THE ROLE OF INCENTIVES AND COMMUNICATION IN STRATEGIC ALLIANCES: AN EXPERIMENTAL INVESTIGATION

Rajshree Agarwal
Department of Business Administration
College of Business
University of Illinois at Urbana-Champaign
350A Wohlers Hall
1206 South Sixth Street
Champaign, IL 61820
217-265-5513
agarwalr@uiuc.edu

Rachel Croson
School of Management, and
School of Economics, Political and Policy Sciences
University of Texas, Dallas, GR31
Green Hall 2.514
Richardson, Texas 75080
972-883-6016
crosonr@utdallas.edu

Joseph T. Mahoney
Department of Business Administration
College of Business
University of Illinois at Urbana-Champaign
140C Wohlers Hall
1206 South Sixth Street
Champaign, IL 61820
217-244-8257
josephm@uiuc.edu

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ABSTRACT

This paper experimentally investigates the determinants of the deviation between *potential* and *realized* value creation in strategic alliances. To better understand how decision making in alliances may influence success, we use an experimental design that juxtaposes two important factors that affect alliance members' decisions: economic incentives and communication. The evidence from our experiment sheds light on the relative impact of each, and importantly, how both factors interact to explain successful outcomes. These results are robust to the use of undergraduates, MBAs and seasoned executives who averaged over 12 years of work experience.

1. Introduction

Strategic alliances[1] are ongoing cooperative relationships and represent an important organizational form for governing business transactions (Dyer & Nobeoka, 2000; Reuer, Zollo & Singh, 2002; Silverman & Baum, 2002; Zaheer & Bell, 2005). Strategic alliances have the potential to create economic value (Gulati & Singh, 1998; Harrigan, 1988; McEvily & Zaheer, 1999), and on average, empirical evidence corroborates this view (Chan, Kensinger, Keown & Martin, 1997; Sarkar, Echambadi & Harrison, 2001). However, approximately half of all strategic alliances fail (Kale, Dyer & Singh, 2002). Indeed, the large gap between *potential* economic value creation and *realized* economic value creation in strategic alliances suggests that there are formidable impediments to successful alliance outcomes (Anand & Khanna, 2000; Ariño & de la Torre, 1998; Gottschlag & Zollo, 2007; Kumar & Nti, 1998; Madhok & Tallman 1998).

The challenges in achieving successful outcomes in strategic alliances relate to the inherent tension between cooperation and competition (Hamel, 1991; Khanna, Gulati & Nohria, 1998, 2000). To realize potential value, alliance partners must invest resources, share knowledge and build synergies through cooperation (Dyer, 1997; Dyer & Singh, 1998; Zeng & Chen, 2003). However, given that the benefits of alliance activity are commonly available to all alliance partners, there arises the potential for "free-riding" or engaging in learning races in the pursuit of private benefit at the expense of the total value creation (Khanna, Gulati & Nohria, 1998). Thus, decision makers in strategic alliances must deal with substantial uncertainty and coordination failures, which can lead to real or perceived opportunism, miscalculation and low performance (Burgers, Hill & Kim, 1993; Dyer & Hatch, 2006; Shan, Walker & Kogut, 1994). Managerial solutions to such impediments are

[1] While both the current paper's theory development and the experimental empirical context in which the participants involved are in terms of "strategic alliances," both the theoretical logic and the empirical results can be applied to a large number of both co-opetition and cooperative settings (e.g., buyer-supplier arrangements, joint ventures, franchising of brands, internal corporate ventures, networks, R&D consortia, technology transfer agreements, and teams, to name but a few) (Baum, Calabrese & Silverman, 2000; Inkpen, 2000; Jarillo, 1988; Lavie, 2007; Lerner & Merges, 1998; Lorenzoni & Lipparini, 1999; Merchant & Schendel, 2000; Phene, Fladmoe-Lindquest & Marsh, 2006; Roethaermel & Boeker, 2008; Roethaermel & Deeds, 2004; Sampson, 2005; Santoro & McGill, 2005; White & Liu, 2005).

often learned over time, albeit in a less than systematic fashion, through hard earned experience with strategic alliance partners (Ahuja, 2000; Gulati, 1999; Kale, Singh & Perlmutter, 2000; Madhavan, Koka & Prescott, 1998). Despite the need for deeper understanding, there has been little systematic research on the role of underlying mechanisms such as incentive alignment and communication in explaining the likelihood of cooperative alliance outcomes.[2] This gap in the research literature has at least two related sources — a lack of theoretical understanding of the relative importance of the mechanisms that lead to strategic alliance success and the need for better methodologies that disentangle the effects of these mechanisms on decision-making.

Broad theoretical issues regarding the formation, governance, and performance consequences of strategic alliances have received significant research attention (Dussage, Garrette & Mitchell, 2000; Lunnan & Haughland, 2008; Stuart, 2000; Uzzi & Gillespie, 2002), and some fundamental theoretical propositions for decision-making within strategic alliances have been developed (Khanna, Gulati & Nohria, 1998; Zeng & Chen, 2003). Specifically, Khanna, Gulati and Nohria (1998) develop theoretical propositions based on the importance of economic incentives, and Zeng and Chen (2003) identify the use of "structural solutions" (e.g., incentives and pay-off matrix), and the use of "motivational solutions" (e.g., communication) as potential ways to increase cooperative rather than competitive outcomes. However, since the underlying theoretical mechanisms often come from different literature streams (e.g., economics vs. social psychology), a systematic analysis of how these mechanisms interplay with each other is lacking.

On the empirical front of examining decision-making, current methods are either at too aggregate a level, based on stock market returns and output measures, or rely upon post-alliance perceptions of success that can suffer from recollection or reconstruction bias. Use of secondary data is also somewhat problematic, since pre-alliance selection effects and potential endogeneity can

[2] Some previous empirical studies on decision-making have investigated internal corporate venturing (Burgelman, 1985; Garud & Van de Ven, 1992), joint ventures (Inkpen, 2008), and alliances (Kale & Singh, 2007; Luo, 2008; Simonin, 1999; Tiwana, 2008). They highlight the importance of communication to overcome bounded rationality. The current paper's findings, derived from an experimental design, corroborate the importance of communication in achieving cooperative outcomes in inter-firm alliances.

confound causal mechanisms that impact decision making in alliances (Hamilton & Nickerson, 2003). For example, since exchange partner selection can impact alliance success (Lazzarini, 2007; Li, Eden & Ireland, 2008; Shah & Swaminathan, 2008), research studies examining causality of decision-making during the strategic alliance need to control for selection factors. This requirement is difficult to satisfy with survey or secondary data. Furthermore, alternative mechanisms, while distinct theoretically, are often confounded in the field. For example, it is difficult to isolate the impact of, or examine the interactions between, economic incentives and communication among alliance partners using secondary data, since these mechanisms exist simultaneously and cannot be teased apart in the real world.

To address these fundamental research challenges, Ireland, Hitt and Vaidyanath (2002) recommend multiple theories and methodologies for studying how alliances can be effectively managed for achieving competitive advantage. Following their recommendation, we combine insights from economics and social psychology to develop hypotheses that relate to the role of economic incentive alignment and communication. We test these hypotheses using an experimental approach, widely employed in economics, psychology and to an increasing extent in strategic management (Davis 2003; Kagel & Roth 1995; Song, Calantone & Di Benedetto, 2002). The methodology enables a direct and clean measurement of both the dependent variable (success in the strategic alliance), and the independent variables (incentives and communication) through the creation of independent "treatments" that represent each underlying causal mechanism. A salient feature of this methodology is that by simulating treatments that may not occur in the field, it enables us to identify the independent and combined effects of these variables (Friedman & Sunder 1994). The laboratory setting also allows the creation of a simulated environment that controls for selection effects by random assignment of strategic alliance partners. This type of evidence is critical for advancing our understanding of the theory of economic organization.

We posit and show that alignment of economic incentives is a necessary, but not a sufficient condition for achieving successful alliance outcomes. Contrary to economic theorizing that talk is cheap (Ledyard, 1995), we find strong evidence of additional benefits of communication. Our paper

thus shows that economics property rights theory (which emphasizes the role of economic incentive alignment) and classic organization theory (which underscores the need to cope with bounded rationality) are both important to decision-making in strategic alliances. In the next section, we develop our theoretical framework and hypotheses for the mechanisms that impact decision-making in strategic alliances. We describe the experimental methodology that simulates participants in an alliance setting in Section 3, and provide the empirical results in section 4. The concluding section 5 includes a discussion, limitations of our study and avenues for future research.

