# ‘PIE-SHARING’ IN COMPLEX COLLABORATION CONTEXTS*

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-- Forthcoming at the *Journal of Marketing Research* --

January 2000

* This research was supported by grants from the International Center for Research on the Management of Technology, Lean Aerospace Initiative, and Center for Innovation in Product Development, at the Massachusetts Institute of Technology. Special thanks to the participating organizations, the many managers, scientists, and engineers who gave their time to share their perspectives on this process and to the students who spent many hours collecting data and readings: Carol Hwang, Dave Godes, Rishi Srivastava, and especially Christina Hsu. The author also acknowledges the constructive comments of three anonymous *JMR* reviewers, the MIT marketing group, and Nader Tavassoli. Thanks also to John Hauser for comments on earlier versions of the manuscript.

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## ABSTRACT

Recently, there has been a growing interest in the development of collaborative relationships between organizations. Much attention has been given to how organizations ‘expand the pie’ of benefits between them; however, there is little that addresses the ensuing issue – *how organizations divide the expanded pie*. This research examines the relational impact of pie sharing in complex collaboration contexts marked by uncertainty in resources and outputs, information asymmetries, intangible aspects, and noncomparable factors and processes. A conceptual framework is developed that examines how the use of *equity* and *equality* sharing principles in conjunction with various resource and organizational conditions can be used to systematically impact relational outcomes. Survey results of 300 R&D managers, scientists, and engineers indicate that sharing principles can have a positive or negative effect on the relationship depending on the type of sharing principle used, and the characteristics of the resources and organizations. In particular, sharing processes should be responsive to the goals of the collaboration. The results underscore the strategic nature of the sharing phenomenon as well as the importance of relational concerns in complex and uncertain interorganizational settings.

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## INTRODUCTION

In many industries, there has been a growing trend toward organizational downsizing and a renewed focus on the development of core competencies. As a result, organizations find themselves having to rely increasingly on collaboration with other organizations in order to accomplish strategic ends. In the channels literature, there has been a great deal of interest in this area. Most research addresses the facilitating conditions, or resources, to collaboration (i.e., Anderson and Narus 1990; Morgan and Hunt 1994; Noordeweir, John and Nevin 1990; Heide and John 1990); very little speaks to the *outputs* of these collaborative efforts. While many have asked, “how do we ‘grow the pie’ of benefits between collaborating parties?” (Jap 1999), no one has asked the ensuing question, “*how do I now divide the pie between us?*” Another critical issue is whether the sharing process has any consequential impact on the collaboration relationship. *Is sharing a strategic, interorganizational process that deserves more systematic attention* or is it merely an ephemeral process that has little bearing on the relationship? This research was motivated by these questions.

The popular view of pie sharing is to view it as a competitive process (cf., Brandenburger and Nalebuff 1996). Much of this thinking emanates from game theoretic research in economics and psychology in which the participants share a common pie and typically know *ex ante* the nature of the pie, the size of the pie, and how to assess the processes and resources that create the pie. But what about collaborations that do not have these characteristics? In many complex collaborations, the nature of the pie, its size, and an assessment of its ingredients may be ambiguous. The participants may not fully understand each other’s competencies, strengths, and weaknesses, and the outcome of the collaboration may not be clear. In a game theory setting,

this would mean that the "rules of the game" are not set, the identity and positions of the players are poorly appreciated, and the payoff matrix may not be entirely clear.[1] Do the classic allocation rules still hold under these conditions? Does the use of these rules have any effect on critical relational outcomes? To date, no one has tried to test or generalize their results to *more complex settings* where such assumptions about the pie may not exist. Research on allocating outcomes among multiple participants in the economics and psychology literature focus on the *size* of the pie shares or the *cognitive processes* for evaluating pie-shares, but neither literature addresses the *process* for how the pie is shared.

In complex collaboration contexts such as R&D, organizations may be involved in an array of activities ranging from explorations in science and technology advancements, to directing programs of activities that develop practical competencies, to developing applied projects aimed at specific tasks (Hauser 1998). These collaborations are often formed in risky, uncertain settings around nonstandard business objectives (i.e., to learn a technology or "keep a window" on an opportunity). Specification of all the expected outcomes or the magnitude of these outcomes prior to the collaboration may be difficult and tying each organization's tasks and resources to its outcomes is also arduous, as these collaborations often involve the use of numerous intangibles (i.e., expertise, tacit understandings, joint knowledge), which are difficult to evaluate. Moreover, the organizations may not share a common pie -- each organization may receive very different benefits. How is sharing accomplished in such complex settings?

Does the sharing process have an impact on key *relational* outcomes such as satisfaction with the collaboration, perceived fairness of the outcomes and willingness to collaborate in the future? As more and more industries experience consolidation, the number of potential collaboration partners is also diminishing. This places a growing importance on *repeated*

collaborations with a few organizations. If the collaboration participants are not satisfied with their outcomes or do not feel that they are receiving a fair share of the expanded pie, then future collaborations are undermined and less likely to occur; it also becomes increasingly difficult to build mutually beneficial relationships between these organizations. Hence, knowing how to effectively share an expanded pie among organizations in complex collaboration contexts such as R&D has important implications for long-term relationship management and interorganizational coordination. Effective management of R&D also carries implications for the successful development of new products.

The focus of this research is on understanding the *relational* impact of pie sharing in complex collaboration settings and the *conditions* under which these consequences occur. In the pages to follow, I describe one potential explanation of the pie-sharing process, based on a review of relevant research in economics, psychology, and marketing, as well as depth interviews with R&D managers, scientists, and engineers. The theoretical literature illuminates the motivational concerns and sharing principles that are operative in the process, while the field interviews identify the specific resource and organizational characteristics that comprise the collaboration context. I propose that the strategic use of sharing principles *in conjunction* with various resource and organizational factors enhance relational outcomes. This possibility is empirically tested via a survey of 300 R&D managers, scientists, and engineers. The paper concludes with a discussion of results, limitations, and directions for future research. By discovering the sharing approaches that are used in practice and observing the conditions under which the principles are used, I seek to stimulate additional thinking and investigations into this important aspect of collaboration management.

## SHARING IN COMPLEX CONTEXTS

In this section, a conceptual framework of the pie-sharing process in complex collaboration contexts is developed. *Collaboration* refers to a close, functionally interdependent relationship in which organizations strive to create mutually beneficial outcomes for all participants. The unit of analysis is the perspective of an organizational participant in a collaboration comprised of two financially independent, non-competitive organizations who each supply a complementary competency that enables the joint effort.[2] Hence, joint ventures, networks, horizontal relationships, and vertically integrated relationships are beyond the scope of this study. Although the organizations may differ in the functions they perform, symmetry is expected in the nature and pattern of causation of the behavioral constructs that underlie their relationship.

The term, *complex*, is used to refer to the difficulty of assessing and comparing each party's contributions, gains, and competencies in the collaboration process. An R&D setting is used as the backdrop for this investigation, since collaborations within this realm typically possess such characteristics. Often, the parties "don't know what they don't know;" in other words, they may have no realization of how much surplus there is to be shared or what type of serendipitous circumstance or outcome may occur over the course of the collaboration. R&D collaborations can occur among individual boundary spanners (e.g., principal investigators) and their counterparts in other firms, universities, and national laboratories and play a critical role in creating new knowledge through specialized innovation (Teece 1998).

In many organizations, the R&D function lays an important foundation in the development of new products. According to a recent National Science Foundation survey, from 1995-97, US companies invested heavily in R&D ($206 billion); in fact, the rate of R&D

expenditures outpaced the national economy as a whole. In order to improve the efficiency of this magnitude of investments, organizations must learn to effectively manage the process and the outcomes received. A growing concern among many R&D units is that their principle investigators, research laboratories, or other organizational units may not be optimally managing this potentially strategic process.

