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# Conceptualizing and Measuring Collaboration

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**ABSTRACT**

This article conceptualizes and measures collaboration. An empirically validated theory of collaboration, one that can inform both theory and practice, demands a systematic approach to understanding the meaning and measurement of collaboration. We present findings from a study that develops and tests the construct validity of a multidimensional model of collaboration. Data collected using a mail questionnaire sent to 1382 directors of organizations that participate in a large national service program provides the basis for a higher order confirmatory factor analysis. The model that emerges from this analysis demonstrates an overall close fit with the empirical data and the high, standardized gamma coefficients estimated in the model confirm that five key dimensions contribute to an overall construct of collaboration. The primary purpose of this research was to stimulate interest in measurement of collaboration and refinement of the model. As such, we present a detailed description of the analytical process, identify areas that affect interpretation of the data (such as possible selection bias), and propose areas for future research. We believe this effort to conceptualize and measure collaboration offers a foundation for further research.

A growing body of multidisciplinary research suggests that we live in an increasingly "networked" world that demands forms of organizing quite different from bureaucracies or firms (O'Toole 1997; Powell 1990). Devolution, increasingly rapid changes in technology, scarce resources, and rising organizational interdependence are factors that explain the emergence of these new forms. Interorganizational collaboration is a term used by scholars and practitioners to describe a process that can emerge as organizations interact with one another to create new organizational and social structures.

Collaboration is emerging as a distinct focus of scholarly research. Although the literature is vast, multidisciplinary, and rich with case research, it also lacks coherence across disciplines. A wide range of theoretical perspectives results in an equally wide variety of definitions and understandings of the meaning of collaboration. Although multiple conceptualizations of collaboration add richness to the research, they often impede its rigor and cumulativeness. To put it simply, lack of consensus among scholars on the

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meaning of collaboration makes it difficult to compare findings across studies and to know whether what is measured is really collaboration.

Practitioners face an equally confusing landscape. Donors, private and public, increasingly require organizations to demonstrate collaborative relationships based on the assumption that collaborating in a networked environment is advantageous for achieving complex policy goals. Collaboration is often assumed as one way to efficiently allocate scarce resources while building community by strengthening interorganizational ties. Case research suggests, however, that practitioners in this environment face significant collective action problems that undermine their potential for building collaborative relationships (Thomson 1999, 2001; Thomson and Perry 1998). Different accountability standards across organizations often have the ironic effect of straining already tenuous collaborative efforts. Furthermore, widespread and varied usage of the term collaboration renders it nearly meaningless (except as a way to manage the expectations of donors). One practitioner describes it this way: "I feel collaboration is a buzzword, like 'working smarter' [and] 'cost-effective.' Unless further defined, the words are meaningless without specifying what can be implemented and what can be measured."

This article takes seriously the challenge Wood and Gray (1991) make to scholars and practitioners of collaboration—to more adequately address the meaning of collaboration. "A general theory of collaboration must begin," they write, "with a definition of the phenomena that encompasses all observable forms and excludes irrelevant issues" (143). In their review of nine research-based articles on collaboration, Wood and Gray began by assuming that a commonly accepted definition of collaboration existed. Instead, they found "a welter of definitions, each having something to offer and none being entirely satisfactory by itself" (143).

Furthermore, if one purpose of research on collaboration is to inform practice, then measurement becomes important because policy makers rely on research findings to make substantive changes in policy. If data contain significant measurement error, there is less certainty about the conclusions we can draw from the data. Measurement error frequently occurs in the social sciences because, typically, the variables of most interest to social scientists are abstract concepts that cannot actually be observed in the real world (Bollen 1989; Carmines and Zeller 1983; Long 1983a, 1983b). Collaboration is one such concept. The consequences of measurement error can be serious, resulting in inconsistent estimators and inaccurate assessments of relationships among variables of interest (Bollen 1989, 179–180).

In this article, we present findings from an analysis testing the construct validity of a multidimensional model of collaboration using structural equation modeling, a method that incorporates and attempts to control the effects of measurement error. The article begins with discussion of theory we used to guide development of the collaboration construct. We next turn to a description of methods used to conduct the analysis, detailing the process by which the model emerges and identifying sources of bias that may affect the interpretation of results. We then present results from quantitative data gathered through a mail questionnaire and conclude with a discussion of the findings and their implications for future research.

## THEORETICAL FRAMEWORK

Our theoretical conceptualization of collaboration is grounded in two sources of evidence. One is a comprehensive review of the theoretical literature and a systematic analysis of

multiple definitions of collaboration across multiple disciplines. The second is field research, which included interviews with 20 organizational directors about their own collaboration experiences and case study research conducted in 1995–96 and 1998–99 (Thomson 1999; Thomson and Perry 1998). These sources of evidence form the basis of the following definition of collaboration:

> Collaboration is a process in which autonomous or semi-autonomous actors interact through formal and informal negotiation, jointly creating rules and structures governing their relationships and ways to act or decide on the issues that brought them together; it is a process involving shared norms and mutually beneficial interactions.[1]

This definition emphasizes that collaboration is a multidimensional, variable construct composed of five key dimensions, two of which are structural in nature (*governance* and *administration*), two of which are social capital dimensions (*mutuality* and *norms*), and one of which involves agency (*organizational autonomy*).

## A Theoretical Model of Collaboration

Conceptually, the five key dimensions of collaboration emerge from the growing body of research on collaboration (Gray 1989, 1996, 2000; Huxham 1996; Huxham and Vangen 2005), and precursor literatures on interorganizational relations (Ring and Van de Ven 1994) and organizational behavior (Hellriegel, Slocum, and Woodman 1986), which strongly support an integrative view of collaboration as a process "through which parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible" (Gray 1989, 5).

The multidisciplinary literature on collaboration confirms that collaboration is not an "either/or" and provides valuable insights into the complex nature of collaborative processes, an area in need of more systematic quantitative research to complement the extensive case research that currently exists. In their review of collaboration research, Wood and Gray (1991) frame their discussion in terms of an antecedent–process–outcome framework and argue that of these three, the interactive *process* of collaboration is least understood. We conceptualize the collaboration process in terms of the five variable dimensions briefly discussed below and significantly elaborated upon in (Thomson and Perry 2006).

### *Governance*

Participants seeking to collaborate must understand how to *jointly* make decisions about rules that will govern their behavior and relationships. Collaboration involves creating structures that allow participants to make choices about how to solve the collective action problems they face by developing sets of working rules about who is eligible to make

1 It is important to acknowledge that this definition of collaboration is strongly influenced by Wood and Gray's (1991) definition—an important definition because it is one of the only definitions in the literature that is derived from a synthesis of findings from nine studies on the subject. This definition expands on Wood and Gray's in that it (1) incorporates key phrases and words from a much broader review of the literature, (2) is rooted in commonalities among multiple theoretical perspectives, (3) expands on the governance and administration aspects of collaboration, (4) incorporates a process framework into the definition, (5) contains identifiable key dimensions, and (6) provides the basis for a covariance structure model of collaboration whose fit has been empirically tested with sample data.

decisions, which actions are allowed or constrained, what information needs to be provided, and how costs and benefits are to be distributed (Ostrom 1990, 51).

This process is neither static nor is there one universal way to go about creating what Bardach (1998) calls "jointness." Warren (1967, 180) conceives reaching general consensus about how to solve collective action problems as a process that involves negotiating an equilibrium where contest and conflict between partners still occurs but only at the margins and within a larger framework of agreement on the appropriateness of jointly determined rules that assure a collaborative environment. To arrive at this kind of equilibrium, public managers need to understand the shared responsibility that accompanies this form of governance when they engage in collaboration (Himmelman 1996; Pasquero 1991).

### *Administration*

Collaborations are not self-administering enterprises. Organizations collaborate because they intend to achieve particular purposes. To achieve the purpose that brought organizations to the table in the first place, some kind of administrative structure must exist that moves from governance to action. These administrative structures differ conceptually from those of governance because the focus is less on institutional supply and more on implementation and management—doing what it takes to achieve a goal.

However, implementation (like joint decision making) in collaboration is complex not only because participation is voluntary but also because traditional coordination mechanisms such as hierarchy, standardization, and routinization are less feasible in situations where actors are autonomous or semiautonomous (Huxham 1996; Huxham and Vangen 2005; O'Toole 1997; Powell 1990; Wood and Gray 1991). Establishing an effective operating system for collaboration that includes clarity of roles and responsibilities, communication channels that enhance coordination, and mechanisms to monitor each other's activities in relation to roles and responsibilities can be particularly difficult when the means of communication is relational rather than routinized (Alter and Hage 1993; Bardach 1998; Powell 1990).

Yet, as public mangers know all too well, decentralized administrative structures still require a central position for coordinating communication, organizing and disseminating information, and keeping partners alert to the jointly determined rules made for governing relationships—what Freitag and Winkler (2001, 68) describe as social coordination. One of the principal administrative dilemmas affecting the ability to get things done in a collaboration is managing the inherent tension between self and collective interests.