2. Theoretical Framework

Strategic alliances are an inter-organizational form where multiple exchange partners agree to invest resources, share knowledge and engage in value-creating activities that build on synergies between the resources and capabilities that each of the partner firms bring to the alliance. While alliances are formed with the intent that all exchange partners will gain from cooperation through economic value creation, there is nonetheless a competitive element; alliance partners have an incentive to compete for the largest share of the benefits. In addition, exchange partners can pursue their own interest over the strategic alliance by engaging in hold-up (Doz & Hamel, 1998; Shuen, 1994), and/or in learning races (Hamel, 1991; Khanna, Gulati & Nohria, 1998).

Since our primary objective is to move beyond *potential* value creation and analyze economic and strategic management issues concerning *realized* value creation in alliances, Olson's (1965) seminal research on "the logic of collective action" is especially salient. Olson (1965) combines aspects of property rights theory (e.g., the tragedy of the commons) with game-theoretic insights[3] in which social dilemma situations can result in persistent severe under-performance of economic value creation potential (Arend & Seale, 2005). The key idea is that strategic alliances typically create economic value that have a "common pool" component, and this lack of well-defined property rights invites potential opportunistic behavior and free riding (Mowery, Oxley & Silverman, 1996;

[3] Lively discussions concerning the role of game theory in the field of Strategic Management can be found in the 1991 Winter Special Issue of SMJ (Camerer, 1991; Postrel, 1991; and Saloner, 1991).

Oxley, 1997; Reuer & Arino, 2002).[4] Thus, a few researchers have underscored the usefulness of examining the conflict between competition and cooperation through the lens of game theory and social psychology, where strategic alliances can be represented as a "public good" or a "social dilemma" problem (Gulati, Khanna & Nohria, 1994; Zeng & Chen, 2003). The social dilemma arises because exchange partners must decide on whether to pursue a higher individual pay-off through competitive choices, even though the collective payoff is larger with cooperation. Further, the common sharing of the economic value created in the alliance introduces the public good element: it is difficult to exclude alliance partners from sharing in the gains, regardless of whether they contributed towards the value creation.

When framed as a social dilemma problem, alliances can be modeled as either a prisoners' dilemma or an assurance/coordination game[5] (Gulati, Khanna & Nohria, 1994). In both settings alliance partners decide how much to invest towards the joint alliance activity. Their investments are crucial for value creation, but the rewards of their investments are common to all partners, and contingent on how much the other alliance partners contribute. Gulati, Khanna & Nohria (1994) note that while alliances are often viewed as prisoners' dilemma games they should be more appropriately characterized as an assurance game. To explicate this logic, we provide a simple

[4] The "common-pool problem" has many applications in economic theory. An extensive research literature on depletable natural resources such as oil fields and fisheries describe how inefficiency arises due to a lack of well-defined property rights causing individual or firms to "over-harvest" the resources (Libecap, 1989). Beyond these examples of conservable resources, Michael (1999) shows how firms tend to under-invest in advertising under a franchising framework where the economic returns to a common brand or trademark are shared by both franchisors and franchisees. Argyres and Liebeskind (1998) report on the business problem caused by the "intellectual commons" for achieving the full potential of a commercializable technology.

[5] The assurance game is also called the Stag-hunt game in a story of social contract told originally by Jean-Jacques Rousseau (1754): Two individuals go on a hunting expedition together. Each person can individually choose to hunt a stag or to hunt a hare. Each individual must choose an action without knowing the choice of the other hunter. If an individual hunts a stag, he must have the cooperation of his hunting partner in order to succeed. An individual can get a hare by himself, but the hare is worth less than the stag. In this stag-hunt game, the rational choice for one person depends on what the other individual will do. There are two equilibria to this game: (1) Both persons choose to hunt the stag (which is the larger mutual payoff) and (2) both persons choose to hunt hare. The individual decision to hunt the stag entails both the potential for greater mutual benefit and the potential for greater personal risk (Skyrms, 1993).

illustration of the different payoff matrices in two-person game in Table 1. In panel 1, we start with the "invisible hand" game where there is *no* social dilemma and the dominant strategy (Nash) equilibrium is for both players to cooperate. Each player is led, by their individual rational self-interest as described by Adam Smith (1776), to the desirable Pareto optimal outcome of (170, 170). In contrast, the other three panels of Table 1 demonstrate social dilemma problems.

In the prisoners' dilemma game of Panel B, the dominant strategy (Nash) equilibrium is to *not* cooperate. Each player chooses their individually rational (self-interested) move, which results in a Pareto inferior outcome of (120, 120), rather than the collectively rational outcome of (170, 170). While there is a dominant strategy of no cooperation in prisoners' dilemma games, the assurance game, depicted in Panels C and D (for homogenous and heterogeneous payoffs respectively) has two potential Nash equilibria outcomes—a pay-off dominant strategy, and a risk dominant strategy (Harsanyi & Selten, 1988). The optimal decision for each alliance partner is dependent on their partners' decisions. If the partner cooperates, then the individual's best response is also to cooperate, while if the partner does not cooperate, the best response is to not cooperate as well. The cooperative equilibrium is payoff-dominant (earning 170 for each player in Panel C). The do-not-cooperate equilibrium is risk-dominant. It earns less for each player (110 in Panel C), but it is also less risky. Each player gains 10 if his partner chooses the other action. In contrast, in the cooperative equilibrium, each player loses 70 if his partner chooses the other action.

Successful alliance outcomes thus rely on exchange partners choosing the payoff dominant strategy where they all cooperate towards the joint goal of value creation, rather than the risk-dominant strategy of not investing in the joint alliance activity. Researchers in both economics and social psychology have emphasized different mechanisms through which a higher likelihood of successful coordination on the payoff-dominant equilibrium can be achieved. Not surprisingly, economists assume perfectly rational decision makers and have tended to focus on "structural" solutions such as economic incentives alignment, while social psychologists assume that people act with limited rationality and emphasize "motivational" solutions such as communication (Zeng &

Chen, 2003). We turn to the role of economic incentives and communication among strategic alliance partners as factors representing each dominant paradigm below.

2.1 Economic Incentives

The important role of economic incentive alignment in strategic alliances harks back to property rights theory, which examines the sanctioned behavioral relations among decision makers in the use of potentially valuable resources (Barzel, 1989; Libecap, 1989). Coase (1960) introduced property rights into the economics of organization and questioned why firms, formal alliance structures, and other institutions exist at all if the price system were perfectly efficient. Coase (1937, 1960) noted that in a world of positive transaction costs, organizational forms matter for achieving efficiency. Property rights theory has much to offer in developing a more systematic approach for understanding strategic alliances (Chi, 1994; Foss & Foss, 2005; Liebeskind, 1996, Oxley, 1999).[6]

In particular, frictions in establishing property rights helps to explain and predict why there can be large and persistent economic gaps between potential and realized value creation (Kim & Mahoney, 2005; Mahoney 2005). Property rights theory emphasizes "getting the economic incentives right." Absent some mutual resource commitments from alliance members to align their economic incentives in a strategic alliance environment, the alliances will fail to achieve synergies and sustained economic value creation (Gulati, Khanna & Nohria, 1994). Following Khanna, Gulati and Nohria (1998), who base their theoretical model on economic reasoning pertaining to property rights, we analyze the payoff structures of strategic alliances in terms of their private and common

[6] Other related theories include agency theory and transactions costs theory. All three hypothesize that getting the economic incentives right is both necessary and sufficient to lead to efficient outcomes. Since our framework later also examines the role of bounded rationality, it is within the camp of incomplete contracting (e.g., transaction costs and property rights theory) and not the complete contracting principal-agent model (Holmstrom, 1982). Thus, the current paper is more precisely about property rights theory than agency theory. Moreover, as Williamson (1996) notes, there are both similarities and differences between trans-action costs theory and property rights theory. An important similarity is that both transaction costs theory (Coase, 1937) and property rights theory (Coase, 1960) are theories of market frictions. An important difference is that property rights research literature treats the definition of property rights and contracting as being far less problematic than does transaction costs theory. Since we are interested in isolating the importance of economic incentives as a mechanism of achieving alliance success, we base our predictions on property rights theory rather than on transactions costs theory.

benefits. Khanna, Gulati and Nohria (1998) define "private" benefits as those accruing to individual firms from activities not governed by the alliance, and "common" benefits as those accruing to all participants in the alliance. More specifically, in the context of the assurance game, private benefits occur when partners "take" from others, in the form of unilateral learning of skills and knowledge and application in areas unrelated to the alliance's activities, while common benefits are realized by collective "giving" or sharing of information and application of the learning in areas related to the alliance (Khanna, Gulati & Nohria, 1998; Spencer, 2003).

