer it. We ask that you not talk with one another for the duration of the experiment. On your place you should have a survey for after the experiment, a pen, and a copy of the consent form. In front of you should be a computer with the experiment software running.

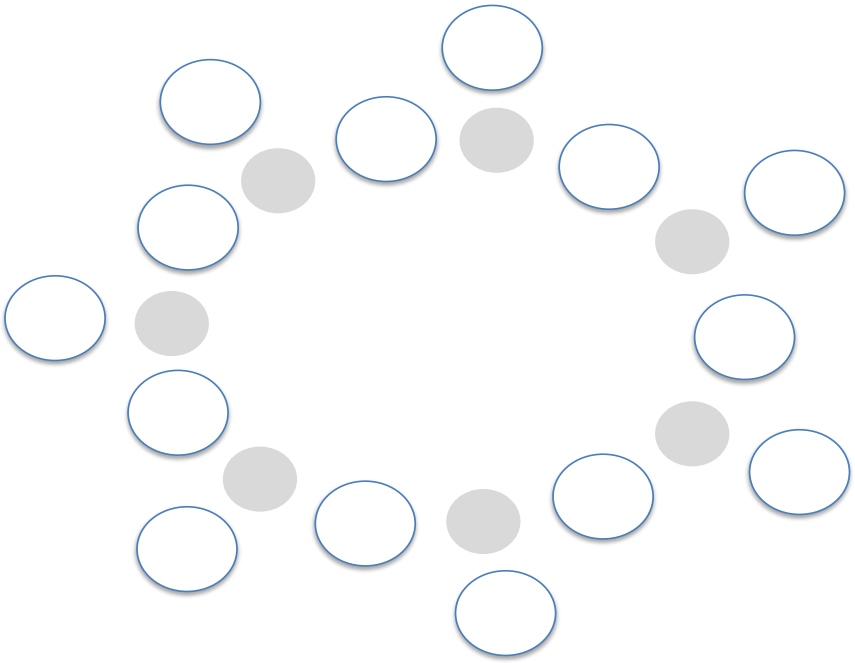


Figure: Structure of supply network

ROLES:

There are six potential roles played by a subject in the experiment
- FA(B): Final Assembler (Buyer)
- S: Supplier in a single supply network
- B | S or S | B: Buyer-supplier network spanner (Plays the role of buyer in one supply network and supplier in another supply network)
- RM(S): Raw Material (Supplier)
- IP(S): Intellectual Property (Supplier)

YOUR ROLE:

FA(B) - Final Assembler: Your company sits at the top of the supply network (shown as FA(B) in the figure). You are the final assembler of a vaccine, which customers buy directly from you. In terms of revenue and the number of people employed, your company is the dominant player in the supply network.

B|S - Boundary Spanner: Your company is a buyer in one supply network and a supplier in another supply network (B | S or S | B in the figure). In the network in which you are the supplier, you are working with one buyer and another supplier. In the network in which you are the buyer, you are working with two suppliers. Your company is dependent on the stronger players in the network for sustained survival.

IP(S) – Intellectual Property Supplier: Your company is well known for its innovation and cutting edge technology (shown as IP(S) in the figure). Your intellectual property has become an industry standard that gets embedded in the product that other companies manufacture.

RM(S) – Raw Material Supplier: Your company is a very large raw material supplier (shown as RM(S) in the figure). Other companies in your supply chain depend on the supplies from your company. In terms of revenue and number of people employed, your company is a dominant player in the supply network.

S – Supplier: Your company is one of many intermediate suppliers in your supply network (shown as S in the figure). You are working with one buyer and another supplier. Your company is dependent on other stronger players in the network for sustained survival.

YOUR AIM:

In the experiments we will be dealing with Experimental Monetary Units (EMUs). In the beginning of the experiment you are endowed with 200 EMUs for the experiment. Note that this endowment is a substantial amount for your firm and you want to maximize the company's money.

THE DECISIONS:

You will decide to allocate 5 EMUs of the available funds towards a group project or to invest in a private project. The group for the group projects consists of your left and right neighbor. You can distribute the 5 EMUs towards group or private project in any proportion that you deem appropriate. However, fractional allocations (e.g., 2.5, 1.5 etc.) are not allowed. To record your decision, you will write EMU amounts in the text-input column in the computer program. Your payoff depends on your decision and on the decision of your group members. After all the participants have made their decisions, each of you will be informed of your gross earnings for the period, however you will not know how much the others invested. Also your investment will not be disclosed. However, after every simulation round it will be disclosed to each of the 14 participants what the highest earning in the supply network was and with which strategy (group / private project investment) this was achieved.