### *Organizational Autonomy*

A defining dimension of collaboration that captures both the potential dynamism and frustration implicit in collaborative endeavors is the reality that partners share a dual identity: They maintain their own distinct identities and organizational authority separate from a collaborative identity. This reality creates an intrinsic tension between *organizational self-interest*—achieving individual organizational missions and maintaining an identity distinct from the collaborative—and a *collective interest*—achieving collaboration goals and maintaining accountability to collaborative partners and their stakeholders (Bardach 1998; Tschirhart, Christensen, and Perry 2005; Van de Ven, Emmett, and Koenig 1975; Wood and Gray 1991).

Huxham (1996) refers to this tension as the autonomy–accountability dilemma. Representatives from participating organizations in the collaboration are likely to experience

significant tension as they are pulled between feeling accountable to the demands of their parent organization (and its constituents) and the demands of their collaborative partners (and the constituents of the collaboration). Unless the individuals representing their various parent organizations are "fully empowered by their organizations to make judgments about what they may commit to [in the collaboration]," Huxham (1996) writes, they will constantly have to check in with their "parents before action can happen" (5). This often exacerbates tension within the collaboration as collaborating partners wait to hear back from the parent organizations and the momentum that collaboration partners may have at first experienced slowly diffuses into what Huxham calls "collaborative inertia." It is not surprising, then, that when collaboration's goals conflict with the autonomous goals of individual partner organizations, identities are at stake and it is likely that individual missions will trump collaboration missions.

This potential tension is significantly exacerbated by the reality that in collaboration, no formal authority hierarchies exist between collaborating partners; this means, writes Huxham (1996), "that working relationships between individuals from different organizations can only be formed on a goodwill basis" (6). The development of that goodwill need not depend on a complete lack of tension, however. In her evaluation of consensus building, Innes (1999) argues that tension holds within it the potential for creativity. "In totally stable environments," Innes writes, "equilibrium powerfully hinders change [while highly] chaotic environments, on the other hand, produce only random responses, and systems cannot settle into patterns" (644).

The key, she writes, rests in finding the intermediate state—on the "edge of chaos" (Innes 1999, 644)—where participating organizations can find the potential dynamism implicit in this tension between individual and collective interests by maximizing latent synergies among individual differences. These latent synergies are captured by the fourth dimension, mutuality.

### *Mutuality*

Mutuality has its roots in interdependence. Organizations that collaborate must experience mutually beneficial interdependencies based either on differing interests (what Powell [1990] calls complementarities) or on shared interests—usually based on homogeneity or an appreciation and passion for an issue that goes beyond an individual organization's mission (such as the moral imperative of environmental degradation or a humanitarian crisis).

Complementarity describes a situation where "parties to a network agree to forego the right to pursue their own interests at the expense of others" and accommodation serves as the *modus operandi* of interaction (Powell 1990, 303). It occurs when one party has unique resources (skills, expertise, money) that another party needs or could benefit from (and vice versa). Such exchange relationships are well documented in interorganizational relations (Levine and White 1961; Van de Ven, Emmett, and Koenig 1975; Warren et al. 1975) and supported by resource dependence theory (Pfeffer 1997; Pfeffer and Salancik 1978). As long as collaboration partners can satisfy one another's differing interests without hurting themselves, collaboration can occur (Wood and Gray 1991, 161).

In contrast to negotiation that begins with differences, other scholars begin with shared interests, jointly identifying commonalities among organizations, like similarity in missions, commitment to similar target populations, and/or professional orientation and culture (Lax and Sebenius 1986). In her study of collaborations in national service,

Thomson (1999) found that commitment to similar target populations proved to be one of the most important factors holding collaborations together. In one case, the power of this commitment was so great that when promised funding did not come through, partner organizations "forked out [their own] money" at the cost of $20,000 to keep the collaboration going (37). This kind of commitment is unlikely without the presence of the final defining dimension of collaboration: norms of reciprocity and trust.

#### *Norms*

Reciprocity and trust are closely related conceptually. In collaboration, participating organizations generally exhibit an "I-will-if-you-will" mentality based on perceived degrees of the reciprocal obligations each will have toward the others. Partners may be willing to bear disproportional costs at first because they expect their partners will equalize the distribution of costs and benefits over time out of a sense of duty. Ring and Van de Ven (1994) call this "fair dealing." This tit-for-tat reciprocity that is contingent and fragile may, however, change over time as perceptions of obligation evolve into less fragile social mores that form the basis of social interaction and reciprocal exchange in the collaboration (Axelrod 1984; Ostrom 1990; Powell 1990).

These mores can also be seen as a form of trust which is a common belief among a group of individuals that another group will: (1) make "good-faith efforts to behave in accordance with any commitments both explicit and implicit," (2) "be honest in whatever negotiations preceded such commitments," and (3) "not take excessive advantage of another even when the opportunity is available" (Cummings and Bromiley 1996, 303). Trust is a central component of collaboration because it reduces complexity and transaction costs more quickly than other forms of organization (Chiles and McMackin 1996; Ostrom 1998; Smith 1995).

The problem is this: Developing trust takes time and time implies the need for repeated interaction among partners that builds the credible commitment so necessary for collective action to occur (Axelrod 1984, 1997; Ostrom 1990). For Ostrom (1998), collective action depends upon the three key core relationships: trust, reciprocity, and reputation. As collaborative partners interact and build reputations for trustworthy behavior over time, they may find themselves moving away from the more contingent I-will-if-you-will reciprocity to longer term commitments based on institutionalized "psychological contracts" (Ring and Van de Ven 1994) based on trust. When personal relationships increasingly supplement formal organizational role relationships, psychological contracts increasingly substitute for legal contracts, and when formal organizational agreements increasingly mirror informal understandings and commitments, interorganizational relationships may be sustained over time (Ring and Van de Ven 1994, 103).

## METHODS

In this section, we discuss the sample, data collection, and the statistical method of structural equation modeling used in the study.

### Sample

Primary data were collected through a mail questionnaire sent to all 1382 directors of organizations that participated in a large national service program, AmeriCorps* State/National

in 2000 and 2001. After two mailings to respondents, follow-up phone calls, and a third mailing to those who had not yet responded, the final number of useable returned surveys was 440 for a response rate of 32%. The sample represents the operational level of national service policy implementation characterized by a complex system of nested networks of organizations at the national, state, and local levels. The organizations in the sample vary in structure, size, capacity, and goals providing a rich environment for systematically studying the meaning of collaboration.[2]

It is important to acknowledge that this sample represents a truncated sample as we do not have information on nonrespondents. Furthermore, the response rate of 32% limits the generalizability of the findings in this study. However, because our focus is on measurement, and our interest is to encourage refinement of the model presented here, we believe that despite possible selection bias, this initial attempt to conceptualize and measure collaboration offers a foundation for further research.

## Data Collection

We used a mail questionnaire to collect data that included the observed variables as well other demographic and descriptive information about the collaborations to which respondents and their organizations belonged. Both the theoretical and empirical literature guided the choice of questionnaire items. To operationalize the dimensions of *governance*, *administration*, *autonomy*, and *mutuality*, we used closed-ended questions that asked respondents the extent to which their organization or partner organizations engage in certain behaviors or exhibit certain attitudes. Responses on a Likert-like scale range from 1 = "not at all" to 7 = "to a great extent." For the last dimension, *norms*, the questions were also closed ended and asked respondents about the extent to which they strongly disagree or strongly agree with a list of 10 statements. As with the other four dimensions, we used a Likert scale ranging from 1 = "strongly disagree" to 7 = "strongly agree."

In this analysis, we treat the data as ordinal-level data although, in principle, there is an interval-level scale lying behind each of the ordinal variables.[3] Table 1 provides the questionnaire items relating to the five key dimensions to which organization directors responded.

Few instruments to measure collaboration exist and those that do are difficult to adapt outside the immediate context of a particular study. Mattessich and Monsey's (1992) collaboration experience questionnaire is the only general scale we found. We did find a number of scales, however, used to measure concepts similar to collaboration from the interorganizational relations and network literature such as Cummings and Bromiley's (1996) Organizational Trust Index, a cost–benefit questionnaire on partnering developed through the Minnesota Center for Survey Research (1996); a survey of collaboration activities developed by the Center for Evaluation Research and a private consulting firm, Professional Data Analysis (1996); social network questions from the Indianapolis Network Mental Health Study (1993) through the Institute for Social Research, Indiana University; and Van de Ven and Ferry's (1980) Organizational Assessment Instruments.

2 For a detailed description of the sample for this study, see Thomson (2001), especially pages 119–128.

3 Because of this, there is a significant body of social science research that treats Likert variables as data on an interval scale. Within the LISREL context, such a view would broaden the range of applicable estimation methodologies to include those that are appropriate for analyzing covariance matrices.