Since strategic alliances typically result in both kinds of benefits, the decision makers in a strategic alliance face an inherent tension between competition and cooperation, as exemplified by learning races where an alliance partner can privately benefit at the expense of the others' in the alliance. Thus, the probability of alliance success depends on the extent to which the decision makers perceive common benefits to be greater than private benefits. From a property rights' perspective, a strategic alliance has elements of the "tragedy of the commons" (Hardin, 1968). If the benefits for contributing to the alliance (and maintaining the value of the common pool) are less the private benefits from "raiding" the pool, then the alliance is less likely to result in cooperative behavior among the decision makers. Consistent with property rights theory (Coase, 1960), we predict that aligning of economic incentives is critical to ensuring alliance success. Accordingly, and consistent with Khanna, Gulati and Nohria (1998), we posit:

H1: Alliances wherein decision-makers have a higher ratio of common to private benefits are more likely to achieve success than alliances wherein decision-makers have a lower ratio of common to private benefits.

The above hypothesis is consistent with the early property rights research literature and the optimistic view that efficiency will be readily achieved (Demsetz, 1967). However, more recently, both theorists and property rights historians have challenged this optimistic view (Eggertsson, 1990; North, 1990). Recent property rights research literature, which works from an incomplete contracting perspective (Hart, 1995) emphasizes that the coordination procedures by which one can obtain the correct economic incentives are exceedingly difficult. For example, Libecap (1989) notes that asymmetric information and distributional conflicts often lead to persistent sub-optimization of

economic outcomes. Further, the more heterogeneous the contractual bargaining parties are, the greater the impediments to achieving the full potential of economic value. These contributions in property rights theory are consistent with theoretical arguments in the strategic management research literature, which focus on the impact of heterogeneity in partner scope and resultant differences in economic incentives on strategic alliance success and failure (Khanna, Gulati & Nohria, 1998; Nielsen, 1988). Given the need for coordination among alliance partners, a key factor that can impact alliance success is whether decision makers are similar or different to each other in terms of perceived benefits of the strategic alliance. An increase in the heterogeneity of decision-makers, as modeled in Panel D of Table 1, increases the difficulty of reaching the efficient economic outcome (Libecap, 1989). Khanna, Gulati and Nohria (1998) discuss differences in relative scope of alliance partners and predict that asymmetric common benefits can cause problems in achieving coordination or cooperation in strategic alliances. There are several reasons why one may expect increases in heterogeneity to cause a decrease in success rates of strategic alliances. First, the need for coordination is greater when exchange partners have to determine the optimal allocation of effort, given differences in relative common benefits from the alliance activities. Second, heterogeneity among alliance partners increases the perception of opportunistic behavior by partners, even when none may be present. Heterogeneity increases the potential for misunderstanding, and creating divergent expectations among alliance partners (Goerzen, 2007; Goerzen and Beamish, 2005). Accordingly, we hypothesize:

> **H2: Alliances in which there is heterogeneity in strategic alliance partners' ratio of common to private benefits will have a lower likelihood of success than alliances where partners are relatively homogenous in their ratio of common to private benefits.**

2.2 Communication

The two hypotheses above relate to factors influencing economic incentive alignment and heterogeneity, and focus on what social psychologists term "structural solutions" to a social dilemma problem (Komorita & Parks, 1994; Yamagishi, 1986). Importantly, both hypotheses, and H1 in particular, rest on the implicit assumption made by economists: that alliance partners act rationally,

and when provided with full information about appropriate economic incentive alignment, gain a complete understanding of the coordination problem that they face.

However, as social psychologists and behavioral economists have later noted, the strong-form property rights theory abstracts away from considerations arising from coordination failure, miscalculation, free-riding behavior, and distributional conflicts (Libecap, 1989; Olson, 1965). The early view relies on optimization based on economic incentive alignment alone, and makes many behavioral assumptions that may not hold in reality. Indeed, in an assurance game context, there is a strong likelihood that the risk-dominant strategy overshadows the payoff dominant strategy (Harsanyi & Selten, 1988). Even in the absence of actual opportunistic behavior by any of the alliance partners, the risk and associated fear that others may not contribute towards joint alliance interests may prevent individual decision makers from undertaking actions that will result in alliance success. Suspicion breeds distrust, and reversion to competitive rather than cooperative actions. Such coordination costs are further exacerbated by decision-making biases caused by uncertainty (Zajac & Bazerman, 1991), the anchoring and/or framing problem (Kahneman, Slovic & Tversky, 1982) or by differences in the considerations of "fairness" across strategic alliance partners (Messick, 1991). In sum, even in strategic alliances wherein decision-makers perceive a higher ratio of common to private benefits ratio, lack of coordination due to insufficient common knowledge, differential perceptions of other decision-makers' actions and the bounded rationality[7] of the participants to clearly see what actions are in their best interests (Simon, 1947) can result in the *realized* value creation from a strategic alliance falling short of the *potential* value creation.

When viewed through the lens of classic organization theory[8] or social psychology, alliances may also benefit from the incorporation of "motivational" or "design" solutions, chief among which

[7] Simon defined bounded rationality as: "The capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problem whose solution is required for objectively rational behavior in the real world --- or even for a reasonable approximation to such objective rationality" and "it is only because human beings are limited in knowledge, foresight, skill, and time that organizations are useful instruments for the achievement of human purpose" (1957: 198-199).

[8] The fundamental insight from classical organization theory is that effective coordination requires not only monetary incentives but also non-monetary rewards, and that both formal and informal managerial

is *communication* among partners (Barnard, 1938; Komorita & Parks 1994; Ledyard, 1995; Scott, 1987; Simon 1947; Zeng & Chen, 2003). Within the context of the strategic management literature, institutional design factors such as the role of both formal and informal communication in achieving cooperation and coordination has been emphasized since Barnard (1938). A key difference between structural solutions (such as economic incentive alignment) and motivational/design solutions is that the former aims to change the underlying structure such as the economic payoffs associated with the problem, while the latter solutions are more "intangible," and attempt to address the institutional design to elicit greater cooperation (Komorita & Parks, 1994; Ledyard, 1995; Zeng & Chen, 2003). Importantly, Zeng and Chen (2003) note that communication among alliance partners can potentially offer a more cost-effective solutions than structural modifications in economic payoffs, given the high costs associated with altering the monetary reward structure, monitoring, and potential restructuring/consolidation of partner businesses.

Communication matters because it can help change strategic alliance partner perceptions of the problem from competitive to cooperative in two distinct ways. First, communication can reduce coordination costs and address issues related to bounded rationality and decision biases. Strategic alliance researchers have recognized the role for personal communications among decision makers for achieving cooperation and coordination (Rodan & Galunic, 2004; Rowley, Behrens & Krackhardt, 2000; Zaheer & Venkatraman, 1995). Investing time and effort in improving communication improves economic returns (Adner & Helfat, 2003; Chung, Singh & Lee, 2000) by facilitating a *flow of information,* which can clarify expectations and causal connections between individual actions and group outcomes (Kogut, 1988, 2000; Thorelli, 1986). When decision makers

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communication can increase the likelihood of cooperation and coordination (Barnard, 1938). What sets organization theory apart from much of economics is this emphasis on the non-material, informal, interpersonal, and moral basis of behavior (Scott, 1987). Contemporary organization theory concerning social capital --- which can be defined as resources embedded in a social structure that are accessed and/or mobilized in purposive actions --- is in many ways connected to this classical organization theory (Koka & Prescott, 2002). While our experimental design cannot strictly be interpreted as one testing social capital theory, there are nonetheless many insights from this research literature that improve understanding in our current business context (Acquaah, 2007; Blyler & Coff, 2003; Lin, Cook & Burt, 2001; Moran, 2005; Tsai, 2000; Yli-Renko, Autio & Sapienza, 2001)

are aware of each other's incentives and orientation towards the strategic alliance, there is an alleviation of fears related to potential partner misconduct. By reducing the possibility of surprises, communication can provide convergent expectations that enhance the coordination and cohesion of the group. Through communication, managers can minimize the bounded rationality problem through joint problem solving (McEvily & Marcus, 2005). Indeed, prior alliance-related research has found a positive relationship between inter-partner communication and superior strategic alliance performance (Doz, 1996; Marks & Mirvis, 1998).