Note: The decisions made by each player will be private information and will not be revealed to others.

Condition 1

Your payoffs from investing in PRIVATE and GROUP ALLOCATION will be based on the following payoff matrix. Imagine that you may invest in joint R&D projects with your supply chain partners (GROUP invest) or in your own process improvements (PRIVATE invest). In case you and the partners invest into the group project, you will all benefit from it. In case you invest in the group project, but the partners do not, you will not benefit, but the partners can free ride. In case nobody invests into the joint innovation, but only into process improvements nobody will gain.

		Your Supply Chain Partner	
		Group Allocation	Private Allocation
You	Group Allocation	3, 3	0, 4
	Private Allocation	4, 0	0, 0

The overall payoff in a round will be based on the following calculation. Let's focus on the triadic network formed by FA(B), B|S and S|B in the figure. Let's assume that FA(B) decides to allocate 3 EMUs for PRIVATE project (e.g., internal R&D project) and 2 EMU for GROUP project (e.g., a joint process improvement project with supplier). B|S allocates the entire 5 EMU for PRIVATE project and S|B allocates 4 EMUs for PRIVATE project and 1 EMU for GROUP project. The payoffs are as follows:

- Payoff of FA(B): **3 EMUs** (utility gained from the allocation of 3 for PRIVATE project) **+ 0 EMUs** (payoff from the payoff matrix based on the pattern of decision made by FA(B) and B|S) **+ 3 EMUs** (payoff from the payoff matrix based on the pattern of decision made by FA(B) and S|B) **+ (2+1)/3** (sharing the money invested in GROUP project by FA(B) and S|B equally among the three partners) = **7 EMUs**
- Payoff for S|B: **4 EMUs** (utility gained from the allocation of 4 for PRIVATE project) + **0 EMUs** (payoff from the payoff matrix based on the pattern of decision made by S|B and B|S) + **3 EMUs** (payoff from the payoff matrix based on the pattern of decision made by FA(B) and S|B) + **(2+1)/3** (sharing the money invested in GROUP project by FA(B) and S|B equally among the three partners) = **8 EMUs**
- Payoff for B|S: **5 EMUs** (utility gained from the allocation of 5 for PRIVATE project) **+ 4 EMUs** (payoff from the payoff matrix based on the pattern of decision made by FA(B) and B|S) **+ 4 EMUs** (payoff from the payoff matrix based on the pattern of decision made by B|S and S|B) **+ (2+1)/3** (sharing the money invested in GROUP project by FA(B) and S|B equally among the three partners) = **14 EMUs**

The payoff received by each participant will be calculated as follows:

Total Payoff_i = $(\text{PRIVATE ALLOCATION})_i$ + $(\text{Payoff received based on the strategy chosen by you and Partner A})_{ij}$ + $(\text{Payoff received based on the strategy chosen by you and Partner B})_{ik}$ + (Equal share of the GROUP ALLOCATION made by the three partners)

To make it easier we provide you with the table payoff calculations for each scenario on your place. It is obvious that you will benefit from having others investing in group projects, but to not invest in group projects yourself. However, it is also clear that everybody is worse off when no company invests in group projects. Remember, the game will be repeated and your group members might adjust their strategy according to your play.

Condition 2

Due to some contextual changes one can gain **higher** returns from PRIVATE ALLOCATION (when others are investing in GROUP allocation) than what was possible in Game 1. Imagine that a new production method is available that would clearly improve the productivity of your facilities.

In the first twenty rounds of this game your payoffs from investing in PRIVATE and GROUP ALLOCATION will be based on the following payoff matrix:

		Your Supply Chain Partner	
		Group Allocation	Private Allocation
You			
Group Allocation		3, 3	0, 5
Private Allocation		5, 0	0, 0

Using the payoff matrix presented above, individual payoffs will be calculated in a similar approach presented for condition1.