**Table 1**
Survey Items Used to Measure Collaboration

Governance

13. Circle the number that best indicates (how much—"not at all" to "to a great extent")
    a. Your organization relies on a formal agreement that spells out relationships between partner organizations?
    b. Your organization relies on standard operating procedures (like rules, policies, forms) created by partner organizations to coordinate each other's activities in the collaboration?
    c. Your organization participates on a board or steering committee *specifically* created for making decisions about the collaboration ?
    d. Partner organizations take your organization's opinions seriously when decisions are made about the collaboration?
    e. Partner organizations (including your organization) formally evaluate the success of the collaboration?
    f. All partner organizations (including your organization) *have to agree* before a decision is made about the goals and activities of the collaboration?
    g. Your organization knows *what* resources (like money, time, expertise) the partner organizations bring to the collaboration?
    h. Your organization knows the reasons *why* partner organizations belong to the collaboration?
    i. Your organization brainstorms with partner organizations to develop solutions to mission-related problems facing the collaboration?
    j. Your organization is involved in implementing specific solutions to mission-related problems facing the collaboration?
    k. Partner organizations (including your organization) rely on mission statement for the collaboration different from each individual partner organization's mission statement?
    l. Your organization relies on informal personal relationships with partner organizations when making decisions about the collaboration?

Administration

14. Circle the number that best indicates (how much—"not at all" to "to a great extent")
    a. Partner organizations (including your organization) rely on a manager to coordinate the collaboration's activities?
    b. Your organization brings conflicts with partner organizations out in the open to work them out among the organizations involved?
    c. Your organization relies on an external authority to resolve conflicts with partner organizations about matters concerning the collaboration?
    d. Your organization relies on formal communication channels when contacting partner organizations about issues related to the collaboration?
    e. Your organization has problems getting in touch with partner organizations when you need to contact them?
    f. You, as a representative of your organization in the collaboration, understand your organization's roles and responsibilities as a member of the collaboration?
    g. Partner organization meetings accomplish what is necessary for the collaboration to function well?
    h. Partner organizations (including your organization) agree about the goals of the collaboration?
    i. Your organization's tasks in the collaboration are well coordinated with those of partner organizations?
    j. You feel partner organizations keep an eye on your organization's activities to make sure you are doing what you are supposed to be doing in the collaboration?
    k. Your organization keeps an eye on partner organizations' activities in the collaboration to make sure they are doing what they are supposed to be doing in the collaboration?

*Continued*

**Table 1** *(continued)*
Survey Items Used to Measure Collaboration

Autonomy

15. Circle the number that best indicates (how much—"not at all" to "to a great extent")
    a. The collaboration hinders your organization from meeting its own organizational mission?
    b. Your organization's independence is affected by having to work with partner organizations on activities related to the collaboration?
    c. You, as a representative of your organization, feel pulled between trying to meet both your organization's and the collaboration's expectations?
    d. Your organization is up-front with partner organizations about what it can and cannot give (in time, money, energy, and other resources) to achieve the collaboration's goals?
    e. You, as a representative of your organization, are allowed to make commitments to the collaboration without having to first get your organization's approval?
    f. Your organization protects its own organizational integrity in matters concerning the collaboration?
    g. Your organization would be hurt if it decided to pull out of the collaboration today?
    h. Information your organization is willing to share with partner organizations for the good of the collaboration even though you would be better off withholding it?
    i. Your organization is familiar with the programs and operations of the partner organizations?
    j. Your organization feels it worthwhile to stay and work with partner organizations rather than leave the collaboration?

Mutuality

16. Circle the number that best indicates (how much—"not at all" to "to a great extent")
    a. Partner organizations have positively influenced your organization's services or operations?
    b. Professional philosophies between your organization and partner organizations make it difficult for you to work together
    c. Your organization sends clients to or receives clients from partner organizations?
    d. The goals and activities of your organization are similar to goals and activities of partner organizations?
    e. Your organization's understanding of the issues that initially brought you to the collaboration differs from those of partner organizations?
    f. Your organization, to accomplish its goals, needs the resources, services, or support of partner organizations?
    g. Partner organizations, to accomplish their goals, need the resources, services, or support of your organization?
    h. Partner organizations (including your organization) have combined and used each other's resources so *all* partners benefit from collaborating?
    i. Your organization shares information with partner organizations that will strengthen their operations and programs?
    j. You feel *what* your organization brings to the collaboration is appreciated and respected by partner organizations?
    k. Your organization achieves its own goals better working with partner organizations than working alone?
    l. Partner organizations (including your organization) work through differences to arrive at win–win solutions?
    m. Partner organizations (including your organization) hold celebrations to recognize joint successes in the collaboration?

*Continued*

**Table 1** *(continued)*
Survey Items Used to Measure Collaboration

Norms

17. Circle the number that best indicates how strongly you disagree or agree with the statements below.
    a. The people who represent partner organizations in the collaboration are trustworthy.
    b. Partner organizations take advantage of organizations in the collaboration that are vulnerable.
    c. My organization can count on each partner organization to meet its obligations to the collaboration.
    d. Partner organizations try to get the upper hand when they negotiate in the collaboration.
    e. My organization will work with partner organizations only if they prove they will work with us.
    f. My organization will find ways to punish partner organizations that do not keep their word.
    g. If partner organizations treat my organization unfairly, we will leave the collaboration.
    h. My organization will pursue its own interests even at the expense of partner organizations.
    i. Even if they do not always meet their obligations to us, my organization has a duty to meet its obligations to partner organizations.
    j. Developing long-term personal relationships with partner organizations is the most important part of collaborating.

Cummings and Bromiley (1996) conducted a confirmatory factor analysis of a multidimensional scale of trust with success in demonstrating a reliable and valid measure of the construct. Given its validity, we rely on the Organizational Trust Inventory to help us operationalize trust adapting their indicators to the context of our study.[4] All the other items on the questionnaire were created expressly for this study.

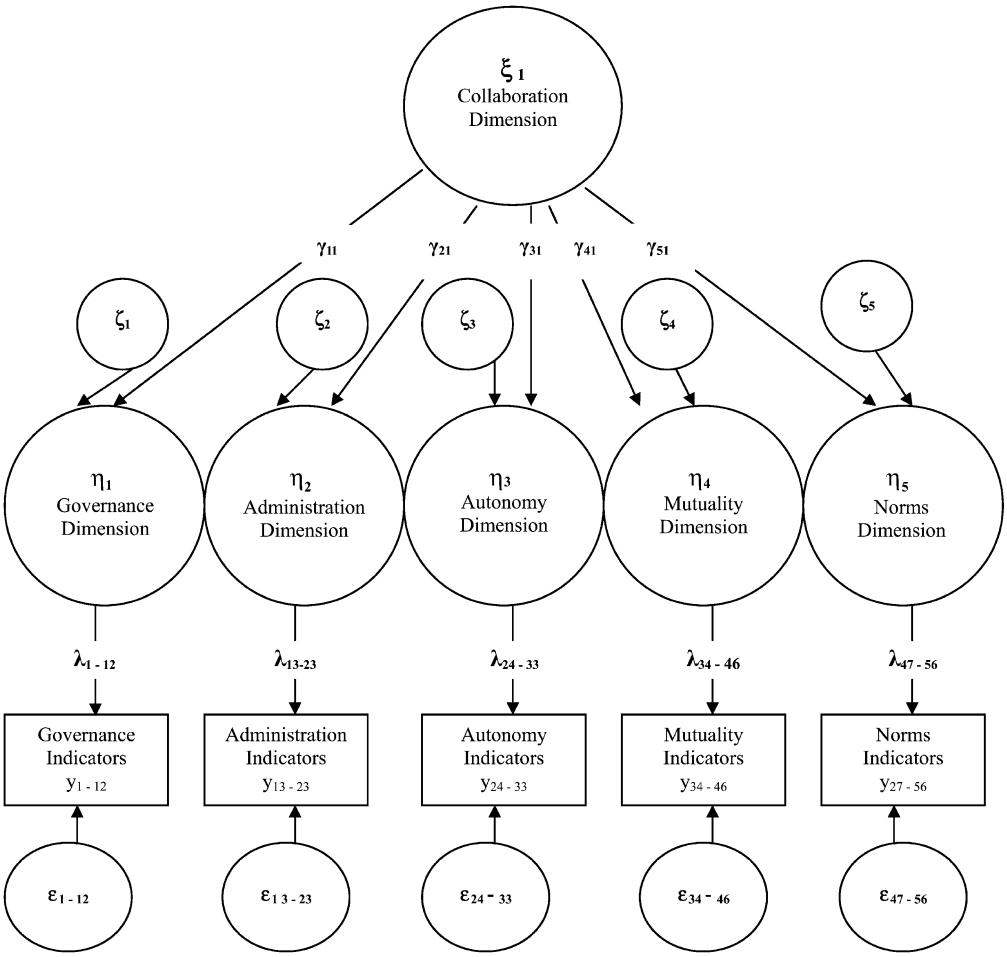
Questionnaire construction involved five stages, each stage yielding a new iteration until completion of the final version. Each of the five stages involved comments from experts and practitioners (individually and in focus groups) convened for pretesting the questionnaire. The final version of the questionnaire is organized into four sections to gather (1) qualitative and quantitative data about the nature of the collaboration, and quantitative data about (2) collaboration outcomes, (3) the five key dimensions of collaboration, and (4) basic demographic data about respondents' organizations such as annual operating budget.