Secondly, communication can engender cooperation through moral suasion, development of group identity and trust (Komorita and Parks, 1994; Ledyard, 1995; Zeng & Chen, 2003). Orbell, Dawes and van de Kragt (1990) underscore the use of multilateral promises in increasing cooperation. These communication efforts may exert *influence* on decision-makers since appeals to cooperation may influence the decision, which may be reinforced by identification with the cooperative system (Barnard, 1938; Simon 1947). Communication can thus permit the development of social capital and trust among alliance partners (Gulati, 1998).

Economists, however, have responded to these critiques by highlighting the possibility of "cheap talk" (Farrell & Rabin, 1996; Ledyard, 1995). In game-theoretic language, pre-play communication carries no payoff-relevant information, is simply cheap talk and should have no effect on the equilibrium outcomes, particularly if there is a single dominant strategy (Ledyard, 1995). Indeed, in the single period prisoners' dilemma context, there is substantial evidence that communication does not increase the probability of cooperation (Crawford, 1998; Farrell & Rabin, 1996; Ledyard, 1995). However, the evidence is mixed for game-theoretic settings, such as assurance games with multiple Nash equilibria that better represent the strategic alliance context, and several researchers have found support for communication enhancing the probability of successful outcomes (see reviews by Crawford, 1998; Farrell & Rabin, 1996; and Ledyard, 1995).

We posit that communication should increase the likelihood that partners choose the payoff dominant strategy over the risk-dominant strategy (Harsanyi & Selten, 1988) when the underlying economic incentives are appropriately aligned. More specifically, we maintain that due to factors

highlighted in this section, economic incentives are not by themselves sufficient, and that the addition of communication will significantly increase the rate of successful alliances. Thus:

> **H3: Alliances with both incentive alignment (i.e., with a high ratio of common to private benefits) and communication have a higher probability of success than alliances with incentive alignment alone.**

3. Methodology

We test the above hypotheses using experimental methodology, an important method of inquiry as demonstrated by seminal research (Kahneman, Knetsch & Thaler, 1990; Plott, 1982; Smith, 2000). Well established in the social psychology and economics of organization as a fruitful approach for the study of issues pertaining to social dilemma problems (Hazlett, 1997; Olson, 1965; Poppe & Utens, 1986), and considered commonplace within the economics and social psychology discipline (Kagel & Roth, 1994; Komorita & Parks, 1994; Samuelson, 2005), experiments have also begun to be utilized in the Strategic Management field (Knez & Camerer, 1994; Song, Calantone & Di Benedetto, 2002). The use of experimental methodology allows us to directly test the theories proposed by implementing different treatments corresponding to each while controlling for factors that may confound with these mechanisms in the real world.

As indicated in the theory section, we model the strategic alliance context as an assurance game. Specifically, we model decision-making within a strategic alliance as a threshold "take some or give some" game, where decision makers either contribute to the strategic alliance for common economic benefit, or use the alliance for private economic advantage. Each participant in the experiment represents a firm making a decision about the extent to which to engage in cooperative activities within their strategic alliance. Each alliance partner has different monetary benefits from the alliance succeeding, which affects their decisions concerning how much knowledge to contribute (give) or extract (take) from the alliance. In a series of experiments, we examine the behavior of participants under different assumptions of the ratio of common to private economic benefits accruing as a result of the strategic alliance. We also investigate the impact of communication on strategic alliance performance, by implementing communication protocols to examine their impacts.

3.1 Experimental Design

Our experimental design is developed for both external and internal validity. The experiments were designed so that strategic alliance issues grow organically out of the hypotheses they are designed to distinguish (Kagel & Roth, 1995). Moreover, our experiments involve *induced valuation* of participants (Smith, 1976, 2000) — they are paid for their participation in the experiment in a way that is responsive to the choices they made —to ensure that participants are motivated by the same factors they would encounter in the real world.

For internal validity, we designed a setting where theories about strategic alliance behavior could be tested directly. Five treatments were developed for the experiment, each representing an interaction between economic incentives (ratio of common to private benefit) and communication. (Details of the implementation are provided in the next section.) The first treatment of *low common benefit* represents a scenario where the ratio of common to private benefits is low, i.e., none of the decision makers have an economic incentive for the alliance to succeed. Second, we consider a scenario of *high common benefit* of alliance activity, where all of the decision makers have a high common to private benefit ratio, i.e., the economic incentives are aligned so that the payoffs when the alliance succeeds is significantly higher for every decision maker than when the alliance is not successful. The third treatment of *mixed common benefit* allows for heterogeneity in the ratio of common to private benefit among the alliance partners. For some decision makers, the ratio of common to private benefit is very high, while for others, the ratio is very low.

The fourth and fifth treatments permit strategic alliance partners to communicate with each other. In the fourth treatment of *high common benefit with communication,* decision makers have a high ratio of common to private benefits and can communicate with each other, while in the fifth treatment of *mixed common benefit with communication* decision makers have heterogeneous ratios of common to private benefits, and the ability to communicate with each other. Thus, comparisons between the different treatments permit an assessment of the individual and interaction effects of economic incentives and communication on alliance outcomes.

3.2 Experimental Procedure

Our experiment involved 405 participants that participated as decision makers in alliances. All participants were business students at a Research I US institution, with the majority of the students enrolled in the MBA (regular and executive) program.[9] Participation was strictly voluntary, and in accordance with the principle of induced valuation, participants were paid in cash based on their performance.

Participants were randomly assigned to one of the five treatments and to their role within the treatment. When they arrived at the laboratory, the participants were seated at a computer terminal. In compliance with Institutional Review Board guidelines, they read and signed a consent form. Participants were provided with a hard copy of their role-specific instructions, and prior to the start of the experiment, a composite version of the instructions was read aloud. To ensure that participants had understood the instructions, the necessary decisions they were being asked to make, and the resulting payoffs, each participant filled a pre-experiment questionnaire, and the answers to the questions were discussed until there was a consensus on the understanding of the experiment. In particular, the pre-experiment questionnaire explicitly asked the participants to calculate and report payoffs under scenarios where the alliance was successful and where the alliance was not successful. The entire experiment was computer-aided, and implemented using a web-based Java application; participants input their decisions, and were given feedback electronically at the end of each period of decision making. After the experiment ended, participants completed an exit questionnaire describing their experiences.

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[9] Specifically, there were 60 Executive MBA students, 300 MBA students and 45 senior level undergraduate students. Since the undergraduate pool of students was relative very small, convenience in scheduling considerations caused us to mix these students with the MBA students. The executive MBA students have an average work experience of 12 years, while the regular MBA students have an average work experience of 4 years. Importantly, almost all of these students had been involved in "social dilemma" settings in their workplace—if not directly in an inter-firm alliance setting, in settings that required team synergies and a similar tension between competition and cooperation. Subsequent to the alliance experiments conducted for research, there were additional experimental simulations conducted for pedagogical purposes (not included in the data to be compliant with Institutional Review Board guidelines). The outcomes in these experiments were consistent with the results reported in the empirical section.

Participants were informed that they would role-play managers that were responsible for allocating resources to their own firm or to an existing, five-firm alliance to which they belonged. Per Zeng and Chen (2003), we model a multi-party alliance rather than a two-person alliance. We designed the study so that participants were (privately) motivated via cash received at the end of the experiment. The experiment involved no deception and thus contamination effects are not a major concern. Further, participants were asked not to discuss the experiment with others.

The experimental context represented a threshold social dilemma game, wherein the common benefits are realized if alliance partners meet a certain threshold level of collective contributions (Ledyard, 1995). At the beginning of the simulation, the alliance common pool was endowed with 100 information units. As members representing decision makers of a five-firm alliance, each participant received 20 information units (created by their R&D staff) in every period. The primary decision concerned how much information they chose to give to or take from the alliance common pool. At the end of every period, each alliance member received $1,000 experimental dollars for information held within their own firm (private benefit). Further, if the alliance common pool had at least 150 information units, the alliance achieved a successful outcome and each alliance member received a bonus representing benefits accruing from the alliance activity (common benefit). The common benefits (bonus amounts) were calibrated for the different treatments described above (low, high and mixed common benefit). While each alliance member knew their own bonus, they did not know with certainty the bonuses of the other alliance members. However, in each treatment, the alliance members were informed about a) whether the other strategic alliance members received similar (homogeneous) or different (heterogenous) bonuses, and b) the range of the bonuses across all alliance members: whether the bonuses were all high, all low, or a mix of the two. This information was sufficient to determine the type of game the participants faced.