APPENDIX B: EXPERIMENT 2

Instructions for the Experiment

OVERVIEW: The overview is the same as in Experiment 1 (see Appendix A)

THE DECISIONS:

You will decide to allocate 5 EMUs of the available funds towards a group project or to invest in a private project. The group for the group projects consists of your left and right neighbor. You can distribute the 5 EMUs towards group or private project in any proportion that you deem appropriate. However, fractional allocations (e.g., 2.5, 1.5 etc.) are not allowed. To record your decision, you will write EMU amounts in the text-input column in the computer program. Your payoff depends on your decision and on the decision of your group members.

Condition 1

Your payoffs from investing in PRIVATE and GROUP ALLOCATION will be based on the following payoff matrix. Imagine that you may invest in joint R&D projects with your supply chain partners (GROUP invest) or in your own process improvements (PRIVATE invest). In case you and the partners invest into the group project, you will all benefit from it. In case you invest in the group project, but the partners do not, you will not benefit, but the partners can free ride. In case nobody invests into the joint innovation, but only into process improvements nobody will gain.

		Your Supply Chain Partner	
		Group Allocation	Private Allocation
You	Group Allocation	3, 3	0, 4
	Private Allocation	4, 0	0, 0

You have the option to punish (or put sanctions) on any partner based on their investment pattern in the previous round. This sanction could be placed on a player within the in group (i.e., the three-player network) as well as the out group (i.e., any member in the entire network comprising of 14 players). Punishing a partner is costly. You will have to pay 1 EMU to reduce the gross earnings of a non-collaborative player by 2 EMUs

After each round (except the first round) you will be provided the following information for all participants in the game. In the first row you will receive information about your own group allocation, private allocation, and payoff:

Member's role*	Level of Adjacency^	Group Allocation	Private Allocation	Payoff
You				

Note: All the decisions and payoffs will be revealed to everyone.
* See the figure for the member's role and member's network number.
^The "level of adjacency" column would capture how far a network members is from the focal player's place in the network. Please see the figure for further details. For each participant we will consider the number of edges to go through to reach another participant. For instance, in network 1 when we consider the perspective of FA(B), the degrees of adjacency of the players to its right (i.e., S|B, S, S|B, IP(S), B|S, …) are 1, 2, 3, 4, …

Based on this information in each round you will not only input your decision regarding how you will distribute 5 EMUs between group allocation and private allocation, but also indicate the specific member on whom you would place sanction. The first row will capture your own group allocation and private allocation. Specifically,

Member's role*	Member's network*	Group Allocation	Private Allocation	Sanctions^
You				

Note: All the decisions and payoffs will be revealed to everyone.
* See the figure for the member's role and member's network number.
^ If the participant wishes to punish one (or more) network members for their decision in the previous round, she/he has to put a "YES" across that member's row.

The payoff received by each participant will be calculated as follows:

Total Payoff$_i$ = (PRIVATE ALLOCATION) $_i$ + (Payoff received based on the strategy chosen by you and Partner A) $_{ij}$ + (Payoff received based on the strategy chosen by you and Partner B) $_{ik}$ + (Equal share of the GROUP ALLOCATION made by the three partners) - $\sum s_{ij} - 2\sum s_{ji}$

where, $\sum s_{ij}$ = player *i*'s expenditure on sanctions and $2\sum s_{ji}$ is the reduction in *i*'s payoff due to the total sanctions received from the rest of the players.

Condition 2

Due to some contextual changes one can gain **higher** returns from PRIVATE ALLOCATION (when others are investing in GROUP allocation) than what was possible in Game 1. Imagine that a new production method is available that would clearly improve the productivity of your facilities.

Your payoffs from investing in PRIVATE and GROUP ALLOCATION will be based on the following payoff matrix. Using the payoff matrix presented below, individual payoffs will be calculated in a similar approach presented for condition1.

		Your Supply Chain Partner	
		Group Allocation	Private Allocation
You			
Group Allocation		3, 3	0, 5
Private Allocation		5, 0	0, 0

Table 1: Wilcoxon signed-rank test

Hypothesis	Using overall panel data (N=280) z-score (p - value)	Using average values for 20 rounds (N = 14) z-score (p – value)
H1: When the temptation to defect increases in a supply network such that the underlying relational norms are altered, the level of collaboration by individual firms in the network decreases.	4.895 (p<0.01)	1.916 (p<0.10)
H2a: The structural embeddedness in supply network enables decision makers to collaborate more intensively in the absence of sanctions as compared to the presence of sanctioning mechanisms.	5.643 (p<0.01)	2.669 (p<0.01)
H2b: When contextual changes in supply network lower the incentive to collaborate, structural embeddedness is not sufficient to induce collaborative behavior to the extent that decision makers will collaborate more intensively in the presence of sanctions as compared to its absence.	0.111 (p = 0.9115)	0.565 (p = 0.5719)