## Structural Equation Modeling

The fundamental idea underlying structural equation modeling is to "explain the variation and co-variation in a set of observed variables in terms of a set of unobserved factors" (Long 1983a, 22). A structural equation model is composed of two distinct models: a *measurement* model that postulates relationships between key dimensions and their underlying observed indicators (in our case, the five key dimensions and the observed indicators operationalized in the questionnaire) and a *structural* model that postulates relationships among the unobserved factors (in this case, collaboration and five key dimensions).

4 We did not use Cummings and Bromiley's entire Organizational Trust Index (OTI) but chose only those items most appropriate for the context of our study and in order to be parsimonious. Many of the questions in the OTI were not directly relevant to our analysis. The items in table 1 that were influenced by the OTI and adapted for use in this study are 17 (a, b, c, and d).

**Figure 1**
Structural Equation Model of Collaboration. Notation for Structural Equation Model




**Notation for Structural Equation Model**

| Symbol | Name | Definition |
|---|---|---|
| ξ | xi | Latent exogenous variable (collaboration) |
| ή | eta | Latent endogenous variables (the five key dimensions) |
| γ | gamma | Coefficients relating eta to xi |
| ζ | zeta | Errors in the structural equations |
| y | | Observed indicators of ή (the fifty-six survey items) |
| λ | lambda | Coefficients relating y to ή |
| ε | epsilon | Measurement errors for y |

Structural equation modeling is used to estimate the measurement and structural model parameters in a situation where the model contains latent variables. Our hypothesized structural and measurement models are summarized in figure 1.

### *The Measurement Model*

Understanding relationships between latent (unobserved) variables and their underlying observed variables constitute the measurement component of a structural equations model.

Because the five key dimensions of collaboration are latent variables—that is, we cannot actually observe them—we rely on observed variables (assumed to be generated by the unobserved variables) that are considered to be measured with error (Long 1983b, 13). The equations that comprise the measurement model used in this research may be represented as:

$$y = \Lambda_y \eta + \varepsilon$$

### *The Structural Model*

In contrast to the measurement model, the structural model is concerned with the causal relationships between and among the unobserved (latent) variables that correspond to concepts—in our case, collaboration and its five key dimensions. The structural model postulates the causal relationships among these six unobserved variables and the equations for these relationships in this research may be represented as:

$$\eta = \Gamma \xi + \zeta$$

### *Estimation*

Given the ordinal nature of our data, we use the weighted least squares (WLS) method of parameter estimation applied to the polychoric correlation matrix (Joreskog [2005] shows how structural equation modeling can be applied to ordinal data). The lambda ($\lambda$) parameters (contained in the matrix $\mathbf{\Lambda_y}$ in the case of the measurement model) and the gamma ($\gamma$) parameters (contained in the matrix $\mathbf{\Gamma}$ in the case of the structural model) are a primary focus of the estimation, along with other parameters that underlie the $R^2$ values for the model equations. These allow the researcher to examine the magnitude of the direct linear relationship between an unobserved variable and each of its indicators (validity), the amount of systematic variance of each indicator explained by an unobserved variable (reliability), and structural relationships among the unobserved variables. The structural equation model depicted in figure 1 is a higher order factor analysis model that hypothesizes collaboration as a higher order factor that influences the observed variables through its influence on key dimensions. One scholar described this higher order effect as the "gestalt" of a concept (Spreitzer 1992, 80).

A piecewise jigsaw technique is used to develop a model that best fits sample data (Bollen 2000). This analytical technique relies on both confirmatory and exploratory data analysis to systematically specify and re-specify models of collaboration seeking balance between parsimony and the need to retain the most statistically and substantively important observed indicators of collaboration. Such an approach is justified when the purpose of the analysis is to identify the best-fit model of a multidimensional scale with construct validity and when the theoretical model contains large numbers of indicators that may or may not be empirically significant, valid, or reliable (Bollen 2000; Ullman 1996).

## THE ANALYTICAL PROCESS

In the interests of encouraging further research on measurement models of collaboration, we describe in greater detail the process by which the multidimensional scale is derived. We begin with the measurement component of the model (which is a foundation for the larger structural model) and involves two primary steps: (1) decomposing the original model postulated in figure 1 into its five component parts—five single-factor measurement models—and then (2) reassembling these five models into a horizontally integrated model. The measurement component of the model addresses the question: "Can each of the five

unobserved dimensions be related to a subset of the observed indicators?" By decomposing the original model into single-factor models, we are able to assess the relationship between each dimension and its corresponding indicators by systematically, one by one, eliminating the *least* theoretically important and statistically insignificant indicators based on evaluation of component and overall fit measures. The primary purpose for reassembling the single-factor models into an integrated whole is to examine how these five best-fit single-factor measurement models perform when integrated into one overall single model.

We conclude this section with a discussion of the structural component of the model and introduce the higher order structural equation model that includes the latent variable, collaboration, as the overall higher order construct from which derive the five key dimensions.

The structural component of the higher order factor model explores the following question: "To what extent is collaboration composed of five distinct dimensions that together amplify the meaning of an overall construct of collaboration?" Here, our primary purpose is to evaluate the relationships among the five dimensions of collaboration and their higher order factor, collaboration. In both the measurement and structural models, we rely on two types of indices to evaluate the specified and re-specified models: component fit and overall fit measures.

### Component Fit Measures

Evaluation of each model using component fit measures involves examining the estimated parameters, especially the lambda and gamma estimates, to determine if they are statistically significant (are the estimates sufficiently large compared to their standard errors? do they make sense? are they in the hypothesized direction?), and evaluating the validity and reliability of the individual indicators using a validity coefficient (standardized lambda coefficient) and an $R^2$ value for each path in the measurement model.[5]

The closer the validity coefficient is to 1, the better the indicator is at reflecting the construct of interest; the closer the $R^2$ is to 1, the more reliable the indicator because the larger the $R^2$, the more variability in each indicator is accounted for by the unobserved factor. In complex models, it is possible to distinguish between the validity and reliability of the measured variables using these methods. However, the model postulated here contains only equations with a single explanatory variable, and in that context, validity and reliability cannot be distinguished and are jointly assessed.

### Overall Fit Measures

The purpose of overall fit measures is to assess the difference between the correlation matrix of the observed indicators and the implied correlation matrix predicted by the model (Bollen 1989, 258).[6] The smaller the difference, the closer the fit and the better is the model. Overall fit measures abound in the literature on structural equation modeling but because no consensus currently exists on which of these is superior, we follow Bollen's (1989) logic, using several different overall fit indices. These include (1) a chi-square test that hypothesizes a perfect fit between the sample data and the theoretical model;

5 For the theoretical and mathematical explanation behind these measures, see Bollen (1989), 197–200, 281–88.

6 For the theoretical and mathematical explanation behind these measures, see Bollen (1989), 256–281.

(2) the root mean square error of approximation (RMSEA), which is the basis of a test of close fit; (3) the goodness of fit index (GFI) that can be thought of as the $R^2$ of the overall model (Ullman 1996, 750); (4) the adjusted GFI (AGFI) that takes into account the number of parameters estimated in the model and rewards models with fewer parameters (Bollen 1989, 276); and finally, (5) the chi-square statistic divided by its degrees of freedom.[7]

Because the goal is to have a perfect fit between the sample data and the theoretical model, we want an insignificant chi-square statistic (small chi square/large $p$ value). Rarely is the hypothesis of a perfect fit achieved, however, so statisticians have also developed the RMSEA, which can be used to test the hypothesis of a close fit between the theoretical model and the sample data. Like the chi-square test, a small RMSEA (less than .05) and a large $p$ value allows us to not reject the null hypothesis of a close fit. Joreskog and Sorbom (1993) quote Browne and Cudeck (1993) on the interpretation of the RMSEA. "Brown and Cudeck," they write,

> suggest that [an RMSEA] value of 0.05 indicates a close fit and that values up to 0.08 represent reasonable errors of approximation in the population. A 90 percent confidence interval of [the RMSEA] and a test of [RMSEA] $< 0.05$ give quite useful information for assessing the degree of approximation in the population (124).