At the end of each period, after the decisions had been made regarding information transfer to or from the alliance common pool and the members had received their experimental earnings, two events occurred. First, the knowledge that was available in the alliance pool depreciated by

33%.[10] Second, a random draw indicated whether the game would continue (80% likely) or end at that period (20% likely). The random draw enabled us to implement an infinitely repeated game in the lab (with a discount rate of .2) avoiding endgame effects (Friedman & Sunder 1994).[11]

3.3 Implementation of Experimental Treatments and Empirical Model

As indicated above, the differences in the ratio of common to private benefit treatments were implemented by differences in bonus structure across the alliance simulations. The details of the implementation of the payoff matrices, the stage-game equilibria, and the repeated game equilibria for each treatment are provided in the Technical Appendix. In the *high common benefit* treatment, the bonuses (in experimental dollars) were $35,000 for two of the firms and $40,000 for three of the firms. This bonus ensured that economic incentives made it worthwhile for each of the decision makers to contribute to the strategic alliance; in any one period, it collectively cost the firms in the strategic alliance $50,000 to contribute to the alliance common pool, and they collectively received $190,000 in the form of common benefits (bonuses).[12] Of course, there is still an incentive problem, since each firm would prefer that the *other* firms do the contributing while they free ride (or even worse, take resources), as long as the alliance remained successful. Note that no one firm has an incentive (or the resources) to unilaterally contribute 50 information units to receive the bonuses (costing $50,000 and gaining at most $40,000). Nonetheless, the payoffs are consistent with economic incentives being aligned towards success of the alliance. As in the assurance game, if others are contributing, it is in the best interests of a target firm to contribute as well.

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[10] The depreciation was implemented to ensure that if the strategic alliance threshold of 150 was met, the start of the next period would replicate the conditions for the first period (100 units of information).

[11] To ensure compatibility across treatments and to reduce variance, the realization of the continuation probability draws was determined in advance and applied to all five treatments, as recommended in Friedman and Sunder (1994). This random draw resulted in 11 periods, which was used in all treatments.

[12] These parameters are chosen so as to make it unattractive for any player to take the alliances' resources in any given period as well. By taking they earn at most $150,000, but they lose their bonuses in this and all future rounds, which occur with an 80% chance. Thus, the expected discounted value of the losses is at a minimum ($35,000 +.8*$35,000 + .82*$35,000, …) = $175,000 > $150,000.

In the *low common benefit* treatment, the bonuses were $4,000 for two firms and $5,000 for three firms. This bonus made it economically inefficient for any of the firms to contribute to the common alliance activity; in any one period, it collectively cost the firms $50,000 to contribute to the alliance common pool, but their collective common benefit was only $23,000. Thus, the payoffs in this treatment are consistent with economic incentives *not* being aligned for strategic alliance success.

Finally, the *mixed common benefit* treatment involved heterogeneity among the bonuses received by the alliance members; while three of the firms received high bonuses ($35,000, $35,000, and $40,000), two firms received low bonuses ($5,000 each). Importantly, the bonus values are still consistent with incentive alignment for the strategic alliance to succeed ($120,000 of benefits versus $50,000 of costs); however the heterogeneity in bonuses creates a problem. For instance, were the alliance only among the three firms with high bonuses they could contribute enough to make the threshold and collect their bonuses (the alliance pool shrinks by 50 units each period, and these three members together control 60 units). However, there is an incentive for the low common benefit firms to take the resources in the alliance pool (earning together $150,000 and losing only their total bonuses of $10,000), and thus preventing the alliance from succeeding. A successful outcome requires that the members of the strategic alliance configure the optimal amount of contributions so that the low common benefit firms are also better off from alliance success.

The two treatments that permitted communication were implemented via a free-form chat box. For both the *high common benefit with communication* treatment and the *mixed common benefit with communication* treatment, the strategic alliance members had the ability to chat with all of the other members in their alliance, or send private messages to any one alliance member. The "chat" feature was implemented using a "chat box" resembling instant messaging, and a record of all prior messages was available for each member as the alliance progressed across periods.

Our primary dependent variable, *Alliance Success*, is coded as 1 if the alliance common pool information units exceeded the threshold of 150 in a particular period, and 0 otherwise. Our second dependent variable, *Transfer of Information*, is measured as the net amount of information transferred to the alliance common pool (total giving minus total taking by all alliance members in each period).

Our last dependent variable, *Information in Alliance* is the total amount of information in the alliance pool at the end of each period, which is the sum of the residual information from the prior period (after depreciation) and the net transfer of information in the current period. As expected, these measures are highly correlated but they capture multiple aspects of the same question: to what extent did alliance members create value?[13]

The main independent variables in the model include the indicator variables for each of the five treatments described above (e.g. *high common benefit* = 1 if the observation was drawn from that treatment, and 0 otherwise), and the *period* in which the decisions were made. In addition, since the experiments represent hierarchical data (alliance members are grouped together), we include group fixed effects to control for unobserved heterogeneity due to idiosyncratic, group specific factors. We use a logistic regression analysis for our first dependent variable, and multivariate regression analysis for the other dependent variables.

4. Results

Table 2a provides the distribution of the observations across each treatment type, the number of groups per treatment, and the number of periods in each treatment. We conducted one-way ANOVA tests for homogeneity across the Executive MBA and MBA/Undergraduate participant pool. As can be seen in Table 2b, there is no significant difference in the success rates across the Executive MBA and the MBA/Undergraduate participants in any of the treatments, justifying our pooling of these two samples.

Table 3a and 3b provide information regarding the differences in the dependent variables across the treatments, and the results from the formal hypotheses testing are reported in Table 4. In particular, the regressions control for unobserved heterogeneity by including an indicator variable

[13] We note that our unit of analysis is at the alliance rather than the firm level. However there is consistency across the two levels, since the payoffs are higher for each firm if they cooperate rather than compete where there are high or mixed common benefits, and vice versa for low common benefits. Thus, while there may be relative greater benefits to some firms than others, there are no clear winners or losers if they all play the optimal strategy (i.e., either they all collectively win by cooperating in a high common benefit strategy, or they "compete" in the form of learning races, etc, in the low common benefit scenario).

for each group and for the period in which the decisions are made. Consistent with Hypothesis 1, economic incentives do matter, and Panel A of Table 3b shows the difference between the low and high common benefit treatments. In the *low common benefit* treatment where there is no financial incentive to participate in an alliance, alliances never succeeded. On average, less than one unit of information is transferred to the alliance, and very little of the initial information stock remains. In stark contrast, in treatments where there is a financial incentive for the alliance to succeed, the alliance success rates are positive. For example, 27% of the alliances in the *high common benefit* succeed. The average amounts of information transferred and in total information the common pool is significantly higher as well. More formally, based on the results in Panel A of Table 4, Hypothesis 1 is supported. Economics incentive alignment is a necessary condition for alliances to succeed, and the coefficient of high common benefit is significant and positive for all three dependent variables.

Further, consistent with Hypothesis 2, heterogeneity in the ratio of common to private benefits reduces the likelihood of success; only 10% of the alliances in *mixed common benefit* treatment result in successful outcomes relative to 27% in the *high common benefit* treatment (Panel B of Table 3b), and the success rates with communication are 22% rather than 59% respectively (Panel C of Table 3b). The formal test of Hypothesis 2 is reported in Panels B and C of Table 4: regardless of whether there is communication or not, the homogeneous *high common benefit* treatment has significantly higher performance than the heterogeneous *mixed common benefit* treatment for all three of the dependent variables in our analysis.

Also, contrary to the optimistic predictions of property rights theory, economic incentives alone are not sufficient. The success rate of 27% in the *high common benefit* treatment is a far cry from the theoretical optimum of 100%. Even when payoffs would be uniformly higher for everyone if they all cooperated, some individuals choose the risk dominant strategy of not cooperating in almost 75% of the cases. Table 3a and 3b demonstrate the importance of communication for successful alliance performance. As seen in Panels D and E of Table 3b, when economic incentives are in place, adding communication in the *high common benefit* treatment more than doubles the success rate

(from 27% to 59%) and the amount of information transferred to the alliance (from 13 units to 35 units), and increases the amount of information contained in the alliance (from 47 units to 78 units). The same effect occurs when communication is included in the *mixed common benefit* treatment. This result is consistent with Hypothesis 3 and is further empirical evidence supporting organizational theory--- i.e., economic incentives are not, by themselves, sufficient, and the addition of communication significantly increases the rate of successful alliances. The formal tests of Hypothesis 3 reported in Panels D and E of Table 4 show strong support for all three dependent variables in the study.