Table 2: GLS regression with random effects and AR(1) disturbances

Dependent variable: Group allocation (t)	Condition 1		Condition 2	
Random effects parameters	Model 1	Model 2	Model 3	Model 4
Constant	2.933**	2.407**	2.323**	2.610**
	(0.552)	(0.542)	(0.549)	(0.592)
Role Dummy 1	-2.044**	-2.277**	0.951*	1.051*
	(0.685)	(0.619)	(0.456)	(0.472)
Role Dummy 2	-2.276**	-2.192**	-0.197	-0.210
	(0.735)	(0.642)	(0.408)	(0.423)
Role Dummy 3	-1.747**	-1.785**	0.311	0.288
	(0.679)	(0.599)	(0.467)	(0.484)
Role Dummy 4	-1.512**	-1.647**	0.248	0.204
	(0.299)	(0.287)	(0.273)	(0.279)
Group allocation (t-1)	-0.121^	0.187	0.404**	0.355**
	(0.062)	(0.115)	(0.057)	(0.085)
Total work experience	-0.059*	-0.054**	0.033*	0.037*
	(0.024)	(0.021)	(0.016)	(0.017)
General risk aversion	-0.070	-0.059	-0.607**	-0.641**
	(0.168)	(0.146)	(0.121)	(0.125)
Gender	-0.185	-0.170	-0.241	-0.192
	(0.413)	(0.359)	(0.289)	(0.300)
SANCTIONED COST (t-1)		-0.039		0.093*
		(0.042)		(0.041)
DEV. FROM AVE. GROUP ALLOCATION (t-1)		-0.362*		0.126
		(0.161)		(0.126)
DEV. FROM MAX. PAYOFF (t-1)		-0.029		0.044*
		(0.030)		(0.019)
Model results				
Number of participants	14	14	14	14
Total observations	266	266	266	266
R-square within	0.0025	0.0271	0.3082	0.3286
R-square between	0.7214	0.7884	0.9258	0.9208
R-square overall	0.3330	0.4039	0.6591	0.6603
Wald Chi-square	48.41**	64.91**	202.10**	188.03**
[degrees of freedom]	[9]	[12]	[9]	[12]
Estimated autocorrelation parameter (rho_ar)	0.399	0.323	-0.242	-0.284
sigma_u	0.326	0.267	0.118	0.107
sigma_e	1.019	1.012	0.975	0.964
Fraction of variance due to u_i (rho_fov)	0.093	0.065	0.014	0.012
Theta	0.244	0.218	0.160	0.148

Note: Standard error in parentheses; Chi-square degrees of freedom in square brackets; ^p<0.10; *p<0.05; **p<0.01

Table 3: Robustness check for H1 and H2 using Somers' D

Hypothesis	Using overall data (N = 280) z-score (p - value)	Using average values for 20 rounds (N = 14) z-score (p – value)
H1. When the temptation to defect increases in a supply network such that the underlying relational norms are altered, the level of collaboration in the network decreases.	Fisher's z-transformed Somers' D Somers' D = 0.233 (Jackknife Std. Err. = 0.078) z-score: 2.99 (p<0.01) 95% confidence interval: [.0799786 .3855779] Untransformed Somers' D = 0.228 95% confidence interval: [.07980846 .36754177]	Fisher's z-transformed D Somers' D = 0.667 (Jackknife Std. Err. = 0.430) z-score: 1.55 (p=0.120) 95% confidence interval: [-.1745252 1.509526] Untransformed Somers' D = 0.583 95% confidence interval: [-.17277455 .90685494]
H2a. The structural embeddedness in supply network enables decision makers to collaborate more intensively in the absence of sanctions as compared to the presence of sanctioning mechanisms	Fisher's z-transformed Somers' D Somers' D = 0.179 (Jackknife Std. Err. = 0.084) z-score: 2.12 (p<0.05) 95% confidence interval: [.0139073 .3445377] Untransformed Somers' D = 0.177 95% confidence interval: [.01390639 .33152246]	Fisher's z-transformed Somers' D Somers' D = 17.62 (Jackknife Std. Err. = 0.028) z-score: 634.19 (p<0.001) 95% confidence interval: [17.56192 17.67081] Untransformed Somers' D = 1 95% confidence interval: [1 1]
H2b. When incentive to collaborate is lowered by contextual changes, decision makers will collaborate more intensively in the presence of sanctions as compared to its absence.	Fisher's z-transformed Somers' D Somers' D = -0.25 (Jackknife Std. Err. = 0.089) z-score: -2.82 (p<0.01) 95% confidence interval: [-.4250643 -.0761381] Untransformed Somers' D = -0.245 95% confidence interval: [-.40118821 -.07599128]	Fisher's z-transformed Somers' D Somers' D = -0.711 (Jackknife Std. Err. = 0.623) z-score: -1.14 (p=0.254) 95% confidence interval: [-1.932 .5106147] Untransformed Somers' D = -0.611 95% confidence interval: [-.95889479 .47042404]