Finally, interpretation of the GFI and AGFI are similar to an interpretation of $R^2$ in regression analysis—the closer these measures are to 1 the better the fit of the model to the sample data. And although no consensus currently exists on what constitutes a "good fit" using the chi-square/degrees of freedom measure, recommendations range from as high as five to three or less (Bollen 1989, 278).

## The Measurement Component of the Model

The original theoretical model specified in this study includes six unobserved factors (collaboration and its five key dimensions) and 56 observed indicators (Likert-scale questions on the questionnaire). Just as the dimensions are broad to capture the nature of collaboration as a process of interaction among organizations, so are the indicators broad to capture the different ways organizations may interact. We deliberately include a large number of indicators, as Carmines and Zeller (1983) advise because we expect some of these to be deleted from the model through the specification and re-specification process. When establishing validity, write Carmines and Zeller (1983), it is always preferable to construct too many items rather than too few because inadequate items may always be eliminated, but "good" items can rarely be added (21).

Using confirmatory and exploratory analysis to identify the most valid and reliable measures provides a way to develop a multidimensional scale of collaboration with construct validity. The primary focus of the measurement analysis involves systematically specifying and re-specifying the model based on repeated evaluations of overall and component fit measures. The purpose of re-specification is to arrive at a multidimensional

7 On the chi-square/df measure, Bollen (1989) writes, "[The justification for this measure] appears to be that the expected value of a Chi-square variate is its degrees of freedom. So Chi-square/df estimates how many times larger the Chi-square estimate is than its expected value . . ." (Bollen 1989, 278).

scale of collaboration that is both reliable and has validity. Bollen (2000) describes this modeling strategy as being

> somewhat like a jigsaw puzzle, where we fit pieces of the model individually and then together until we find a coherent whole; [part] of the analysis is to see if the fit is still reasonable as you assemble the pieces at each stage [without fixing] the coefficient estimates when assembling the full model (79).

This "piecewise jigsaw technique" illustrates the (often) blurred distinction between confirmatory and exploratory factor analysis.

#### *Step One: Breaking the Complex Theoretical Model into Its Component Parts*

To assess the measurement component of the model, we begin by breaking the complex theoretical model with its six unobserved latent variables and 56 indicators into its component parts and systematically examining individual single-factor measurement models. Each of these models is systematically examined using the following logic (1) estimating a baseline single-factor measurement model, (2) testing the fit of this model with the sample data, (3) evaluating the model using component and overall fit measures, and (4) respecifying the model, one change at a time, until a best-fit model emerges.

At this stage, we also use exploratory factor analysis as a way to check our conceptualization of the individual measurement models to determine whether we might have missed a factor not specified in the confirmatory factor model. The goal is to derive individual best-fit measurement models (for each of the five dimensions) with statistically valid and reliable indicators in preparation for horizontal integration into a new confirmatory factor analysis model. The final result of this first step in the analysis is five best-fit measurement models with indicators that are theoretically and statistically significant and valid.

#### *Step Two: Reassembling the Five Models into an Integrated Model*

To examine these relationships, the best-fit measurement models that emerge in the previous step are reassembled across the key dimensions into a single integrated model. Following the same logic of analysis as in the previous step, we (1) estimate a baseline integrated model, then (2) test and evaluate the fit of the model using component and overall fit measures, and (3) re-specify the model, one change at a time, until a best fit integrated model is derived.

This process involves systematically comparing the parameter coefficients of the individual measurement models to those in the estimated integrated model to see if there are any large changes that might suggest misspecification. Bollen (2000) strongly advises this evaluation as a way for the analyst to check whether, by estimating the individual measurement models, certain "spurious or suppressor relations" are missed in the process (80). We also examine the relationships among the unobserved factors in the newly integrated model to prepare for the third and last stage in our analysis: estimation of a higher order factor analysis model that can be used to test hypotheses in future research.

Examining the structural relationships provides information useful for specifying alternative models of collaboration. Bollen (2000) suggests that when using this kind of piecewise strategy, specifying alternative models is helpful to assess the relative performance of different specifications of a complex construct (Bollen 2000, 81). Just as the goal of the first stage of the analysis is the identification of best-fit measurement models, the goal of this step is the identification of a best-fit horizontally integrated model of collaboration with construct validity.

Reassembling the five measurement models into an integrated model and the analyses that follows this integration yielded three alternative models of collaboration that can be viewed as nested in the original theoretical model depicted in figure 1. *Overall fit measures* for the three confirmatory factor models of collaboration demonstrate no significant change in overall fit among the three models of collaboration but when the individual measurement models are reassembled into an integrated model, *component fit indices* indicate problems with two of the three specified models that led us to choose the model that included five key dimensions and their corresponding 17 indicators (Thomson 2001).

### The Structural Component of the Model: A Higher Order Factor Model of Collaboration

Our focus of analysis now shifts from the measurement model to the structural model where the relationships of interest are between the unobserved dimensions of collaboration. The structural equation model in figure 1 incorporates both the measurement and structural components of the model into an integrated model and introduces a higher order latent variable, collaboration, to create an integrated complex whole. The first two stages of our analysis yield a 17-indicator multidimensional scale of collaboration and six unobserved latent variables. The final model that emerges from our analysis postulates that the five unobserved dimensions directly influencing the 17 observed indicators are influenced by the higher order factor, collaboration, a dimension that does not necessarily have direct effects on the observed indicators.

As with the previous analyses, the logic is the same. We use the measurement component of the model—relationships between dimensions and their corresponding indicators—to derive a multidimensional scale of collaboration with valid and reliable indicators that may be used to examine other relationships of interest. We then examine the structural component of the model—relationships among the unobserved factors—to determine how the correlations among these unobserved factors might account for the correlations among the observed indicators. When the primary purpose of the analysis is establishing the meaning of a construct and its measurement, both analyses are important for establishing construct validity.

## RESULTS

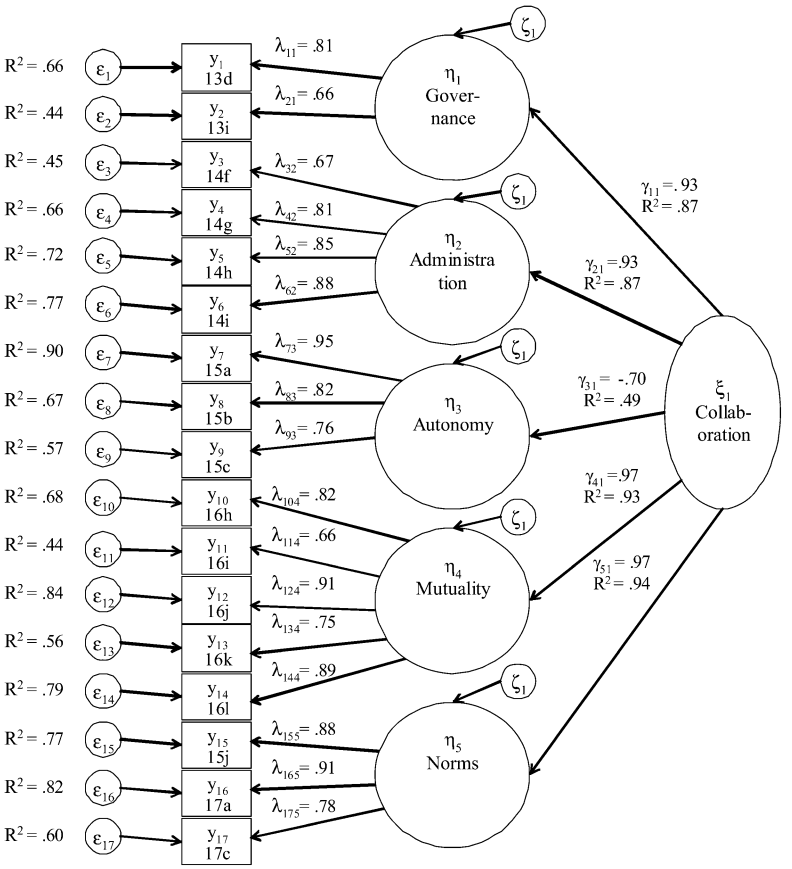
Having demonstrated the process by which we derived the multidimensional scale of collaboration, we now present results of these analyses. Figure 2 represents the modified final higher order factor model derived through structural equation modeling.

We organize our discussion of results in much the same way as our discussion of the analytical process beginning with the measurement component and concluding with the higher order model that includes both the structural and measurement components of the multidimensional model of collaboration

### The Measurement Model: Principal Findings

The analytical process of systematically examining each indicator's performance in multiple specifications of models using overall and component fit indices simplifies the original theoretical model with its six unobserved latent variables and 56 observed indicators to a model with just 17 indicators. We excluded indicators that did not withstand the

**Figure 2**
Modified Structural Equation Model of Collaboration




statistical and theoretical scrutiny used in the systematic re-specification process. Component fit indices are summarized in table 2.