**Relationship Quality**

A central concern in this study is the impact of sharing principles on the *relationship* between organizations. Much of the past research on sharing outcomes among multiple participants examines each party's maximization of its individual outcomes (see Roth 1995 for a review). There is also a research stream that considers appropriate metrics for R&D project success (see Hauser 1996 for an annotated bibliography). While these aspects are important to consider, research on sharing should also consider how the use of these principles impacts the relationship between the participants, because enhancement of the relationship may have a significantly greater impact on their *joint* utility.

How the sharing process impacts the relationship also carries long-term ramifications. In many industries, organizations need to work with each other on a repeated basis. If organizations act opportunistically in the short-term, they may develop a negative reputation that will inhibit other organizations from working with them in the future. Hence, it is important that organizations in collaborations learn to develop a sharing process that fosters satisfaction with the collaboration, a sense of fairness in the outcomes, and a willingness to collaborate again in the future. The value of these benefits is reflected in the attitudinal variable, *relationship quality*. The essence of relationship quality is a belief in the integrity and reliability of the other party (Crosby, Evans, and Cowles 1990; Dwyer and Oh 1988; Kumar, Scheer, and Steenkamp 1995).

These beliefs are reflected in (i) an organization's evaluations of the present relationship (i.e., satisfaction with the collaboration and outcome fairness) and (ii) future expectations of the relationship, (i.e., willingness to collaborate in the future). Although there is no consensus on the definition of relationship quality, researchers have identified several distinct, though related constructs. Dwyer and Oh (1988) first defined it in terms of satisfaction, minimal opportunism, and trust. Crosby et al. (1990) underscores trust and satisfaction as critical components. Kumar et al. (1995) add conflict, commitment, willingness to invest, and expectations of continuity to the notion of trust, but do not include satisfaction.

I conceptualize relationship quality as a higher order concept involving satisfaction, outcome fairness and willingness to collaborate in the future. These three elements are useful in reducing uncertainty because they provide insight into the motivations and performance of the other party and project the value and persistence of these factors into the future. Relationship quality in R&D collaborations operates in a manner similar to interaction quality in information-sharing relationships (Moorman, Zaltman & Deshpande's 1992); both are useful in reducing uncertainty in the interorganizational context. Conflict is not included in this conceptualization because it can be either functional or dysfunctional to the relationship (Deutsch 1969).

*Evaluation of the present relationship*. Satisfaction and outcome fairness are attitudinal constructs that capture the evaluation of the current relationship. *Satisfaction with the collaboration* is a positive affective state resulting from the appraisal of all aspects of a working relationship. In the literature on channel relationship management, it is one of the most studied outcome variables (see Gaski 1984 for a review) and an important indicator of the impact of the collaboration process on the relationship. *Outcome fairness* is the organization's perception that it has received a fair share of the divided pie of outcomes, benefits, and gains from the

collaboration. Together, these constructs provide insight into the perceived reliability and integrity of the other party. Satisfaction with the relationship reduces uncertainty regarding the degree to which the relationship exceeded expectations, while fair outcomes indicates that the other party is not solely concerned with its own individual position.

*Future expectations.* The third aspect of relationship quality is *willingness to collaborate in the future*. This indicates the degree to which an organization would be willing to engage in mutual endeavors again, should the opportunity arise. Heide and Miner (1992) highlight the close relationship between expectations of future interaction ("the shadow of the future") and cooperative behavior. Anderson & Weitz (1989) underscore the importance of future expectations in determining the continuity of exchange in channel dyads. Similarly, the literature on social exchange points to the role of future expectations in determining the long-run survival of the relationship. If the parties do not perceive that they will receive worthwhile benefits from the relationship in the future, they are likely to exit.

**Fairness and Sharing**

Research in economics and psychology examines outcome allocation among *individuals*. Allocation of outcomes among organizations may differ in important ways, which I consider in building the conceptual framework. The economics and psychology literature indicate that relational concerns and norms of fairness often motivate allocations among participants. The classic demonstration of this is in research using ultimatum and dictator games. In the ultimatum game, one player (the proposer) offers to another player (the responder) some portion of the money to be allocated. The responder can accept the offer or reject it, in which case both parties receive nothing. Although economic theory would predict that the offer should be a penny (or the smallest unit of currency available) and the responder should accept, the average offer is

around 30-40% with 50-50 splits often the mode. Offers less than 20% are typically rejected. This is a robust phenomenon, that doesn't change as the stakes are increased (Hoffman, McCabe and Smith 1996) or across various nationalities of the individual participants (Roth, Prasnikar, Zamir and Okuno-Fujiwara 1991).

Many economists attribute this result to relational concerns and norms of fairness; proposers offer more because they know that the responder can reject an offer that is very unfair. Rabin (1993) describes a "fairness equilibrium" in which players differentiate between an intentional act of meanness, which they will punish, and an inadvertently mean act, which they will tolerate. Consistent with this, Blount (1995) finds that responders are more likely to accept small offers if they come from a random device, than if they are chosen by the proposer. Hence, it appears that individuals will not reject inequality, but will punish unfairness.

This has led Camerer and Thaler (1995) to propose what they call the "economics of manners," to explain the negative relationship between a responder's own utility and the other player's payoffs when responders reject small offers. They argue that players do not care about the other's welfare per se, but desire some kind of equity in the context of the interaction. Research on dictator games (i.e., the responder has no choice about accepting the offer) indicates that individuals are willing to share a pie with a stranger, but not if the player feels that it has earned the right to the pie or the relationship is impersonal (Hoffman, McCabe, Shachat and Smith 1994a, b). Polite business practice, or norms of fairness (Kahneman, Knetsch and Thaler 1986), may require an individual to share gains with a friend, but does not require sharing with a stranger. Hence, manners, or fairness, guide how outcomes are shared between individuals. Such norms are learned rules that are difficult to repress even in one-shot encounters (Hoffman et al 1994b, Murnighan and Saxon 1994). Why do individuals leave tips in restaurants that they

may never expect to visit again? Because it would be rude to do otherwise. This is not to say that self-interested behavior has no role in outcome allocation decisions. As information asymmetries are introduced, proposers will continue to appear fair, but will capitalize on the responder's lack of information (Kagel, Kim and Moser 1996). When competition is introduced between the players, the proposer's offer will move closer to zero (Schotter, Weiss and Zapater 1994, Roth et al 1991).

**Sharing Principles**

In R&D collaborations, the assurance of fairness in allocating outcomes is particularly critical because there may be a great deal of uncertainty in the nature of the pie, its potential size, and the probability of successful pie-expansion. By demonstrating an attempt to uphold fairness concerns in the sharing process, participants gain some assurances against this uncertainty. They realize that regardless of what happens, there will be an attempt to insure fair outcomes for both parties. One way that this may occur is by the application of sharing principles in the collaboration process. While one might expect that the principles for sharing in R&D collaborations would be more complicated than the principles used in less complex contexts, I found that participants relied on some very simple principles for sharing. This may be due to the fact that such principles are relatively intuitive, easy to implement, and often less costly than trying to resolve an indeterminate situation (Schelling 1960). Often, simple rules can be relatively robust to varying information constraints and uncertainties and tend to leave the participants in improved positions.

The two sharing principles most commonly discussed by my informants were equity and equality. *An equity rule specifies that each member's payoffs are a function of its resources* – tangible and intangible contributions, costs incurred, etc. – to the collaboration. The greater

one's contribution to the collaboration, the greater one's payoff. Equity principles for sharing are derived from equity theory (Adams 1965; Walster, Walster and Berscheid 1978), which states that people judge an outcome as fair when the ratio of their own resources and outputs equals the ratio of resources and outputs of comparison others. The literature in group decision-making indicates that equity principles are generally used when productivity is the primary goal (Deutsch 1985; Kabanoff 1991) and is typically advocated by those with high resources (McGrath 1984). In field interviews with R&D participants, many informants told me that an equity principle would be used to account for resources to the task such as financial contributions, technical expertise, and asset ownership. The organization that contributed the bulk of the expertise or equipment would receive a larger proportion of the benefits gained.