Table 4: Fixed effects regression models

Dependent variable: Group allocation (t)		
Fixed effects parameters	Model 1 (Condition 1)	Model 2 (Condition 2)
Constant	0.690*	0.729**
	(0.347)	(0.233)
Group allocation (t-1)	0.389**	0.509**
	(0.114)	(0.089)
Role Dummy 4[#]	-0.858	-0.002
	(0.637)	(0.599)
SANCTIONED COST (t-1)	-0.046	0.076^
	(0.045)	(0.042)
DEV. FROM AVE. GROUP ALLOCATION (t-1)	-0.450**	-0.038
	(0.168)	(0.142)
DEV. FROM MAX. PAYOFF (t-1)	-0.052	0.045*
	(0.032)	(0.019)
Model results		
Number of participants	14	14
Total observations	252	252
R-square within	0.064	0.212
R-square between	0.211	0.969
R-square overall	0.138	0.656
F statistic	3.18**	12.52**
[degrees of freedom]	[5]	[5]
Estimated autocorrelation parameter (rho_ar)	0.022	-0.114
sigma_u	0.901	0.751
sigma_e	1.006	0.959
Fraction of variance due to u_i (rho_fov)	0.445	0.380

Note: Standard error in parentheses; Chi-square degrees of freedom in square brackets; ^p<0.10; *p<0.05; **p<0.01

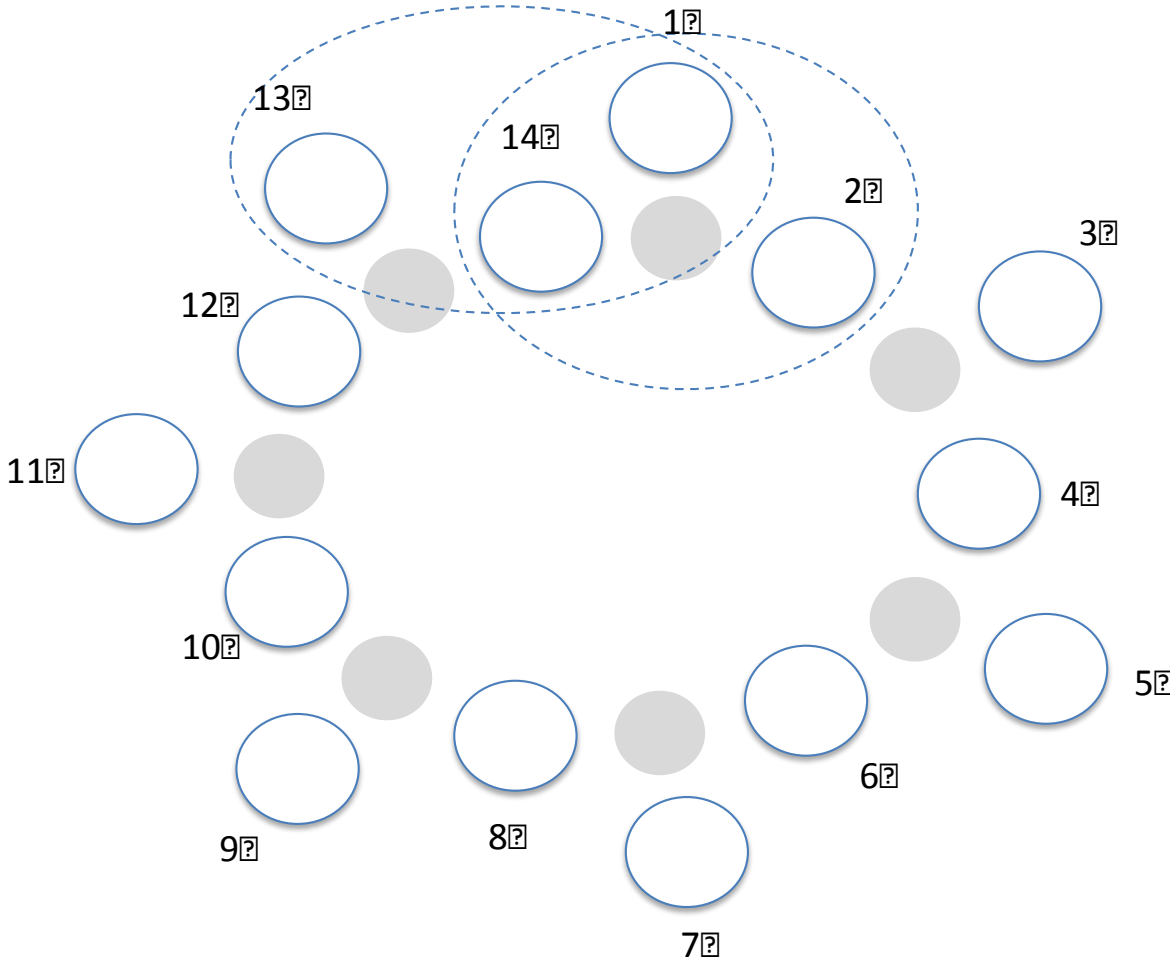
[#] Role Dummies 1, 2, 3, and 5 as well as time invariant participant characteristics total work experience, general risk aversion, and gender were dropped because of collinearity.