Each lambda (λ) parameter relates a latent variable to a measured indicator in one of the equations of the measurement model. The estimate for each of these 17 parameters is highly significant statistically but also substantively as indicated in table 2. Since each of these equations has but one explanatory variable, and since this analysis is based on a polychoric correlation matrix, the lambda (λ) parameter estimates are equivalent to the standardized estimates, which serve as validity coefficients. Also in this context, the standardized estimate is equivalent to the Pearson correlation coefficient between the latent and measured variables (with a range of $-1$ to $+1$), and thus the $R^2$ value for the equation, which measures the reliability of the indicator, is related to the lambda (λ) estimate. Using these methods, therefore, validity and reliability are not independent constructs.

Of the 17 indicators, 14 have standardized lambda (λ) coefficients of .75 or greater and most of these (11) have coefficients of .80–.95. Of the remaining three indicators, two

**Table 2**
Standardized Lambda (λ) Coefficients and $R^2$ Values for the 17 Indicators in the Modified Structural Equation Model Standardized Lambda Coefficients

| Survey Item | Governance | Administration | Autonomy | Mutuality | Norms (Trust) | $R^2$ |
|---|---|---|---|---|---|---|
| 1. Partner organizations take your organization's opinions seriously when decisions are made about the collaboration. | .81 | | | | | .66 |
| 2. Your organization brainstorms with partner organizations to develop solutions to mission-related problems facing the collaboration. | .66 | | | | | .44 |
| 3. You, as a representative of your organization in the collaboration, understand your organization's roles and responsibilities as a member of the collaboration. | | .67 | | | | .45 |
| 4. Partner organization meetings accomplish what is necessary for the collaboration to function well. | | .81 | | | | .66 |
| 5. Partner organizations (including your organization) agree about the goals of the collaboration. | | .85 | | | | .72 |
| 6. Your organization's tasks in the collaboration are well coordinated with those of partner organizations. | | .88 | | | | .77 |
| 7. The collaboration hinders your organization from meeting its own organizational mission. | | | .95 | | | .90 |
| 8. Your organization's independence is affected by having to work with partner organizations on activities related to the collaboration. | | | .82 | | | .67 |
| 9. You, as a representative of your organization, feel pulled between trying to meet both your organization's and the collaboration's expectations. | | | .76 | | | .57 |
| 10. Partner organizations (including your organization) have combined and used each other's resources so *all* partners benefit from collaborating. | | | | .82 | | .68 |
| 11. Your organization shares information with partner organizations that will strengthen their operations and programs? | | | | .66 | | .44 |
| 12. You feel *what* your organization brings to the collaboration is appreciated and respected by partner organizations. | | | | .91 | | .84 |
| 13. Your organization achieves its own goals better working with partner organizations than working alone. | | | | .75 | | .56 |

*Continued*

**Table 2** *(continued)*
Standardized Lambda (λ) Coefficients and $R^2$ Values for the 17 Indicators in the Modified Structural Equation Model Standardized Lambda Coefficients

| Survey Item | Governance | Administration | Autonomy | Mutuality | Norms (Trust) | $R^2$ |
|---|---|---|---|---|---|---|
| 14. Partner organizations (including your organization) work through differences to arrive at win–win solutions? | | | | .89 | | .79 |
| 15. The people who represent partner organizations in the collaboration are trustworthy. | | | | | .88 | .77 |
| 16. My organization can count on each partner organization to meet its obligations to the collaboration. | | | | | .91 | .82 |
| 17. Your organization feels it worthwhile to stay and work with partner organizations rather than leave the collaboration. | | | | | .78 | .60 |

*Note:* $N = 422$. The lambda (λ) parameter estimates shown in this table are all significant at the .001 level.

have coefficients of .66 and one has a coefficient of .67. These indicators with lower standardized lambda (λ) coefficients have been kept in the model for their theoretical importance. For example, the administration indicator "You, as a representative of your organization in the collaboration, understand your organization's roles and responsibilities as a member of the collaboration" is theoretically important. Clarity of roles and responsibilities is a recurrent theme in the collaboration and implementation literature (Bardach 1998; Himmelman 1996; Huxham and Vangen 2005).

The governance indicator "Your organization brainstorms with partner organizations to develop solutions to mission-related problems facing the collaboration" is also theoretically important and finds support in the collaboration and the organizational behavior literature (Gray 1996; Hellriegel, Slocum, and Woodman 1986; Huxham 1996) as an important first step in building collaborative relationships. It is also consistent with the literature on networks (Alter and Hage 1993; Powell 1990) that describes network forms of organizing as distinctly different and looser forms of organizing than hierarchy, for example.

The findings for reliability would be identical due to the relationship between the validity and reliability measures stated above. Overall, based on the component fit measures, the measurement model provides empirical support for each of the five distinct dimensions of collaboration. Were the validity and reliability coefficients well below 1.00, we would be concerned about the extent to which we could conclude that the five unobserved dimensions can be derived from these observed indicators. It is important to acknowledge that no commonly held rules or standards currently exist that objectively identify a point at which the standardized lambda (λ) coefficient passes a "validity test" or the $R^2$ passes a "reliability test" except to assert that the closer to 1, the more valid and reliable. Clearly, this process involves careful grounding in the literature and systematic and logically designed rules to guide one's analysis.

The results also suggest nuances in the original conceptualization of the five dimensions. For this sample of organizations, the governance dimension is manifest in terms of the more informal negotiation mechanisms of brainstorming and appreciation of each other's opinions rather than the formal mechanisms of standard operating procedures and formal agreements. In contrast to governance, the structural elements of implementation manifest in the administration dimension are clarity of roles and responsibilities, effective collaboration meetings, goal clarity, and well-coordinated tasks. Each of these is more closely linked to the administration dimension than are formal mechanisms of reliance on a manager, formal communication channels, and monitoring.

Indicators of the mutuality dimension that did not withstand statistical scrutiny are questions that attempt to capture the extent of shared interests among partners. For this sample, collaboration seems to involve forging commonalities from differences rather than finding solidarity through shared interests. Mutuality in collaboration is manifest in partner organizations that (1) combine and use each other's resources so all benefit, (2) share information to strengthen each other's operations and programs, (3) feel respected by each other, (4) achieve their own goals better working with each other than alone, and (5) work through differences to arrive at win–win solutions.

The primary norms dimension indicators that are statistically significant and valid are the trust indicators. We found little support for the indicators of reciprocity. For this sample, collaboration involves a process characterized by a belief that (1) people who represent partner organizations in collaboration are trustworthy, (2) partner organizations

can count on each other to keep their obligations, and (3) it is more worthwhile to stay in the collaboration than to leave.

Given the importance of reciprocity in the literature, we discuss the lack of statistical support in this study for reciprocity later in this article.

Finally, the analysis suggests that collaboration is a process characterized by various degrees of tension between individual organization's self-interests and the collective interests of collaborating partners as captured in the autonomy dimension. The statistically significant indicators for this dimension are the extent to which (1) organizations perceive the collaboration hindering them from meeting their own missions, (2) organizations believe their independence is affected by collaborating, and (3) organizations' representatives feel pulled between trying to meet the expectations of their own organizations and those of partner organizations. The findings suggest that for this sample, the greater the tension, the less likely collaboration may occur.

It is important to acknowledge that other researchers could have reached different conclusions about indicators to retain using these very same data but we believe this would occur only at the margins.[8] Structural equation modeling is confirmatory (not exploratory) in that the specified model is grounded in the theoretical literature. But once the model has been specified and estimated using the sample data, the researcher often moves to exploratory analysis in hopes of achieving a better model fit (Ullman 1996). The exploratory analysis may lead different researchers to arrive at different conclusions based on their theoretical perspectives and empirical focus. To avoid as much subjectivity as possible in our analysis, we deliberately sought to ground our theoretical analysis in cross-disciplinary research and our empirical analysis with a step-by-step, thorough, and rigorous strategy that relied on multiple overall fit and component fit measures to evaluate the final higher order factor model of collaboration.

## The Structural Model: Principal Findings

As discussed earlier, the structural component of the model concerns itself with the relationships among the unobserved variables—collaboration and its five key dimensions. The higher order factor model postulates that the five unobserved dimensions directly influencing the observed indicators are influenced by the higher order factor, collaboration. If this proposition is correct, we expect the model to have component fit indices demonstrating estimates that are significant, large relative to their standard errors, and in the hypothesized direction, and high $R^2$ values for the structural relationships. We also expect the five unobserved dimensions of collaboration to be highly correlated with each other and to their higher order factor, collaboration.

Examination of the component fit indices for this portion of the model sheds light on the interfactor relationships. In LISREL notation, the factor loadings between collaboration and its five key dimensions are labeled gamma ($\gamma$) coefficients. Table 3 presents these estimates (standardized), their standard errors, the $z$ statistic, and the squared multiple correlations for the structural relationships. As indicated earlier, these relationships are summarized in the equation: $\eta = \Gamma\xi + \zeta$.