*The equality rule specifies that each party receives an equal share of the payoffs* – a 50/50 split, in this research. This rule is typically used in groups when the priority is to maintain within-group harmony, social relationships, and dissension reduction (Deutsch 1985; Kabanoff 1991) and is typically advocated by those with low resources (McGrath 1984). Research on this rule indicates that although it may not foster the highest levels of productivity, it does facilitate close cooperation among members; it is particularly useful when differences between various resources are vague and hard to measure (Allison and Messick 1990; Allison, McQueen and Schaerfl 1992).

My interviews with key informants indicated that participants relied on one or a combination of the rules to apply to various resource and organizational conditions in the collaboration. Although these principles are clearly not exhaustive of the universe of possibilities, I focus on them in this research as an incremental first step toward understanding the use of sharing principles in complex collaborations. By focusing on the use of simple rules, I

do not mean to imply that complex sharing rules are not used in R&D collaborations; a few informants did use such principles. However, when these complex rules were examined more closely, it was clear that they were merely combinations of the basic equity and equality principles. For example, the parties may begin a collaboration by using an equity rule until each organization has received its respective return from its investment. Over time, each organization's processes, roles, and investments may become increasingly interdependent and the organizations may switch to an equality rule. In other instances, organizations may use an equity rule to apply to one aspect of a project, and an equality rule to apply to other parts. In sum, I found that despite the complexity of the collaboration context, the participants often relied on these relatively simple heuristics to guide their sharing process or aspects of it.

In the next section, I hypothesize that the use of these sharing principles in conjunction with specific resource and organizational conditions can aid in improving relationship quality between the parties because these rules uphold and support fairness concerns between the parties.

## THE CONCEPTUAL MODEL

An overview of the conceptual model is displayed in Figure 1. My primary goal is to understand how the sharing process impacts relational outcomes between the parties. Hence, I examine factors such as satisfaction with the collaboration, outcome fairness, and willingness to collaborate in the future. Research in economics and psychology suggests that participants are motivated by fairness concerns and the risks of external contracting. As a result, I hypothesize that they will (i) evaluate the contributions, or resources, of each organization and (ii) consider organizational information that reduces moral hazard and adverse selection risks. The field interviews highlight some generalized characteristics of the resources (i.e., asymmetric, separable, idiosyncratic) and organizations (i.e., the ability to observe the other party's actions,

understanding of the transformation process, and equal payoff valuations) in complex collaboration contexts that address these concerns. I propose that organizations apply a sharing rule to these resource and organizational conditions in such a way as to have a positive impact on overall relationship quality.

I now consider the resource and organizational conditions that are brought to R&D collaborations as well as the moral hazard and adverse selection risks associated with such close relationships. Then I describe how the application of sharing principles to these specific conditions can positively impact relationship quality.

**Resource Conditions**

In psychology, research on equity theory indicates that people judge an outcome as fair when the ratio of their own resources and outputs equals the ratio of resources and outputs of comparison others (Adams 1965; Walster, Walster and Berscheid 1978). Research on joint authorship collaboration indicates that individuals attempt to value the size of each participant's contributions and efforts when determining credit as a co-author (Floyd, Schroeder and Finn 1994; Spiegel and Keith-Spiegel 1970). In fact, the Academy of Management recently endorsed the sharing of credit "in correct proportion to the various parties' contributions" (*Academy of Management Journal* 1990:903). In R&D collaborations, my field interviews indicated that organizations also consider each party's contributions in determining its fair share of the pie. Each participant may contribute resources such as intellectual property, human resources, equipment, funding, and specific expertise. The nature of these resources may be asymmetric or easily separable between the organizations, or they may be idiosyncratic to the joint relationship.[3] Each organization is motivated to insure that they get a fair return on their investments. There is also some concern that the other party receives a fair share (Guth,

Schmittberger and Schwarze 1982; Schmitt and Marwell 1972). Neither party wants the other party to receive less than a fair share, but each party also does not want the other to receive a disproportionately greater share of the outcomes (Pruitt and Rubin 1986). These concerns can be managed via the application of a sharing rule that best accounts for each organization's contributions and insures a fair share of the expanded pie.

Organizations will judge the impact and appropriateness of a sharing principle differently, depending on the characteristics of the resources to the collaboration. If one organization makes *asymmetric* contributions to the relationship – contributes more resources than the other party – then it is vulnerable to opportunistic behavior from the partner. Consistent with this, Gundlach, Achrol, and Mentzer (1995) find that firms making smaller investments than their partners tend to act opportunistically within the relationship. Hence, the organization who contributes more resources than the partner will be motivated to use an equity rule in order to assure itself a larger portion of the expanded pie. By using an equity rule, the organization can manage the potential vulnerability resulting from asymmetric resources because this rule provides an assurance that the one who has made the greater contribution will receive the dominant share of the outputs. Hence, the use of this rule should have a positive effect on relationship quality when an organization's resources are asymmetric to its partner.

H1: When resources are asymmetric, the use of an equity sharing principle has a positive effect on relationship quality.

When each party's resources are *separable* – easily distinguished from the resources of the other party – then an organization will be motivated to use an equity rule because it is easy to account for the relative contribution of each participant. An equity rule enables a clear mapping between such resources and a fair share of the pie. Hence, the use of an equity rule when the

resources are separable should have a positive effect on satisfaction with the collaboration, outcome fairness, and willingness to collaborate in the future.

H2: When resources are separable, the use of an equity principle has a positive effect on relationship quality.

Sometimes, the parties create *idiosyncratic investments* (e.g., software, specific expertise and skill sets) that are dedicated to the specific collaboration. These investments are nonfungible, or nontransferable, to alternative collaboration arrangements and lose value if the relationship is prematurely terminated (Williamson 1985). Since the investments are created to support the joint relationship, the use of an equality principle should have a positive impact on relationship quality. An equity sharing rule might promote relationship maintenance, by incenting the parties to remain in the relationship until the value of the investments are recovered. However, an equity rule may be more difficult to apply than an equality rule, particularly if each party's role is vague or hard to measure.

H3: When resources are idiosyncratic to the relationship, the use of an equality sharing principle has a positive effect on relationship quality.

**Organizational Conditions**

In many collaborations, organizations pair with other organizations who have complementary competencies or processes that enable the dyad to achieve goals and outcomes beyond each organization's individual reach (Weitz and Jap 1995). Although effective for joint success, this approach to external contracting activities creates moral hazard and adverse selection risks. Moral hazard is a form of post-contractual opportunism that arises when actions required or desired under the contract are not freely observable (Grossman and Hart 1983; Milgrom & Roberts 1992). This can be remedied by structuring the transaction in such a way so that the counterpart will take actions that is in the best interest of both parties. In R&D

collaborations, this may be accomplished via *the ability to observe the other party* and *an understanding of the other party's transformation process.* Both of these factors reduce moral hazard risks.

The more an organization is able to *observe the other party's actions,* the easier it is to monitor the counterpart's effort in the collaboration and manage the moral hazard risks in the collaboration (cf., Radner 1985). As an organization is able to observe the actions of its counterpart over time, it is better able to assess whether its actions are in the best interests of the collaborative effort. This may be due to the fact that there are more opportunities to spread the risk over multiple time periods (Fudenberg, Holmstrom and Milgrom 1990). Using an equity rule when an organization has the ability to observe the other party's processes and actions helps insure that the counterpart's outcomes are in accordance with its efforts over time. Hence, the ability to observe the other party's actions and the allocation of outcomes in accordance with this action incents the counterpart to act in a way that is supportive of the collaborative effort. This should have a positive impact on satisfaction with the collaboration, perceptions of fairness in the outcomes, and willingness to collaborate in the future.