Figure 1: Experimental design

		Temptation to Defect	
		No	Yes
Sanctions	Yes	Hypothesis: Experiment 2 (Hypotheses: H3a, H3b, H4a and H4b)	Hypothesis:
	No	Experiment 1 (Hypotheses: H1)	

Note: We compare the results of both experiments to test H2a and H2b

Figure 2: Supply network considered for the behavioral experiments



- FA(B): Final Assembler (Buyer)
- S: Supplier in a single supply network
- B | S or S | B: Buyer-supplier network spanner (Plays the role of buyer in one supply network and supplier in another supply network)
- RM(S): Raw Material (Supplier)
- IP(S): Intellectual Property (Supplier)

Figure 3: Payoff matrices for each condition presented in the experiments

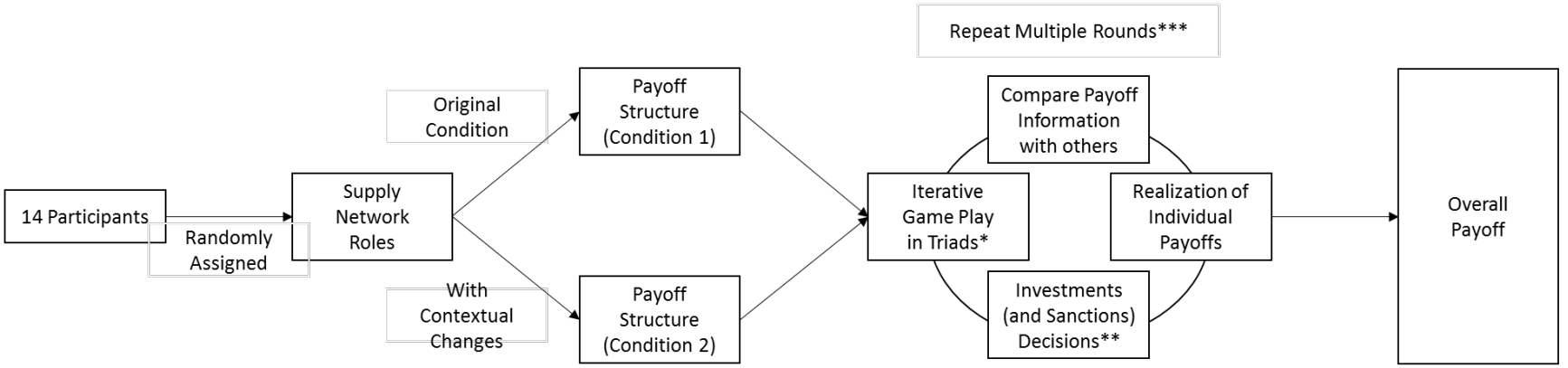
Condition 1
Base Case

You \ Your Supply Chain Partner	Group Allocation	Private Allocation
Group Allocation	3, 3	0, 4
Private Allocation	4, 0	0, 0