Table 3 presents the component fit indices of this model.

8 For a detailed step-by-step discussion of the analytical process of specification and re-specification of the measurement model, see Thomson (2001).

**Table 3**
Standardized Gamma ($\gamma$) Coefficients and $R^2$ Values for the Structural Components in the Modified Structural Equation Model

| | Collaboration | |
|---|---|---|
| | Standardized Gamma Coefficient (SE), $z$ Statistic | $R^2$ |
| Governance | .93 (0.03), 28.67 | .87 |
| Administration | .93 (0.04), 20.87 | .87 |
| Autonomy | −.70 (0.03), −21.98 | .49 |
| Mutuality | .97 (0.03), 35.17 | .93 |
| Norms (trust) | .97 (0.03), 33.38 | .94 |

*Note:* $N = 422$. The gamma ($\gamma$) parameter estimates shown in this table are all significant at the .001 level.

The coefficients used to assess the relationships between collaboration and its five key dimensions have a possible range of −1.00 to + 1.00 as LISREL automatically sets the variance of latent variables to 1 unless specified differently. This means that the gamma coefficients are standardized and interpretation of the WLS estimate is stated in terms of change in standard deviations. For example, the estimate of .93 for the governance–collaboration relationship indicates the number of standard deviation units governance is expected to change for a 1 standard deviation change in collaboration: For every 1 standard deviation change in collaboration, governance will increase by .93 standard deviations.

These indices demonstrate that the relationships between the five key dimensions are all significant, large relative to their standard errors, and in the hypothesized direction. The high $R^2$ values for governance, administration, mutuality, and norms (trust) dimensions indicate that a large portion of their variability is accounted for by collaboration. The lower $R^2$ for autonomy (.49) suggests that other factors, not included in this model, are accounting for a substantial portion of the variability in the autonomy dimension.

Table 4 presents the correlation matrix of the five dimensions of collaboration.

The governance, administration, mutuality, and norms dimensions are highly correlated with values in the .87–.94 range. The correlation between autonomy and the other four dimensions in this model is negative and between .65 and .68. The relationship between autonomy and the other four dimensions suggests an important area for future research. This particular dimension is clearly one of the most complex of the five dimensions in this model given that it is meant to capture the potential conflict between

**Table 4**
Correlation Matrix of Collaboration and Its Five Key Dimensions

| | Governance | Administration | Autonomy | Mutuality | Norm (Trust) |
|---|---|---|---|---|---|
| Governance | 1.00 | | | | |
| Administration | 0.87 | 1.00 | | | |
| Autonomy | −0.65 | −0.65 | 1.00 | | |
| Mutuality | 0.90 | 0.90 | −0.68 | 1.00 | |
| Norms (trust) | 0.90 | 0.90 | −0.68 | 0.94 | 1.00 |

*Note:* $N = 422$.

**Table 5**
Overall Fit Measures for the Modified Structural Equation Model of Collaboration

| Model | Chi Square ($p$) | Chi Square/df | RMSEA ($p$ value for test of close fit) | RMSEA CI[a] | GFI | AGFI |
|---|---|---|---|---|---|---|
| 6 factors: (collaboration and its five key dimensions) 17 indicators | 305.28 (0.00) | 3.07 | .063 (0.01) | .055–.072 | .97 | .96 |

*Note:* $N = 422$; df = 114.
[a]CI refers to the RMSEA 90% confidence interval.

individual and collective interests. This kind of conflict is frequently difficult to operationalize given the potential for unpredictable organizational responses.

### Overall Fit of the Model

Table 5 presents the overall fit indices for this model.[9]

Since the chi-square value associated with the model is highly significant statistically, the hypothesis of perfect fit between the model and data is clearly not supported. There is some support for the hypothesis of close fit in the RMSEA, although it is not strong support. The GFI, however, is well within accepted range as are the ratio of chi square to degrees of freedom and the value of the AGFI. In the framework of Browne and Cudeck (1993), the level of support for the model would be termed "reasonable." From an overall fit point of view, therefore, there is support for the model, but clearly one of the objectives of future efforts should be to improve the overall fit profile of the collaboration model.

## CROSS-VALIDATION OF THE MODEL

Chen (2004), in his study of interorganizational networks in Los Angeles County's Family Preservation Program uses the 17-indicator collaboration scale developed by Thomson (2001) with the same survey questions she used. Although there are differences in the designs, samples, and policy contexts of the two studies, the use of the same survey in both studies gives us an initial opportunity to cross-validate the measurement model for collaboration based on 17 measured indicators. Chen provided his correlation matrix for these 17 measures based on the 133 collaborations he studied.

9 Given that this analysis is meant to stimulate future research, it is helpful to consider other estimation techniques that might be used to assess the construct validity of this model. For example, if we consider the data to be continuous (though nonnormally distributed), rather than ordinal, then we can use robust maximum likelihood estimation (MLE) that takes nonnormality into account. When we compare component and overall fit measures across the robust MLE and WLS structural equation models, the differences are not great (see Thomson 2001, chap. six, for results using robust MLE), although some of the overall fit measures for the model generated by robust MLE are better than those generated by the WLS. For example, the RMSEA for the robust MLE model is .048 (compared to the RMSEA of .063 for the WLS-generated model). However, the component fit measures are improved using WLS. For example, all the standardized lambda ($\lambda$) coefficients in the measurement model are improved by .10–.20 and the standardized gamma ($\gamma$) coefficients (in the structural model) are improved by several units (in the case of the governance dimension, e.g., the standardized gamma [$\gamma$] coefficient moves from .79–.93).

**Table 6**
Comparison of AIC Values for the Base Model and Five Collaboration Dimensions

| Model/Component Model | AIC |
|---|---|
| Base | 1209.5 |
| Governance | 1182.7 |
| Administration | 1147.3 |
| Autonomy | 1085.5 |
| Mutuality | 1212.1 |
| Norms (trust) | 1181.8 |

Because of the limited data we have from Chen's analysis, we are restricted here to an analysis based on maximum likelihood estimation, which given that correlation matrices are analyzed, is not ideal. We approached the cross-validation by analyzing Chen's and our correlation matrices as a multiple group problem within the LISREL framework. We first estimated a model where corresponding parameter values were constrained to be equal in the context of the two groups of collaborations. The Akaike Information Coefficient (AIC), widely regarded as a useful measure for comparing alternate formulations of a model (Kaplan 2000, 114), is used as a base measure of fit, and the value for this model is 1209.53 (Akaike 1987). This measure incorporates the chi-square value, which is the most basic measure of fit in the structural equation context, and the number of parameters estimated in a model. In general, a lower AIC value implies a better fit between the data and the model.

The model used in our study has five basic components, each focused on one of the first-order latent variables. The approach to cross-validation used here takes each of these components in turn and estimates a model where the parameters for that component alone are allowed to vary across the two groups of cases, while maintaining equal values for all other corresponding parameters. As an example, in the case of the governance latent variable (which has two indicators), there are five parameters in the measurement model that can take on different values across the two groups to better fit the data. These include two lambda ($\lambda$) parameters, two measurement error variance parameters, and the variance parameter for the latent variable.

We have estimated that model (governance) and report the AIC value in table 6. A similar analysis was done for each of the other four model components with their corresponding AIC values reported in table 6.

The fact that there are relatively small differences between the AIC values of the base model and the models when the governance, mutuality, and trust dimensions are allowed to vary supports the construct validity of these three dimensions. The more the model fit improves when allowing model parameters to vary, the less the support for validation of that component of collaboration.

The AIC value for the model when autonomy is allowed to vary differs substantially from the base model, suggesting that the greatest difference between the two data sets exist for this collaboration dimension. The difference from the AIC value of the base model when administration is allowed to vary also indicates some divergence between our model and Chen's results. These conclusions are based on our intuitive assessment of the differences in the AIC values, not on a formal statistical test of difference. Although cross-validation of the collaboration scale is clearly an important area for future research, one

conclusion we can draw from this analysis is that support exists for the overall logic of the model, but the scale and its validation merit further research. We discuss this issue in greater depth below.[10]

## DISCUSSION

Overall, the findings from this study support the proposed structural equation model of collaboration. The five dimensions are rooted in a wide cross-disciplinary body of theoretical literature and substantiated by interviews with organization directors. The overall close fit of the higher order structural equation model and the high gamma coefficients that characterize the structural relationships between the higher order factor, collaboration, and its five key dimensions suggests empirical support for the conceptualization of collaboration. For this sample, the 17 indicators that represent the multidimensional scale of collaboration are theoretically and statistically valid measures of each of the five dimensions.