H4: When an organization has the ability to observe the other party, the use of an equity sharing principle has a positive effect on relationship quality.

*An ability to understand the other party's transformation process* – how the party converts resources to outputs – enables an organization to map a reasonable expectation of the payoff to the collaboration *ex ante*. This increases an organization's ability to evaluate the degree to which the counterpart is acting in accordance with the best interests of the joint effort. The use of an equity sharing approach when an organization understands the counterpart's activities provides an assurance that the counterpart's behaviors will be fairly rewarded

according to the value of it's transformation process. This should have a positive impact on relationship quality.

H5: When an organization understands the other party's transformation process, the use of an equity sharing principle has a positive effect on relationship quality.

Adverse selection is a form of precontractual opportunism that arises when the counterpart in an exchange has private information about something that affects the organization's net benefit from the exchange (Milgrom & Roberts 1992). One solution to this problem of information asymmetry is for the counterpart to signal its intention to the other organization. This may be done by revealing its valuation of the expected payoff from the collaboration. Each organization enters into a collaboration with the hope of achieving some type of desired end – patents, reduced time to market, control over future technologies, potential commercial applications, etc. By signaling its valuation of its expected payoff from the collaboration, the counterpart gives the organization information about its intentions and likely effort.

When an organization knows that the counterpart has *equal payoff valuations* – both organizations value these benefits similarly and they place an equal value on the expected outcomes of the collaboration (e.g., they both want to produce joint patents or jointly control future technologies) -- then the organization gains an assurance that the counterpart will behave in a manner that is beneficial to the joint effort. If the counterpart behaves differently, it will adversely affect its own position as well as the joint position. If both organizations value the outcomes of the collaboration similarly, an equality sharing rule should have a positive impact on relationship quality. The use of such a rule incents both parties to cooperate closely in order to achieve desired ends and promotes social harmony in the process (McGrath 1984). It also represents an assurance that each participant will receive a fair share of the expanded pie.

H6: When the organizations value the payoffs similarly, the use of an equality sharing principle has a positive effect on relationship quality.

These six hypotheses are developed based on the theoretical literature and the environmental context as described by key organizational informants. However, in practice, it is possible that the alternative rule also works well or even better, due to some systematic aspects of the environment or collaboration. It might also be that the alternative rule has a *negative* impact on the relationship and should be avoided. In other words, these sharing rules may have additional effects in practice that have not yet been discovered or considered in the literature thus far. I examine this possibility explicitly in the analysis.

## METHOD

### Questionnaire Development

Because of the lack of research on sharing among multiple participants in complex settings, 31 depth interviews were conducted with various R&D participants (managers, scientists, and engineers) in the telecommunications, automotive, chemical, and petroleum industries. The purpose of these interviews was to enhance My understanding of the sharing process in complex collaboration contexts and the principles that are used to share the pie. Each informant described its perceptions of how the outcomes of R&D collaborations are shared in a variety of short- and long-term collaborations along with the organization's a priori goals, expectations, resources, and outcomes achieved.

A survey instrument was created, based on the depth interviews. This instrument incorporated the language of the informants, drawing upon their experience, in order to elicit responses that accurately reflect the organization's viewpoint (Campbell 1955). All of the constructs were measured with multiple item, 7-point Likert-type scales, according to the recommendations of Nunnally (1978). The idiosyncratic resource scale was based on Anderson

& Weitz (1992). All other scales were designed specifically for this research; at the time of the questionnaire design process, I was not aware of any known scales that measured these constructs of interest. Pretests with a select group of respondents from various types of organizations and backgrounds were iterated throughout the development of the questionnaire; the results of each round of pretests were incorporated into a revised questionnaire and pretested on a new group of R&D participants. A list of the items and scale reliabilities is listed in the Appendix. The anchors for all items were "1=strongly disagree" to "7=strongly agree." Table 1 exhibits the means, standard-deviations, and correlations between the constructs.

**Data Collection**

*Characteristics of the sample.* I solicited questionnaire participation from the R&D departments of five organizations in the United States: (i) a federal research laboratory (the same one that participated in the field interviews), (ii) a military and commercial jet aircraft manufacturer (annual sales of $52 billion), (iii) a manufacturer of aerospace products: commercial aircraft, defense systems and space systems (annual sales of $45 billion), (iv) a tire manufacturer (annual sales of $14 billion), and (v) a steel bearing manufacturer (annual sales of $2 billion). All of the manufacturing organizations were leaders in their respective industries. Each organization was offered a report of overall results and customized analyses for their internal purposes. Collectively, these firms contributed 29% (n=260) of the mail sample.

The federal research laboratory provided the names of 648 points of contact for R&D collaborations conducted over a five year period. These R&D collaborations were explicitly created to exploit potential technology transfers between the federal laboratories and the commercial sector. In these arrangements, a federal R&D organization worked with a commercial organization and each party contributed personnel, expertise, and facilities or

equipment toward a mutual problem of interest. These collaborations were not procurement transactions -- the federal organizations were not allowed to contribute monetary funds; hence, the agreements were mutual endeavors that required joint effort and cooperation from both organizations. The collaborations were mutually negotiated, even in the sharing aspects. There were no specific sharing algorithms or contracts imposed upon the parties in these collaborations. The firms could employ intellectual property created by the collaboration for commercial purposes, while the government might retain a license to use the technology advancement for its own purposes as well.

Collectively, 908 surveys were mailed to respondents at the five organizations. A total of 299 surveys were returned (a 33% response rate overall).[4] Of these, 161 were from commercial organizations, while 138 were from federal organizations. The referent collaborations in the sample lasted an average of 2.1 years (sd=2.8). Respondents came from various areas of R&D: 118 were managers, 66 were scientists, 106 were engineers, and 9 were staff. The respondent's knowledge of key aspects of the collaboration was assessed via a battery of specific items at the conclusion of the survey (cf., Cusumano and Takeishi 1991). Respondents were asked to indicate how knowledgeable they were regarding: the intended goals and purpose of the collaboration, each organization's resources to the collaboration, the overall success of the collaboration, and the outputs of the collaboration. They marked their response using a 7-point Likert-type scale (1=hardly knowledgeable, 7=very knowledgeable). The mean response to these items was 6.3 (sd=.82).

Nonresponse bias was examined by comparing early (first 75%) to late (last 25%) responses received (Armstrong & Overton 1977). T-tests of all constructs in the conceptual model indicated no significant differences between the early or late responses. Additionally,

there were no differences in the type of collaboration (Tier 0-4, from Appendix) reported on, or the duration of these collaborations. Collectively, this suggests that there were no fundamental differences in the responses or nature of the collaboration between early or late respondents.

*Collaboration types*. I included a categorical measure in the questionnaire to assess the types of R&D collaborations reported on by the respondents; the complete measure and associated frequencies are displayed in the Appendix. Respondents were asked to classify their collaboration along the 'tiers of R&D' as described by Hauser (1998). These tiers describe various types of research endeavors ranging from basic research that lays the foundations for additional R&D (tier 0) to routine engineering for continuous improvement of products and processes (tier 4). I examined the comprehensibility of this measure extensively in pretest efforts and found no evidence that respondents had any difficulty understanding the descriptions or classifying their work along the tiered structure. Over 70% of the sample described themselves as working on tier 2 and 3 levels of research. Tier 2 research includes directed programs of activities to develop practical competencies that support or fulfill an organization's strategic directions, while tier 3 research comprises applied projects aimed at specific tasks.