5. Discussion and Conclusions

In an attempt to better understand decision-making in strategic alliances, our research brings together complementary streams of literature that emphasize the role of economic incentives (as in economic property rights theory) and the role of communication (as in social psychology and classic organizational theory) and tests their relative effects by using an experimental design that permits the isolation of the underlying causal mechanisms. Consistent with property rights theory, we find that aligning economic incentives is necessary for success (Barzel, 1989) but are not sufficient as some would predict (Demsetz, 1967). This suggests of myriad of factors like coordination costs, bounded rationality, and lack of trust in the absence of shared knowledge can create endogenous uncertainty regarding partner actions, and cause realized value creation to be less than potential value creation. While designing the right payoff structure is a necessary condition to alliance success (Khanna, Gulati & Nohria, 1998), it does not seem to be sufficient.

In this context, the ability to communicate significantly increases the probability of success. The results are both economically and statistically significant; communication approximately doubles the rate of alliance success. As depicted in Figure 1, the success rates in the absence of communication are low and relatively constant across periods. If the decision makers did not "get it right" the first time, the probability of success was very low for the strategic alliance across time. In

contrast, communication increases success rates not only in the first period, but also causes success rates to increase as decision makers interact with each other in subsequent periods.

An informal inspection of the communication content of the decision makers revealed that communication allowed alliance members to recover from mistakes and coordinate. The following excerpts from an alliance communication represent the various effects of communication, including but not limited to creating a shared understanding of the rules, explanation of behavior, and development of trust.

Company 5: "Alliance partners let's aim to maximize profits."

Company 2: "I think it is beneficial if we all work together."

Company 4: "If everyone enters 10 every time, there will always be 100 at the beginning of the quarter. Therefore, we can easily reach 150 every time [to make our bonus]. What does everyone think?

Company 1: "There are many [computer] windows to manage; hard to keep an eye on the clock … You guys … woops, I made a mistake! I am putting 15 now to win back your trust. [Otherwise] revenge will destroy us."

Company 3: "Yeah, please do not do that again … You'll make me paranoid."

Thus, in line with classical organizational theory and social psychology, in our setting we believe that communication enables managers to set goals, to coordinate, and to provide initial communications and subsequent feedback. Communication can reduce defection from cooperative outcomes, mitigate problems of bounded rationality (Simon, 1947), lessen fears of opportunism (Hennart, 1988), and allow the group to recover from mistakes. Communication also enables leaders of the group to make appeals not to be selfish and to cooperate (Barnard, 1938; Miller, 1992), which seem to work for some of the participants for some of the time.

We note that the transactions costs literature has developed a rich understanding, based on the seminal work by Williamson (1975), of the role that opportunistic behavior, uncertainty, asset specificity, and their interactions play when determining the governance form choice among feasible alternatives.[14] However, Williamson (1975) also identified other factors that are critical determinants

[14] For example, there is a substantial body of empirical evidence that supports the significant role of interactions between uncertainty and asset specifity, which include: Anderson (1985), Coles & Hesterly (1998), Leiblein & Miller (2003), Leiblein, Reuer & Dalsace (2002), Villalonga & McGahan (2005) and Walker & Weber (1987), among others.

of success, which have perhaps not received as much attention in subsequent research in the transactions costs literature stream. For instance, Williamson (1975) underscored the presence of bounded rationality in decision making, and that heterogeneity among decision makers further exacerbates difficulties in achieving cooperative outcomes (Williamson, 1975: 239-240). Importantly, Williamson (1975) asserted that the development of *convergent expectations* is a vital managerial role, and that managerial communication promotes convergent expectations by attenuating uncertainties generated when interdependent parties make independent decisions (Malmgren, 1961). Our empirical results find strong support for the role that these factors (economic incentives, bounded rationality, heterogeneity, and communication) play in determining successful alliance outcomes. We hope that our empirical findings will generate new interest and empirical inquiry concerning factors that relate to strategic alliance success. Indeed, more generally, the theoretical logic and empirical results presented here can be applied to a large number of strategic contexts including buyer-supplier arrangements, joint ventures, networks, R&D consortia, and technology transfer agreements (Gulati, Nohria & Zaheer, 2000; Oxley & Sampson, 2004; Reuer & Ragozino, 2006).

Our study has some limitations, which also open up avenues for future research. Our laboratory setting and use of experimental methodology allowed us to disentangle the relative and interaction effects of the causal mechanisms underlying decision-making in alliances, but at some cost of realism incurred by in our need to abstract away from the confounding issues that are clearly relevant in actual strategic alliances undertaken by corporations in the real world. For instance, our experiments controlled for selection effects by randomly assigning participants to the different treatments, and did not take into account exogenous uncertainty (either technological and demand driven). Future research examining the role of prior relationships, due diligence in the pre-alliance phase in exchange partner choice, and the use of contractual safeguards can help shed light on the effect of these factors on decision-making. In the same vein, our anonymous experimental setting did not permit alliance members to credibly threaten consequences for deviant behavior, and research in this area would be beneficial as well. All of these factors may be important additional criteria for increasing the likelihood of success. This is a particularly important area of further

research since our results show that even in the treatments where there was *both* incentive alignment and communication, there was a 40% likelihood that the alliance would not succeed. Thus, our experiment demonstrated that even in simple game structures that we used, alliance partners may place a non-zero probability that others will not cooperate, and accordingly choose the risk-dominant strategy among the multiple Nash equilibria. Exogenous uncertainty may interact with the endogenous uncertainty about alliance partner actions to create additional challenges in the realization of the potential economic value creation, and research that examines such interaction effects would be fruitful.

The use of students as subjects is open to the criticism that students may not emulate the actual decisions of managers in an alliance setting. We believe that this concern is somewhat mitigated in our setting for the following reasons. First, the majority of the participants in our experiments had at least three years of work experience. Further, there was no significant difference in the results obtained for groups in which the alliance members were Executive MBA's; the average age of this cohort was approximately 40 years, and they had a minimum of seven years work experience. Some of the executives had also participated in alliance activity as part of their job description. Finally, research in experimental economics has addressed this issue explicitly. Indeed, Dyer, Kagel and Levine (1989) and Croson and Donohue (2006) find that "real world" decision makers performed the same or sometimes worse in the laboratory setting than students.

We contribute to the extant research literature by examining decision-making that leads to alliance success or failure, and in particular, focus on the relative and interaction effects of economic incentive alignment and communication. In doing so, we integrate across conceptual papers examining strategic alliances that have used either an economic game-theoretic lens and highlighted the role of economic incentives (Gulati, Khanna & Nohria, 1994; Khanna, Gulati & Nohria, 1998) or a social psychology lens and highlighted the role of communication as a motivational solution (Zeng & Chen, 2003). By continuing in this under-researched route of examining alliances using the social dilemma paradigm, we contribute to the literature by developing and testing hypotheses based on some of their propositions, and developing novel ones that integrate across the two

complementary strands of research. Methodologically, we contribute to the strategic management literature by using under-utilized but powerful experimental methods to isolate the effects of alternative causal mechanisms, and we hope that more researchers use this well-established technique to address more strategic management issues.

Through the current empirical research, we can appreciate more fully the importance of organization activities that create a shared confidence in one another's cooperativeness (Barnard, 1938; Miller, 1992). In most real-world settings, people do not have a dominant strategy to defect or to cooperate. Instead, cooperation is rational when each person has a high level of confidence that others will cooperate. If an organization fails to gain and maintain convergent expectations of cooperation, the cooperative system can quickly unravel. In a world of limited information processing and bounded rationality (Simon, 1947), communication can be essential for obtaining "common knowledge" that each strategic alliance partner intends to cooperate, that each alliance partner knows the other exchange partners intend to cooperate, and so on (Schofield, 1985). Thus, our findings underscore Barnard (1938)'s emphasis that building a cooperative system requires inculcating belief in the real existence of common purpose.