Condition 2
Higher Temptation

You \ Your Supply Chain Partner	Group Allocation	Private Allocation
Group Allocation	3, 3	0, 5
Private Allocation	5, 0	0, 0

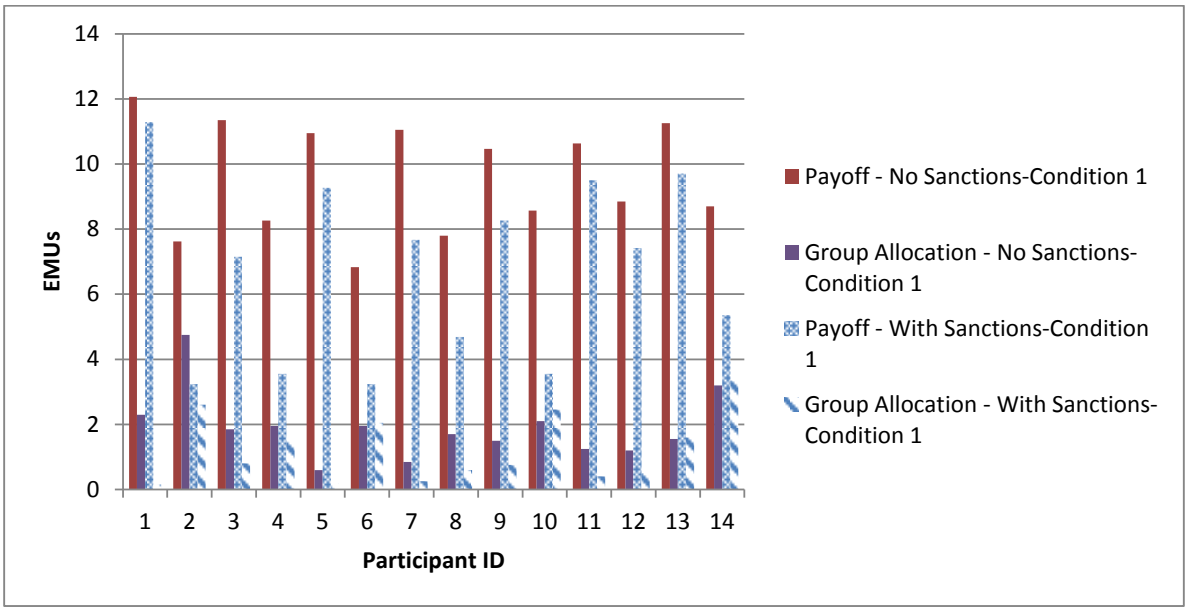
Figure 4: Flow chart of the experiments



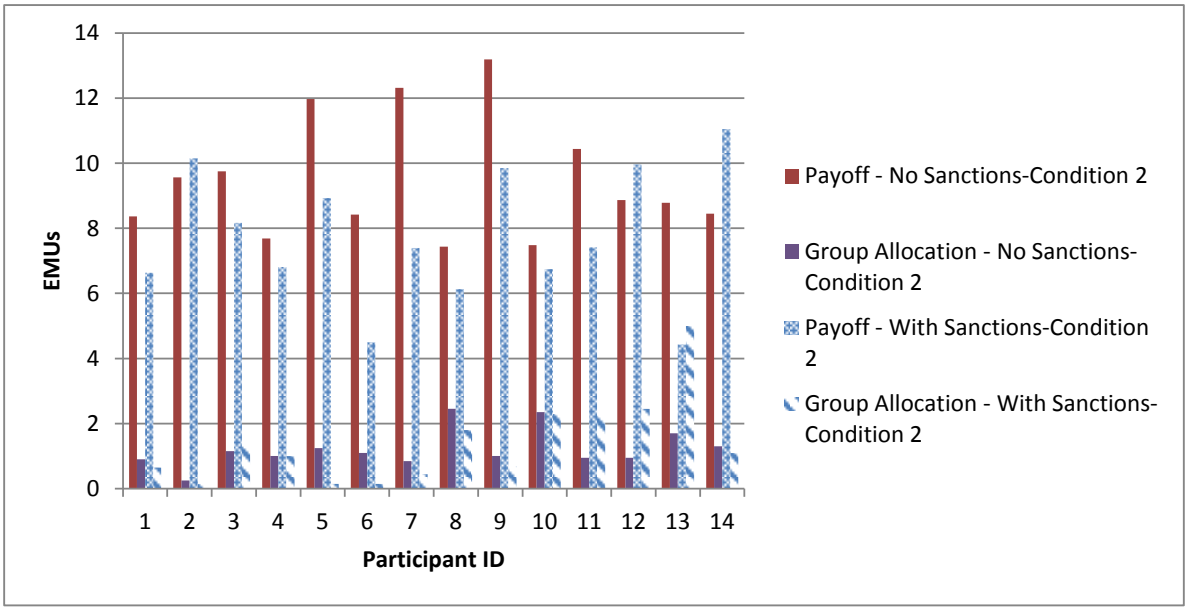
* Each participant simultaneously plays an iterative Prisoner's Dilemma game with two neighboring partners forming a triad. Each triad is a conceptualized as a subset of the overall supply network.
** In experiment 1, participants only make investment decisions between an individual project and a group project. In experiment 2, participants can put sanctions as well as investment decisions.
*** After sharing the payoff information of the initial round, the game is repeated for 20 rounds.

Figure 5: Group allocation and Payoffs

PANEL A - Condition 1 (Base-case supply network)



PANEL B - Condition 2 (Supply network with higher temptation to defect)



Highlights

- By organizing practicing managers in a supply network, the study investigates the role of structural embeddedness, norms, and sanctioning mechanisms on the level of collaboration.
- The results of this study confirm that while sanctions are detrimental for collaborative behavior in a supply network, they play an important role when the underlying norms of governance of such a network are perturbed.
- Once the incentive structure is altered, the adaptive collaborative behavior is replaced by a behavior in which firms try to maximize their returns and forego collaborative decision-making behavior.

*Response to Reviewers

Response to Senior Associate Editor's Comments:

Following the most recent round of revisions, the highlights are not as "sharp" anymore as before. The third highlight, for instance, does not really read like a highlight. I cannot see how this is an essential element of your study. It is more a general remark. Can you please have another look to see which 3-5 sentences sum up the highlights of your study?

We have removed the third highlight so as to ensure that we include sentences that clearly relate to the key contribution of our study.