*Procedure.* Questionnaires were mailed to respondents along with a postage-paid envelope and cover letter from the researchers explaining the purpose of the study. The letter told them that they had been randomly selected from the participating organization's list of collaborative relationships to participate in a university study designed to better understand R&D collaborations. The respondents were guaranteed anonymity of their responses and offered a summary report in exchange for their participation.

Respondents from the federal research organization were provided the name of a specific collaboration that they worked on and were asked to complete all items with respect to that

particular collaboration. Respondents from the manufacturing firms were asked to consider a recent collaboration and complete all items with respect to that particular collaboration. They were specifically told that the selected collaboration, "does not have to be a highly successful or complex collaboration, although it may be. I am trying to sample from a variety of relationship types and would like to consider many possibilities." In this way, I was able to insure that I had the heterogeneity necessary to capture statistical variation among the constructs and increase the representativeness of the relationships studied.

**Measurement Estimation**

Confirmatory factor analysis (CFA) techniques are used to estimate a measurement model comprised of eleven first-order, latent factors and intercorrelations. These models are estimated using full-information maximum-likelihood (FIML) in LISREL 8.03 (Jöreskog and Sörbom 1993). Each of the 33 observable indicators loaded significantly (alpha=.001) on their intended factors, indicating convergent validity among the items of each scale. The item loadings and measurement errors are in acceptable ranges (Bagozzi and Yi 1988); these values are listed in the Appendix. Discriminant validity between the scale measures is assessed using the stringent test of Fornell and Larcker (1981). This involves examination of the amount of variance extracted by each construct (taking measurement error into account) relative to the squared-correlation between pairs of constructs. This is considered to be a more stringent test of discriminant validity than Campbell (1959) or Jöreskog (1971) because it recognizes the possibility that measurement error can vary in magnitude across items. All possible pairs of factors passed the Fornell and Larcker test, evidencing discriminant validity between the measures.

The overall chi-square for the model is 786.3 ($p<.00$) with 440 degrees of freedom (df). Three fit indices – the comparative fit index (CFI), incremental fit index (IFI), and the Tucker-Lewis fit index (TLI) are examined; their values are .94, .94, and .93 respectively. Since high fit indices can also give the false impression that the model explains much when it really is the result of freeing more parameters to be estimated from the data, a useful index to consider is the root mean square error of approximation (RMSEA). This is a parsimony measure that accounts for potential artificial inflation due to the estimation of many parameters. Values between zero to .05 indicates a close fit of the model in relation to its degrees of freedom, .05 to .08 is indicative of a satisfactory fit of the model, while models with values greater than .10 should be rejected (Steiger 1980; Steiger and Lind 1980). The RMSEA of the measurement model is .051. Hence, it appears that the scale measures are internally consistent, able to discriminate, and provide a good fit of the factor model to the data.

*Higher-order factor.* A second-order factor model of relationship quality is also estimated. This model includes three first order factors: satisfaction with the collaboration, outcome fairness, and willingness to collaborate in the future. Each of these first order factors have significant ($p<.001$) loadings of .96, .90, and .87 respectively, on the second order factor. The overall chi-square for this model is 92.6 ($p<.00$) with 24 df. The CFI, IFI, and TLI are .97, .97, and .96 respectively, with an RMSEA of .098.

## RESULTS

### Tests of Hypotheses

Tests of hypotheses are conducted via the use of hierarchical moderator regression. The model specification includes the main effect and interaction terms of both sharing principles, to allow for the possibility of discovering more about the consequences of using an alternative rule.

Thus, the following specification is a more complete specification than the specific hypothesized effects:[5]

$$Y = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_1 X_2 + \beta_5 X_1 X_3 + \varepsilon$$

Where Y is relationship quality, $X_1$ is a resource or organizational condition, $X_2$ is an equity sharing principle, $X_3$ is an equality sharing principle, and $X_1X_2$ and $X_1X_3$ represent the respective interaction of these sharing principles with $X_1$. Although the formal hypotheses focus on the application of sharing principles with specific resources and organizational conditions, I include the main effect of both principles so that I can observe the effects of the alternative principle on relationship quality. $\alpha_0$ is the regression intercept, $\beta_{1-5}$ are regression coefficients, and $\varepsilon$ is the error term for the equation. The data is mean-centered, to reduce potential collinearity with the interaction terms. This model is estimated for two groups: the federal research organization and the commercial organizations. In these analyses, three stepwise hierarchical regressions are conducted. In step 1, the main effect of resource/organizational condition is entered into the equation. In step 2, the main effects of the two sharing principles are added to the equation. In step 3, the interactions are entered into the equation (Cohen and Cohen 1983). Table 2 overviews the step 3 regression coefficients for both groups. When the interactions are non-significant, the step 2 estimation results using uncentered data are also displayed. This is done because the main effects of the step 3 regression are changed in the presence of higher order terms. In the sections to follow, I evaluate the tests of hypotheses and note other significant patterns in the data.

**Resource Conditions**

When an organization has contributed more resources to a collaboration than its partner, the use of an equity rule has no significant effect on relationship quality for federal ($\beta_4$ = -.01, ns)

or commercial organizations ($\beta_4$ =.01, ns) Thus, there is no support for H1. However, the use of an equality rule when resources are asymmetric has a significant negative effect on relationship quality ($\beta_5$ = -.10, p<.01) for commercial organizations. The stage 2 main effects estimation for federal organizations suggests that asymmetric resources has a significant, negative impact ($\beta_1$ = -.22, p<.01) on relationship quality. Equality sharing has a significant, positive effect ($\beta_3$ = .28, p<.01), while the effect of equity sharing is non-significant ($\beta_2$ = .12, ns).

When the resources to the collaboration are separable and an equity rule is used, there is a nonsignificant effect on relationship quality for federal ($\beta_4$ = -.00, ns) and commercial ($\beta_4$ = -.07, ns) organizations. Thus, H2 is not supported. Stage 2 estimation for federal organizations indicate that resource separability and equality sharing have significant positive effects ($\beta_1$ = .30, p<.01 and $\beta_3$ = .31, p<.01, respectively) on relationship quality, but the effect of equity sharing is not significant ($\beta_2$ = .11, ns). However, the effects of resource separability ($\beta_1$= .23, p<.01), equity sharing ($\beta_2$ = .20, p<.01), and equality sharing ($\beta_3$ = .14, p<.03) are positive and significant for commercial organizations.

When the resources are idiosyncratic in nature and an equality rule is used, there is a nonsignificant effect on relationship quality for federal organizations ($\beta_5$ = -.07, ns) and commercial organizations ($\beta_5$ = .01, ns). Thus, there is no support for H3. The stage 2 estimation results for commercial organizations indicate that idiosyncratic resources ($\beta_1$ = .24, p<.01) and equality sharing ($\beta_3$ = .13, p<.01) have significant, positive effects on relationship quality, but the effect of equity sharing is non-significant ($\beta_2$ = .18 ns). For federal organizations, idiosyncratic investments ($\beta_1$ = .43, p<.01) and equality sharing ($\beta_3$ = .24, p<.01)

have significant, positive effects on relationship quality, but the effect of equity sharing is non-significant ($\beta_2$ = .07, ns).

**Organizational Conditions**

If an organization is able to observe the partner and an equity rule is used, this has a significant positive effect on relationship quality for federal organizations ($\beta_4$ = .07, p<.05), but the effect is nonsignificant for commercial organizations ($\beta_4$ = -.04, ns). Hence, H4 is supported for federal organizations, but not for commercial organizations. For federal organizations, the ability to observe the other party and equality sharing has a significant, negative effect on relationship quality ($\beta_5$ = -.08, p<.05). Stage 2 estimation results for commercial organizations indicates significant positive effects on relationship quality for the following factors: the ability to monitor the other party ($\beta_1$ = .18, p<.01), equity sharing ($\beta_2$ = .22, p<.01) and equality sharing ($\beta_3$ = .15, p<.02).