In conclusion, by undertaking the integration and testing of complementary theories and underlying mechanisms, we contribute to strategic alliance theory. Consistent with Khanna, Gulati and Nohria's (1998) propositions, we find empirical evidence that payoff structures are critical for determining alliance outcomes, and that increased heterogeneity in strategic alliance scope can result in lower rates of success. Thus, an important contribution to organizational theory literature is that alliance partners need to give close attention to the underlying economics of a strategic alliance, and to ensure that win-win situations are created for all members in the alliance. Further, by integrating key insights from social psychology and classical organizational theory, we make an important contribution to property rights theory; that successful strategic alliance outcomes are more likely when *both* economic incentives *and* communication are present. These two mechanisms are thus complements, rather than substitutes, in determining the success of strategic alliances.

Technical Appendix: Parameters and Resulting Equilibria

Key Characteristics of All Treatments:

Players	5 players
Endowment	20 units per period
Value	$1000 per unit when used for private production
Initial level	100 units in alliance
Threshold for success	150 units
Depreciation	33%
Continuation Probability	80%

"Common Benefits" or Bonus Earned by Treatment

Player	Low Benefit	High Benefit	Mixed Benefit
Player 1	4000	35000	35000
Player 2	4000	35000	35000
Player 3	5000	40000	40000
Player 4	5000	40000	5000
Player 5	5000	40000	5000

Stage-Game Equilibria

High common benefit treatment;

There are multiple equilibria in this treatment. The payoff-dominant equilibrium outcomes involve the set of five managers allocating enough resources for the alliance activities to succeed. As is typical of these situations, there are multiple ways that this goal can be achieved.

For example, consider the unique symmetric payoff-dominant equilibrium. Each firm contributes 10 units to the alliance. The alliance collects 50 units over its starting value of 100 units, and thus meets its threshold for success. Each firm thus earns its own bonus ($35,000 or $40,000), plus $10,000 in private consumption of its remaining units. So payoffs to each firm are $45,000 or $50,000 in this equilibrium.

To see that this is indeed an equilibrium of the stage game, consider a unilateral deviation by one player. First note that no firm has an incentive to deviate by contributing more than 10. Excess contributions cost the firm ($1000 per unit) and bring no additional benefit. Second, consider downward deviations. For example, imagine that a firm decided to contribute zero instead of their equilibrium strategy of 10. Their earnings from private consumption would increase to $20,000. However, the alliance would not meet its threshold, thus they would not earn their bonuses. This deviating firm would earn only $20,000 instead of $45,000 (or $50,000). No firm has an incentive to deviate by contributing less than their "share" of 10. Thus this allocation of resources represents an equilibrium of the stage game (and, it turns out, of the infinitely repeated game as well).

Of course, there are *many* equilibria of this game; any outcome in which the alliance is successful and each firm earns at least $20,000 is a payoff-dominant equilbrium. But, these equilibria are differentially attractive to the different players (that is, each firm prefers the equilibrium in which they allocate fewer resources toward the alliance activities and the others allocate more). For example, consider the allocation (20, 0, 20, 10, 0). Exactly 50 is allocated to the alliance, so it succeeds and each firm earns its bonus. Each firm also earns $1000 for each unit of information it keeps, thus the net earnings for firms 1-5 are ($35,000, $55,000, $40,000, $50,000, $60,000). Again, no firm wants to deviate by contributing more, as those contributions would simply be wasted. Again, no firm wants to deviate by contributing less, as this would involve the loss of their bonus, and result in earning only $20,000. Thus each firm is playing a best-response to the strategies of the other firms, and this contribution profile is also a payoff-maximizing equilibrium (although an asymmetric one). Of course, firm 5 prefers this equilibrium to the symmetric one, while firm 1 prefers the symmetric equilibrium to this one. There are many such asymmetric equilibria (in this treatment, 116,601 of them); the task of the firms in the alliance is to coordinate on one. Earnings for each firm range from $35,000 to $55,000 ($60,000), depending on which equilibrium they are in (as can be seen in the asymmetric example above).

There is also a unique (risk-dominant) equilibrium in which no resources are allocated toward the alliance activity. Each firm receives $20,000, yet no firm has an incentive to deviate by contributing more. Imagine one firm considering a deviation of contributing all 20 units. They would still not reach the threshold to collect their bonus, and their earnings would reduce to $0. Given that other firms are playing their part of this strategy, the best-response is to also contribute zero.

Low common benefit treatment:

There is one equilibrium in this treatment, where nobody contributes anything toward the alliance. Given that others are not contributing, no individual has an incentive to contribute unilaterally.

Given low common benefits for all players, there are no payoff-dominant equilibria in which the alliance is successful. In particular, the most each firm is willing to contribute to the alliance is the amount of their bonus, (4, 4, 5, 5, 5) units = 23 units, not enough to reach the threshold of resources necessary for success.

Mixed common benefit treatment:

As in the *high common benefit treatment*, there is again a risk-dominant equilibrium for the mixed benefit where no firm contributes anything (zero). As before, no firm has an incentive to deviate from this outcome by contributing, as their contributions would simply be lost and no resources earned.

There are also a series of payoff-dominant equilibria, but fewer than in the *high common benefit treatment*. In particular, the symmetric contribution profile of before (where each firm contributes 10) is no longer an equilibrium. While the high-valued firms would be happy with this arrangement, the low-valued firms would each earn only $15,000 each ($5,000 from their bonus, and $10,000 from their retained resources), less than the $20,000 they would earn if they simply kept their resources.

Still, there are many payoff-dominant equilibria of this game; any outcome in which the alliance is successful and each firm earns at least $20,000 is a payoff-dominant equilbrium. For example, consider the contribution profile (16, 10, 20, 4, 0). The alliance is successful, and the firms earn ($39,000, $45,000, $40,000, $21,000, $25,000). Each firm earns at least as much as it would by keeping its resources ($20,000), eliminating the temptation to deviate by contributing less. As before, no firm is tempted to deviate by contributing more, as these resources are simply wasted.

Earnings from the risk-dominant equilibrium are $20,000 for each firm. Earnings from the payoff-dominant equilibrium vary between $20,000 and $60,000, depending on the firm's bonus level and amount contributed.

Repeated Game Equilibria

In the proceeding analysis we solved for the stage-game equilibria of the game. However, we did not consider the possibility of individuals *taking* resources from the alliance, only deviations which involved them not contributing. In order to constrain taking behavior, we rely on the infinitely repeated nature of the interaction.

High common benefit treatment:

Imagine an equilibrium in which four firms are contributing together 50 units to the alliance. The fifth firm is considering playing their equilibrium strategy of contributing zero, or taking the entire 150 units available in the alliance. We assume that all other players will play a *trigger strategy*, that is, once the pool has been harvested, they will not contribute in the future. (Note, this is a reasonable assumption since, even if everyone contributes all 20 units, it will take at least 2 periods of full contribution to reach the threshold of 150).

If our fifth firm takes the entire common pool, he earns $150,000 in this period. However, he then loses the bonuses he would have received over the rest of the game. Since the continuation probability is 80%, he thus loses $35,000 + .8*$35,000 + .8*35,000 + … = $175,000 > $150,000. Thus this fifth firm would prefer to play his part of the equilibrium (contributing 0) to deviating and taking the alliance resources in this treatment.

Note that this example is the worst-case scenario for the equilibrium. We have maximized the amount the deviator can earn from taking (all 150) and assumed the lowest bonus firm ($35,000). The result is strengthened when we consider the other firms, or lower earnings from taking.

Low common benefit treatment:

In the *low common benefit treatment*, the only equilibrium is an inefficient one. This means that in the first round, each of the five firms has an incentive to raid the alliance, and never to contribute again.

Mixed common benefit treatment:

In the *mixed common benefit treatment*, the analysis from *high common benefit* applies to the high-valued firms. For the low-valued firms, they instead have an incentive to raid the common pool; their losses of the low bonus from raiding are outweighed by the current benefit of the raiding. Thus the challenge for the high-valued firms is to persuade the low-valued firms to leave the alliance pool untouched (at the very least).