Please shorten the abstract. The target should be to shorten it by about a third. And while doing so, please revise the final sentence in light of the latest revisions. I.e., please make sure it is not about a change as such, but a change in a particular direction.

We have made changes to the abstract in light of your comment.

On p.2, I think that it should say "manifest themselves" in the second sentence. And the third sentences can be taken out altogether, I feel.

We have made this change.

The Toyota example on p.4 is a nice addition. **It is not clear however what the last sentence of that example means. How it illustrates a change in embeddedness.** Without additional information about the parties mentioned there, e.g., Trim Masters, it is not clear what the changes to the network were.

In the revised paper, we have added some additional contextual details regarding Trim Masters Inc. Specifically, we state: "Similar actions were taken with regards to Trim Masters Inc., which was formed in 1987 as a joint venture 49%-owned by Johnson Controls (JCI) and 51%-owned by Toyota Boshoku and Toyota Tsusho. After Toyota realized they were getting too embedded with JCI, Toyota and JCI phased out the joint venture in 2008. Now Trim Masters, Inc. operates as a subsidiary of Toyota Tsusho America, Inc."

A final issue to consider is that you say that structural embeddedness is important when partners know they will work together in the future. In my own words, when there is a shadow of the future. In your experiments, did participants know when it was the final round? If so, there is no shadow of the future in that round. Did you observe different behaviors in that final round? Please discuss this as you see fit.

The participants were aware of the final round. We examined the pattern of decisions made over the course of 20 rounds and did not find any discernible bias in the final round. We also conducted multivariate tests for the equality of means and the results suggest that the group allocation in different game scenarios is not significantly different for different time-steps. We have added a note regarding this in the revised paper.

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