If an organization understands its partner's transformation process and uses an equity rule, there is a significant negative effect on relationship quality for the federal organizations ($\beta_4$ = -.19, p<.01) and the commercial organizations ($\beta_4$ = -.12, p<.05). Thus, there is no support for H5. However, when a federal organization understands its partner's transformation process and shares equally, there is a significant, positive effect ($\beta_5$ = .18, p<.01) on relationship quality.

When both parties value the payoffs of the collaboration similarly and an equality rule is used, there is a significant negative effect on relationship quality for federal organizations ($\beta_5$ = -.10, p<.05), but a significant positive effect for commercial organizations ($\beta_5$ = .09, p<.05). Hence, H6 is supported for commercial organizations. When the parties value the payoffs similarly and an equity rule is used, the opposite pattern of results occurs. There is a significant

positive effect on relationship quality for federal organizations ($\beta_4$ = .10, p<.05) and a significant negative effect on relationship quality for commercial organizations ($\beta_4$ = -.12, p<.01).

## DISCUSSION

To date, there has been little systematic attention given to the sharing process as an interorganizational phenomenon. Research in marketing has examined the issue peripherally, in other contexts, but there has never been an explicit focus on the *process* or its impact on the *relationship*. For example, research on channel coordination mentions the use of an equality rule (Jeuland and Shugan 1983) and an equity rule (Stern, El-Ansary and Coughlan 1996) in aligning the parties' incentives and fostering desirable coordination behaviors. Research on bargaining behavior examines the payoffs to individual parties, however the emphasis of this stream of work is on how bargaining processes determine the terms of exchange or enable the parties to manage power asymmetries (Dwyer 1984; Dwyer and Walker 1981; Walker 1981).

The results of this research indicate that the ability to separate each organization's inputs to a collaboration and the joint creation of idiosyncratic inputs improves relationship quality, in general. I also find that the use of more complex sharing principles, such as the equity principle, when both parties have an understanding of each other's transformation process, has a *negative* impact on relationship quality. This suggests that the use of an equity principle when an organization can map a reasonable expectation of the payoff *ex ante* may be excessive.

### Spinning Technology In and Out

Along with these general effects, several results differed systematically for federal and commercial organizations. Subsequent interviews with the organizations revealed an explanation for these differences. Apparently, a major goal of many federal research collaborations with industry is to "spin" technology *out* to the private sector, with the expectation

that the private sector will apply the technology in material and product development efforts. These materials and products provide better value to society and will subsequently be procured back into the government sector. In contrast, the goal of a commercial organization is to bring technology *into* the firm. For them, return on investments, share of benefits, and process efficiency are critically important. These seemingly opposite orientations helps us understand differences in results.

In particular, it underscores the need for the sharing process to be *responsive* to the goals of the collaboration. For example, when the collaboration process is meant to "spin" technology into the organizations (e.g., commercial firms), then the sharing strategy should reduce the likelihood of opportunism, insure a fair return on investments, and facilitate efficient process. Specifically, being able to observe the other firm's activities improves relationship quality. However using an equality principle when the firm's inputs are greater than the counterpart's inputs has a negative effect on relationship quality because it doesn't insure a fair share. Moreover, the use of an equity principle when idiosyncratic investments exist or the firms value the payoffs of the collaboration similarly also has a negative impact on the relationship, because the principle may be cumbersome to implement. Instead, it is better to use an equality principle when the firms value the payoffs similarly.

When the collaboration process is meant to "spin" technology out of the organization (e.g., federal laboratories), then the sharing process reflects less concern with resource inputs (although a large asymmetry is not good) and more concern with successful transfer of the technology. Specifically, an equality sharing principale is generally good, particularly when the organization understands the counterpart's transformation process *ex ante*. Some exceptions to this is if the counterpart's behavior is observable or it has similar payoff values. Under these

conditions, an equity principle is better for relationship quality. It may be that a more complex sharing principle under these conditions helps insure a better transfer process in the collaboration.

In summary, the results highlight the sharing process as a strategic, interorganizational process for complex collaboration contexts. The careful application of equity and equality sharing principles applied judiciously to specific types of complex collaborations can improve the participants' satisfaction with the collaboration, their perceptions of the fairness of the outcomes, and their willingness to collaborate again in the future.

**Limitations**

There are a few limitations to consider. First, the fact that all of the commercial organizations were market leaders may limit the generalizability of the results. Second, the survey methodology may have created common method variance that could have inflated construct relationships. This could be particularly threatening if the survey respondents were providing responses that they felt were socially acceptable -- i.e., positive relationship outcomes and a high degree of sharing. However, the respondents were not told that sharing was the specific issues of interest in this study, nor did anyone in the pretest efforts guess that this was the real purpose of the study. Respondents were merely told that the purpose of the study was to understand how to better manage R&D collaborations between organizations. Additionally, the items for all of the constructs were separated and mixed with items of other constructs so that no one respondent would be able to detect which items were affecting which factors. Hence, the biasing possibilities of common method variance were minimized to some degree.

Clearly, there are many other factors that could affect the use of sharing rules and the type of rules that are used in noisy collaboration environments. There is also a level of detail in the process that my measurements are not able to capture and reflect.

**Future Research Directions**

There remain many aspects of interorganizational sharing yet to be understood. For example, one aspect that was not explicitly investigated in this research is the effect of the external environment on sharing strategies. In particular, one interesting aspect to consider would be the interaction of a technology lifecycle and the nature of sharing in interorganizational collaborations. Canairca, Colombo and Mariotti (1992) have examined how types of agreements in equity ventures should vary appropriately at various stages of a technology lifecycle. It may be that sharing strategies also vary systematically over the *lifecycle*.

Future research might also investigate *the impact of these rules on interorganizational behavior and processes*. It may be that the choice of a sharing rule impacts how organizations work together – e.g., does the use of an equality rule cause the parties to be less productive in their individual efforts? Such possibilities are worth investigating.

In this study, I have tried to examine the impact of sharing in close collaborations and discover the process by which this occurs in complex contexts. My results indicate that the sharing process can significantly impact overall relationship quality in a positive or negative way, depending on how sharing principles are applied in conjunction with various resource and organizational conditions and depending on the goals of the collaboration. By observing the rules and conditions under which the rules are used, I am able to infer something about the information environment in which these rules exist. I might also have stimulated thinking on how to better design the rules.

## APPENDIX

## ITEMS, RELIABILITIES, LOADINGS AND MEASUREMENT ERRORS

| Asymmetric Resources ($\alpha$ = .87) | Loading | Meas Error |
|---|---|---|
| Our organization has made greater contributions to complete the task than the other party. | 0.83 | 0.31 |
| Our resources to the R&D effort were greater than the other organization's resources. | 0.85 | 0.27 |
| We have contributed more resources to this effort than the other party. | 0.79 | 0.37 |

| Separable Resources ($\alpha$ = .64) | Loading | Meas Error |
|---|---|---|
| It is difficult to trace each party's contributions to the task. (R) | 0.48 | 0.77 |
| Each party's resources into the task are easily separated. | 0.71 | 0.49 |
| Each party's contributions to the task are distinct. | 0.66 | 0.56 |

| Idiosyncratic Resources ($\alpha$ = .76) | Loading | Meas Error |
|---|---|---|
| Both organizations have made investments that would be lost if the relationship were prematurely terminated. | 0.78 | 0.39 |
| If the collaboration were to end, both organizations would waste a lot of knowledge that's tailored to their relationship. | 0.76 | 0.42 |
| Both organizations have made investments that are unique to this relationship. | 0.54 | 0.71 |
| If either organization were to switch to another partner, they would lose a lot of the investments made in the present relationship. | 0.58 | 0.66 |