Figure 1: Effect of Communication on Success Rate in High Common Benefit Treatments

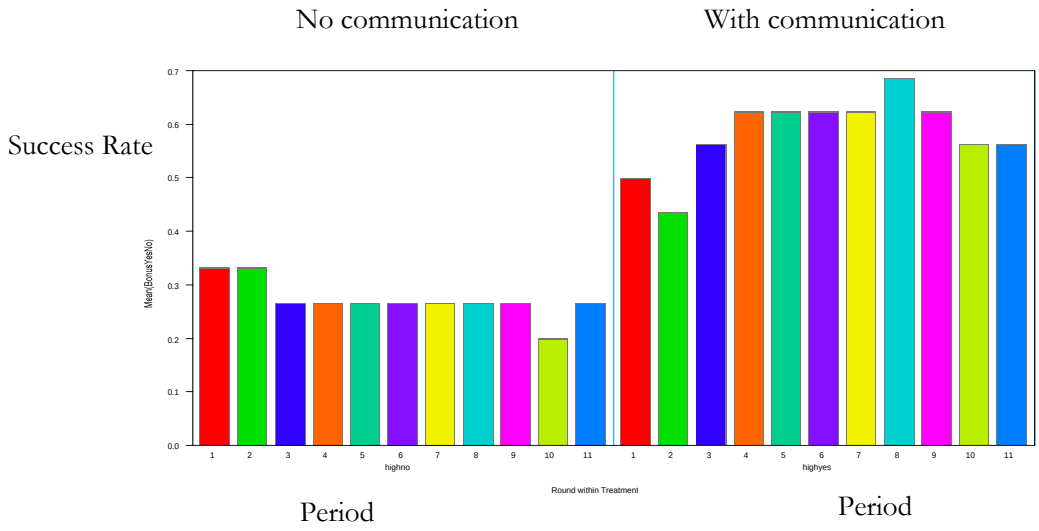

Table 1: Pay-off Matrices for Social or Public Dilemma Games

Panel A: Invisible hand game

		Player 2	
		Cooperate	Do not Cooperate
Player 1	Cooperate	**(170, 170)**	(130, 140)
	Do not Cooperate	(140, 130)	(120, 120)

Panel B: Prisoners' dilemma game

		Player 2	
		Cooperate	Do not Cooperate
Player 1	Cooperate	(170, 170)	(110, 190)
	Do not Cooperate	(190, 110)	**(120, 120)**

Panel C: Assurance game

		Player 2	
		Cooperate	Do not Cooperate
Player 1	Cooperate	**(170, 170)**	(100, 120)
	Do not Cooperate	(120, 100)	**(110, 110)**

Panel D: Assurance game with heterogeneous payoffs

		Player 2	
		Cooperate	Do not Cooperate
Player 1	Cooperate	**(270, 80)**	(140, 75)
	Do not Cooperate	(160, 65)	**(150, 70)**

Table 2a: Sample Statistics across Treatments

	Low Common Benefit	High Common Benefit	High Common Benefit, with communication	Mixed Common Benefit	Mixed Common Benefit, with communication
Number of Observations	187	165	176	176	187
Number of Groups	17	15	16	16	17
Number of Periods	11	11	11	11	11

Table 2b: Tests of Homogeneity across Participant Pool

	Low Common Benefit	High Common Benefit	High Common Benefit, with communication	Mixed Common Benefit	Mixed Common Benefit, with communication
Executive MBA	0.00	0.19	0.59	0.11	0.22
	(0.00)	(0.15)	(0.24)	(0.11)	(0.18)
MBA	0.00	0.27	0.58	0.10	0.21
	(0.00)	(0.15)	(0.24)	(0.09)	(0.16)
F-statistic*	n.a.	2.45	0.07	0.08	0.14

*The critical F statistic for a 5% level of significance is 3.85, thus the hypothesis that the two samples are drawn from the same population cannot be rejected.

Table 3a: Success Rates across Treatments

	Without Communication	With Communication
Low Common Benefit	0%	n.a.
High Common Benefit	27%	59%
Mixed Common Benefit	10%	22%

Table 3b: ANOVA Tests across Treatments

Panel A. High vs. low common benefit, no communication			
	High, no communication	Low, no communication	Chi-Squared / F-ratios
Observations	165	187	
Alliance success	27.27%	0.00%	75.75**
Transfer of	13.59	0.47	9.61**
Information	(3.09)	(2.90)	
Information in	47.00	24.47	37.37**
Alliance	(3.00)	(2.52)	
Panel B. High vs. mixed common benefit, no communication			
	High, no communication	Mixed, no communication	Chi-Squared / F-ratios
Observations	165	176	
Alliance success	27.27%	10.11%	17.20**
Transfer of	13.59	3.01	5.28*
Information	(3.09)	(3.37)	
Information in	47.00	31.78	13.24**
Alliance	(3.00)	(2.98)	
Panel C. High vs. mixed common benefit, with communication			
	High, with communication	Mixed, with communication	Chi-Squared / F-ratios
Observations	176	187	
Alliance success	58.52%	21.93%	52.06**
Transfer of	35.40	20.53	11.27**
Information	(2.98)	(3.27)	
Information in	78.64	55.93	29.85**
Alliance	(2.90)	(2.91)	
Panel D. High common benefit, with vs. no communication			
	High, no communication	High, with communication	Chi-Squared / F-ratios
Observations	165	176	
Alliance success	27.27%	58.52%	34.57**
Transfer of	13.59	35.40	25.92**
Information	(3.09)	(2.98)	
Information in	47.00	78.64	57.49**
Alliance	(3.00)	(2.90)	
Panel E. Mixed common benefit, with vs. no communication			
	Mixed, no communication	Mixed, with communication	Chi-Squared / F-ratios
Observations	176	187	
Alliance success	10.11%	21.93%	9.63**
Transfer of	3.01	20.53	13.89**
Information	(3.37)	(3.27)	
Information in	31.78	55.93	33.64**
Alliance	(2.98)	(2.91)	

Standard errors in parentheses; * Significant at the 5% level; ** Significant at the 1% level

Table 4: Fixed Effects Regression

Panel A. High vs. low common benefit, no communication

Independent variable	Alliance Success	Transfer of Information	Information in Alliance
Intercept	----	3.60	55.32**
		(4.18)	(2.21)
High Common Benefit	1.23**	6.56**	11.27**
	(0.19)	(1.95)	(1.03)
Period	0.35**	0.57	-3.26**
	(0.04)	(0.62)	(0.33)
Observations	352	352	352
Log likelihood	-134.56		
R2	0.08	0.25	0.74
$\chi 2$ / F	$\chi^2 = 22.35$**	F = 3.25**	F = 28.55**

Panel B. High vs. mixed common benefit, no communication

Independent variable	Alliance Success	Transfer of Information	Information in Alliance
Intercept	----	7.58	61.56**
		(4.94)	(4.27)
High Common Benefit	0.60**	5.29*	7.49**
	(0.15)	(2.31)	(1.99)
Period	0.05	0.12	-3.67**
	(0.05)	(0.73)	(0.63)
Observations	343	343	343
Log likelihood	-163.58		
R2	0.06	0.02	0.13
$\chi 2$ / F	$\chi^2 = 18.29$**	F = 5.27*	F = 14.07**

Panel C. High vs. mixed common benefit, with communication

Independent variable	Alliance Success	Transfer of Information	Information in Alliance
Intercept	----	25.47**	73.08**
		(4.37)	(2.84)
High with communication	0.79**	7.42**	11.35**
	(0.11)	(2.04)	(1.33)
Period	0.05**	0.42	-0.97*
	(0.02)	(0.64)	(0.42)
Observations	363	363	363
Log likelihood	-243.81		
R2	0.09	0.25	0.66
$\chi 2$ / F	$\chi^2 = 43.33$**	F = 3.34**	F = 19.10**

Panel D. High common benefit, with vs. no communication

Independent variable	Alliance Success	Transfer of Information	Information in Alliance
Intercept	----	22.82**	74.55**
		(3.99)	(2.19)
High with communication	0.66**	10.90**	15.82**
	(0.12)	(1.86)	(1.02)
Period	0.04*	0.28	-1.96**
	(0.02)	(0.59)	(0.32)
Observations	341	341	341
Log likelihood	-233.39		
R2	0.07	0.36	0.81
$\chi 2$ / F	$\chi^2 = 32.48$**	F = 5.65**	F = 43.54**

Panel E. Mixed common benefit, with vs. no communication

Independent variable	Alliance Success	Transfer of Information	Information in Alliance
Intercept	----	10.18*	59.87**
		(4.75)	(3.05)
Mixed with communication	0.35**	8.76**	12.11**
	(0.13)	(2.22)	(1.42)
Period	0.22**	0.27	-2.68**
	(0.02)	(0.70)	(0.45)
Observations	363	363	363
Log likelihood	-161.47		
R2	0.11	0.22	0.61
$\chi 2$ / F	$\chi^2 = 60.67$**	F = 2.80**	F = 15.76**

Standard errors in parentheses; Group dummies included (not reported); * Significant at the 5% level; ** Significant at the 1% level

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