| Ability to Observe the Other Party's Actions ($\alpha$ = .88) | Loading | Meas Error |
|---|---|---|
| We can easily observe their actions. | 0.95 | 0.10 |
| It is easy for us to observe their efforts. | 0.92 | 0.16 |
| It is difficult for us to observe their activities. (R) | 0.68 | 0.54 |

| Understanding of the Transformation Process ($\alpha$ = .78) | Loading | Meas Error |
|---|---|---|
| We know the processes and actions that the other party must do in this task. | 0.66 | 0.56 |
| We understand well what the role of the other organization is in completing this task. | 0.82 | 0.32 |
| We can comprehend what the other party must do to accomplish their share of the task. | 0.73 | 0.47 |

| Equal Payoff Valuation | Loading | Meas Error |
|---|---|---|
| Both parties value the payoffs of this relationship similarly. | 0.82 | 0.32 |
| The benefits of this collaboration are equally valued by both organizations. | 0.82 | 0.33 |

| Equity Sharing ($\alpha$ = .77) | Loading | Meas Error |
|---|---|---|
| An organization's resources to the collaboration determine its share of the outputs of working together. | 0.69 | 0.52 |
| Each organization's share of the benefits of this collaboration depends on its contributions to the task. | 0.76 | 0.42 |
| Each organization's share of the outcomes depends on what it provides to support the joint effort. | 0.72 | 0.48 |

| Equality Sharing ($\alpha$ = .78) | Loading | Meas Error |
|---|---|---|
| The organizations share the outcomes of the collaboration equally between them. | 0.56 | 0.68 |
| Each party receives half of all benefits from the collaboration. | 0.76 | 0.42 |
| The gains from the joint effort are equally shared between the organizations. | 0.90 | 0.19 |

| Outcome Fairness ($\alpha$ = .86) | Loading | Meas Error |
|---|---|---|
| Our outcomes received from this collaboration are just. | 0.75 | 0.43 |
| The benefits of collaboration with them have been fair. | 0.82 | 0.33 |
| Our gains from this collaboration have been fair. | 0.85 | 0.27 |

| Satisfaction with the Collaboration ($\alpha$ = .90) | Loading | Meas Error |
|---|---|---|
| Our collaboration with them has been a successful one. | 0.87 | 0.24 |
| Our collaboration with them has more than fulfilled our expectations. | 0.82 | 0.33 |
| We are satisfied with the outcomes from this collaboration. | 0.93 | 0.14 |

| Willingness to Collaborate in the Future ($\alpha$ = .94) | Loading | Meas Error |
|---|---|---|
| We would welcome the possibility of additional collaboration in the future. | 0.88 | 0.22 |
| We would be willing to work with them again in the future. | 0.94 | 0.11 |
| We would be willing to collaborate with them again, should the opportunity arise. | 0.94 | 0.12 |

Types of R&D Collaborations

R&D Collaborations differ in many ways. Which of the following best describe the nature of the collaboration between you and this organization? (*select only one)*

| Frequency (% of sample) | |
|---|---|
| 25 (8.4%) | *Tier 0:* Basic research that lays the foundations for additional R&D. |
| 29 (9.8%) | *Tier 1:* Long-term explorations in science and/or technology to build or maintain basic capabilities. The use of basic foundations to explore tools of the future. |
| 71 (24.1%) | *Tier 2:* Directed programs of activities to develop practical competencies that support or fulfill an organization's strategic directions. The creation of tools. |
| 135 (45.8%) | *Tier 3:* Applied projects aimed at specific tasks with clearly defined, more immediate goals. Pioneering the use of created tools. |
| 39 (13.2%) | *Tier 4:* Routine engineering for continuous improvement of products and processes. Routine use of the tools. |

As an example, consider an organization that wants to communicate detailed 3- dimensional (3D) images to and from a remote field site. Tier 0 might be the development of the fractal mathematics that allow the images to be coded for transmission; tier 1 might include the development of algorithms that use fractal mathematics to code the images; tier 2 researchers might write the software and develop (or buy) the hardware to implement the algorithms; tier 3 research may involve the development of a pilot application to demonstrate the 3D imaging system and solve problems of implementation. Tier 4 might involve handing the 3D imaging system to the business units.

**TABLE 1**
**MEANS, STANDARD DEVIATIONS AND CORRELATIONS**

| | *Variable* | *Mean* | *SD* | *Min* | *Max* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Equity sharing | 4.30 | 1.2 | 1 | 7 | ---- | | | | | | | | | | |
| 2. | Equality sharing | 4.19 | 1.2 | 1 | 7 | **0.08** | ---- | | | | | | | | | |
| 3. | Asymmetric resources | 3.46 | 1.6 | 1 | 7 | **-0.10** | -0.18 | ---- | | | | | | | | |
| 4. | Separable resources | 5.41 | 1.1 | 2 | 7 | 0.15 | 0.14 | **-0.10** | ---- | | | | | | | |
| 5. | Idiosyncratic resources | 4.58 | 1.3 | 1 | 7 | 0.19 | 0.19 | -0.20 | 0.12 | ---- | | | | | | |
| 6. | Ability to observe the other party's actions | 4.10 | 1.6 | 1 | 7 | 0.17 | 0.23 | -0.19 | 0.13 | 0.15 | ---- | | | | | |
| 7. | Understanding of the transformation process | 5.52 | 1.1 | 1.7 | 7 | **0.03** | 0.18 | **-0.10** | 0.47 | 0.24 | 0.24 | ---- | | | | |
| 8. | Equal payoff valuations | 4.91 | 1.4 | 1 | 7 | 0.18 | 0.36 | -0.23 | 0.25 | 0.50 | 0.26 | 0.29 | ---- | | | |
| 9. | Satisfaction with the collaboration | 5.06 | 1.3 | 1 | 7 | 0.19 | 0.30 | -0.27 | 0.21 | 0.45 | 0.29 | 0.17 | 0.43 | ---- | | |
| 10. | Outcome fairness | 5.40 | 1.0 | 1 | 7 | 0.22 | 0.25 | -0.28 | 0.33 | 0.42 | 0.29 | 0.29 | 0.48 | 0.75 | ---- | |
| 11. | Willingness to collaborate in the future | 5.82 | 1.3 | 1 | 7 | 0.21 | 0.26 | -0.23 | 0.30 | 0.44 | 0.28 | 0.20 | 0.44 | 0.73 | 0.76 | ---- |

Correlations in bold are **not** significant at $\alpha = .05$

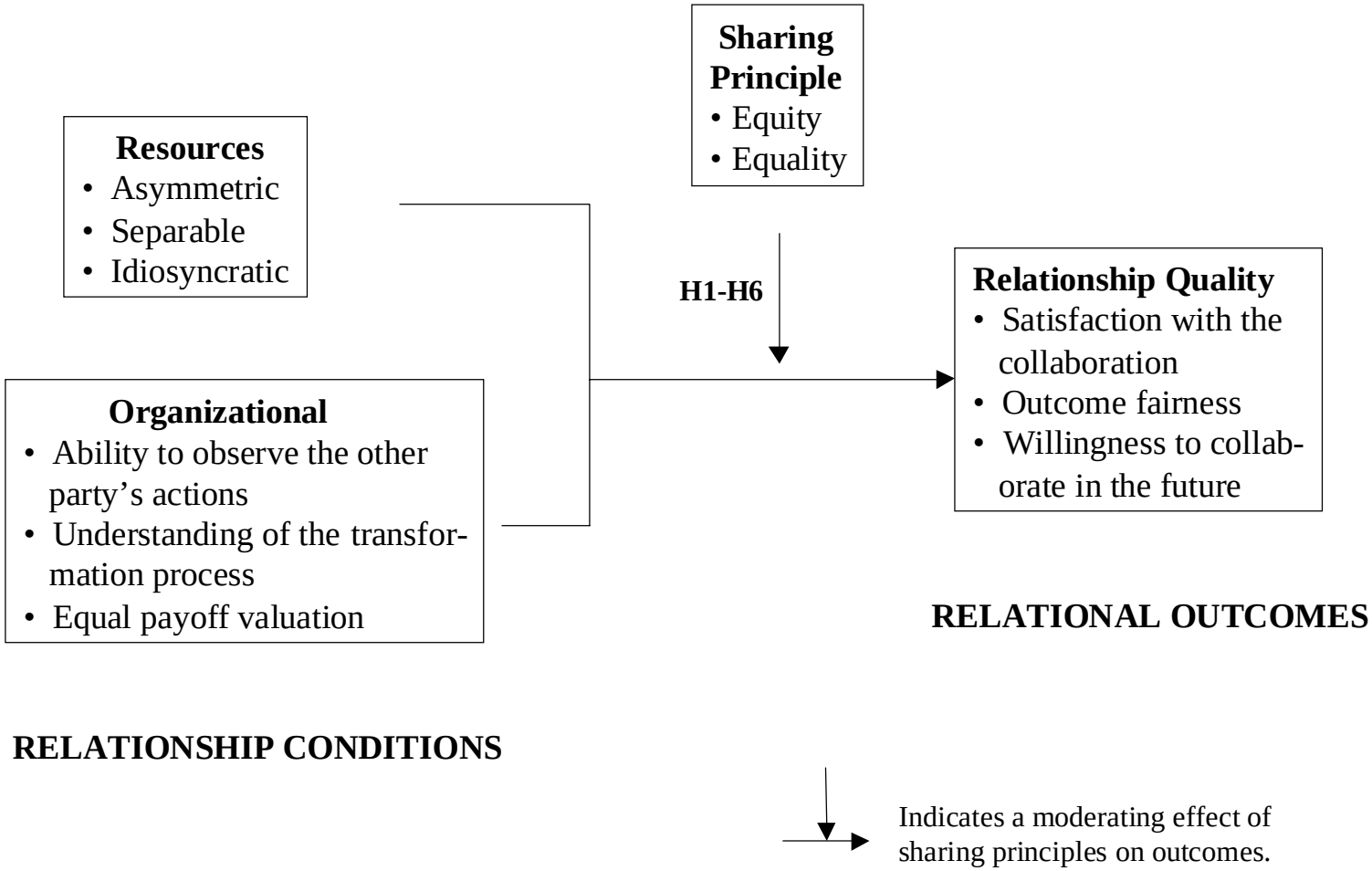
## TABLE 2
## REGRESSION ANALYSIS FOR RELATIONSHIP QUALITY

Stage 2 estimation results are provided when the hypothesized interaction is not significant. Hypothesized interaction is highlighted in italics.

| Coefficient / Independent Variable | | Federal | | Non-Federal | |
|---|---|---|---|---|---|
| | | Stage | | Stage | |
| **Resource Conditions** | | **2** | **3** | **2** | **3** |
| H1: | Intercept | 4.38 | -.33 | | 1.29 |
| | $\beta_1$ Asymmetric resources ($X_1$) | -.22** | -.31 | | .31 |
| | $\beta_2$ Equity sharing ($X_2$) | .12 | .13 | | .18 |
| | $\beta_3$ Equality sharing ($X_3$) | .28** | .17 | | .47** |
| | $\beta_4$ *Asymmetric resources*Equity sharing ($X_1X_2$)* | --- | *-.01* | | *.01* |
| | $\beta_5$ Asymmetric resources*Equality sharing ($X_1X_3$) | --- | .03 | | -.10** |
| | Adjusted $R^2$ | .25 | .24 | | .15 |
| H2: | Intercept | 3.13 | 2.69 | 2.86 | 2.82 |
| | $\beta_1$ Resource separability ($X_1$) | .30** | .76 | .23** | .74** |
| | $\beta_2$ Equity sharing ($X_2$) | .11 | .12 | .20** | .56* |
| | $\beta_3$ Equality sharing ($X_3$) | .31** | .94* | .14* | .46 |
| | $\beta_4$ *Resource separability*Equity sharing ($X_1X_2$)* | --- | *-.00* | --- | *-.07* |
| | $\beta_5$ Resource separability*Equality sharing ($X_1X_3$) | --- | -.11 | --- | -.06 |
| | Adjusted $R^2$ | .22 | .22 | .17 | .18 |
| H3: | Intercept | 2.12 | 1.14 | 7.49 | 1.94 |
| | $\beta_1$ Idiosyncratic resources ($X_1$) | .43** | .69** | .24** | .66* |
| | $\beta_2$ Equity sharing ($X_2$) | .07 | .04 | .18 | .67** |
| | $\beta_3$ Equality sharing ($X_3$) | .24** | .52** | .13** | .07 |
| | $\beta_4$ Idiosyncratic resources*Equity sharing ($X_1X_2$) | --- | .01 | --- | -.10* |
| | $\beta_5$ *Idiosyncratic resources*Equality sharing ($X_1X_3$)* | --- | *-.07* | --- | *.01* |
| | Adjusted $R^2$ | .39 | .39 | .19 | .20 |
| **Organizational Conditions** | | | | | |
| H4: | Intercept | | .14 | 3.22 | 1.06 |
| | $\beta_1$ Ability to observe other party ($X_1$) | | .20 | .18** | .44* |
| | $\beta_2$ Equity sharing ($X_2$) | | -.22 | .22** | .40* |
| | $\beta_3$ Equality sharing ($X_3$) | | .57** | .15* | .21 |
| | $\beta_4$ *Ability to observe other party*Equity sharing ($X_1X_2$)* | | *.07** | --- | *-.04* |
| | $\beta_5$ Ability to observe other party*Equality sharing ($X_1X_3$) | | -.08* | --- | -.02 |
| | Adjusted $R^2$ | | .22 | .18 | .17 |
| H5: | Intercept | | .43 | | 1.63 |
| | $\beta_1$ Understands transformation process ($X_1$) | | .24 | | .60* |
| | $\beta_2$ Equity sharing ($X_2$) | | 1.29** | | .92** |
| | $\beta_3$ Equality sharing ($X_3$) | | -.73* | | -.15 |
| | $\beta_4$ *Understands transformation process*Equity sharing ($X_1X_2$)* | | *-.19*** | | *-.12** |
| | $\beta_5$ Understands transformation process*Equality sharing ($X_1X_3$) | | .18** | | .05 |
| | Adjusted $R^2$ | | .21 | | .23 |
| H6: | Intercept | | -.06 | | .71 |
| | $\beta_1$ Value payoffs similarly ($X_1$) | | .37 | | .44* |
| | $\beta_2$ Equity sharing ($X_2$) | | -.45* | | .77** |
| | $\beta_3$ Equality sharing ($X_3$) | | .68** | | -.35* |
| | $\beta_4$ Value payoffs similarly*Equity sharing ($X_1X_2$) | | .10* | | -.12** |
| | $\beta_5$ *Value payoffs similarly*Equality sharing ($X_1X_3$)* | | *-.10** | | *.09** |
| | Adjusted $R^2$ | | .39 | | .31 |

* $\alpha$=.05, ** $\alpha$=.01

**FIGURE 1**
**THE CONCEPTUAL MODEL**



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## ENDNOTES

[1] Each of these conditions introduces mathematical complexities that make it difficult or impossible to determine an equilibrium condition.

[2] These collaborations are not merely procurement exchanges, but involve the joint development of outcomes.

[3] The resources may also possess all three of these characteristics simultaneously. In this research, I consider each of these characteristics individually, and encourage future research to further consider the interactions between all three factors.

[4] The average response rate from respondents at the four firms was 62%, while the response rate from the federal research laboratory respondents was 21%.

[5] The results of strict hypotheses tests do not change, even as the model specification expands to include the alternative sharing rule and interaction.