Our approach to defining collaboration falls within a collective action view of organizations that focuses on networks of symbiotically interdependent yet semiautonomous organizations that interact to construct or modify their collective environment, working rules, and options (Astley and Van de Ven 1983, 251). The focus on measurement implies, as Gray (2000) asserts, that collaboration exists as an independent phenomenon and not just as a subjective interpretation of reality. That the structural equation model closely fits the sample data and that support for the five dimensions in these models can be found in the literature and in the field suggests that collaboration is more than just a normative and subjective construct. As the first of its kind, then, this study fills a gap in the literature on collaboration.

Several results from this study merit further discussion. One is the lack of statistical support for the reciprocity indicators as part of the norms dimension. The other is how these findings can inform a future research agenda on collaboration. Here, in the interest of encouraging further refinement of the model, we identify some of the areas in need of improvement such as selection bias, the truncated sample, and the cross-sectional nature of the data.

### Reciprocity in Collaboration

The overall lack of statistical support for the reciprocity items in the measurement model is puzzling given the strong support for reciprocity in the collaboration literature (Axelrod 1997; Huxham and Vangen 2005; Ostrom 1990, 1998; Powell 1990). Several explanations may account for the reciprocity results. One explanation is the cross-sectional nature of this study. Development of reciprocity rooted in obligation and informal relationships takes time. Most of the collaborations in this sample are fairly young. It may be that the

10 Some notable differences between Chen's and our data deserve mention. Chen's questions differ from those of our study by focusing on the relationship between the dimensions of collaboration and collaboration outcomes. His smaller sample size does not allow him to use covariance structure modeling as a statistical tool. Instead, he uses OLS regression and his unit of analysis is dyadic relationships. Our unit of analysis is the collaboration itself. His sample derives from a network of social service agencies in a program administered by a county government but contracted out to a lead agency. Thus, the hierarchical relationships between some organizations in the networks he studied may reduce the real autonomy of some collaborators. Our sample derives from a decentralized national program whose operational level is left largely in the hands of collaborating partners at the grassroots.

organizations in these collaborations, many of them smaller nonprofits, may simply be unable to bear the short-term costs of unequal organizational relationships (in terms of size and resources, for example) in hopes that those costs may even out over time.

Another explanation is that reciprocity is partly accounted for in the trust dimension (that includes questions of trustworthiness important for Ostrom's [1998] conception of reputation) and in the mutuality dimension (that focuses on mutually beneficial relations and willingness to share information for the benefit of each other). In his examination of systems that include multiple partners, Axelrod (1997) found that in situations where the potential for misunderstanding is high, cooperation can occur when tit-for-tat reciprocity and repeated interaction are supplemented with generosity and contrition. These findings may have relevance for collaboration as well. The mutuality dimension contains hints of generosity with its emphasis on willingness to share information that will strengthen partner organizations' operations and programs.

An examination of the Pearson correlation matrix of the reciprocity, trust, and mutuality indicators, however, does not support this explanation. Although there is a moderate intercorrelation between two of the trust indicators and four of the five mutuality indicators (range .40–.51), all of the intercorrelations between the mutuality and reciprocity indicators are small in comparison. Neither are the trust and reciprocity indicators highly intercorrelated, but one reciprocity indicator "Partner organizations try to get the upper hand when they negotiate in the collaboration" is moderately correlated with two of the trust indicators (range $-.41$ to $-.43$).

Yet another explanation for these findings lies in the potential for selection bias in this study. The questionnaire asks respondents to identify a collaboration in which they are currently involved. This may have resulted in a truncated sample where the variation on collaboration is less than the full range of variation that does exist (King, Keohane, and Verba 1994, 130). It may be that the 68% of organizational directors that did not respond to this survey were either currently not involved in a collaboration or were involved in one they did not feel positively about or in one that did not work out. In this situation, the presence of tit-for-tat reciprocity may be more pronounced. Studying "failed" collaborations, therefore, represents an important area for future research.

## A Future Research Agenda on Collaboration

In their review of the literature and analysis of nine collaborative alliances, Wood and Gray (1991) map out a preliminary research agenda for collaboration scholars. If we are to develop a comprehensive theory of collaboration, several overarching issues need to be addressed (Wood and Gray 1991). These include a better understanding of (1) the meaning of collaboration, (2) how collaborations are convened, (3) the relationship between collaboration and environmental uncertainty and control, and (4) the relationship between the individual and collective interests of collaborating partners (143). A discussion of the strengths and weaknesses of our study may help to sensitize collaboration scholars to several aspects implicit in Wood and Gray's call for the development of a comprehensive theory of collaboration.

### *Strengths and Weaknesses*

This study has both strengths and weaknesses. Its greatest strength lies in its purpose: to address the difficult question of the meaning and measurement of collaboration. Its greatest

weaknesses may be the cross-sectional nature of the research design and selection bias that results from the potential of a truncated sample and the fact that the respondents representing their organizations in the collaboration, not outside observers, are providing the data used to study collaboration.

In the field of collaboration research, few empirically tested tractable models exist. This study offers scholars and practitioners one such model as a contribution to the broader research agenda of mapping the terrain for a family of models on collaboration. The comprehensive, systematic cross-disciplinary examination of the literature grounded in case study research and fieldwork yields a definition that spans a broad range of theoretical perspectives, not just one as is often the case. Furthermore, the construct validity of this definition, specified in a structural equation model, is successfully tested empirically against sample data.

The 17-item collaboration scale provides researchers and practitioners one way to measure collaboration. The strength of this scale is that it has been subjected to rigorous empirical examination. At least for this sample, its validity is fairly high, its reliability less so. Certainly, the scale needs cross-validation on other independent samples, but as it is, this scale can be used to examine relationships between collaboration and its outcomes despite the continued presence of some measurement error. In a forthcoming article, Thomson, Perry, and Miller (forthcoming) demonstrate how the scale might be used to examine outcomes.

In the interest of stimulating interest in building a comprehensive theory of collaboration, we also identify several of the weaknesses of this study. The cross-sectional nature of the research design, for example, makes it difficult to isolate the five key dimensions into process variables versus antecedent and outcomes variables. We have socially constructed them to be process variables. This is clearly problematic and underscores again the analytical difficulty so prevalent in the literature of distinguishing antecedent, process, and outcome variables when studying collaboration.

Though the unit of analysis of this study is organizational and differs from the unit of analysis Axelrod (1997) uses in his study of complex *n*-person games, some of his conclusions are applicable to the study of collaboration. Process suggests some form of adaptation over time. In complex systems, actors satisfice by using adaptive rather than optimizing strategies (Axelrod 1997, 4). The consequences of such strategies, Axelrod writes,

> are often very hard to deduce when there are many interacting agents following roles that have non-linear effects; [this often makes computer] simulation of an agent-based model the only viable way to study populations of agents who are adaptive rather than rational (4).

The snapshot of collaboration that this study provides cannot possibly capture the adaptive behaviors the organizations in our sample are almost certainly exhibiting as they try to work with their partners.

Another weakness in this study is the selection bias that results from a truncated sample, the 32% response rate, and the fact that the sources of the study are participants of collaboration. Selection bias occurs when observations are chosen in a manner that "systematically distorts the population from which they were drawn" (King, Keohane, and Verba 1994, 28). That the final sample for this study may represent only one end of the range of collaborations that exist (the other end being those that no longer exist or that are struggling) suggests a lack of variation making causal inferences about collaboration

problematic. It will be important to conduct future research on unsuccessful collaborations to supplement the findings in this study.

Furthermore, that the respondents providing information on collaboration are also the participants in the collaboration suggests a threat to internal validity. "Social science data," write King, Keohane, and Verba (1994),

> are susceptible to one major source of bias of which we should be wary: people who provide raw information that we use for descriptive inferences often have reasons for providing estimates that are systematically too high or low (64). The effects of this bias, like those of selection bias, suggest causal inferences about collaboration need to be made with great caution.

This study is the first of its kind and represents the earliest stages of research. Sudman (1983) argues that low-quality samples are justified "at the earliest stages of a research design when one is first attempting to develop hypotheses and procedures for measuring them" (148). Clearly, this study needs to be seen as only the first step in a larger research agenda.

### *Areas for Future Research*

This discussion of strengths and weaknesses is meant to identify areas for future research. We believe it is advisable in subsequent empirical research to assess not only the 17 items validated in the present study but also a larger pool of items and multiple scales. It is certainly possible that the 17-point collaboration scale may not be the most applicable in a given setting. We strongly encourage the exploration of multiple scales, drawing not only from the larger pool of 56 indicators but increasing that pool as needed. The measurement development process in the present study needs to be ongoing. We strongly endorse experimentation and testing of the scales we used and additional items and scales that other investigators might find appropriate. This is the only way to build theory. In this spirit, the results of this study suggest several interesting areas for future scholarship.

Improvement upon the multidimensional scale developed here is clearly a first step in a research agenda. Attempts to minimize the weaknesses in this study are helpful. Nevertheless, we believe testing this multidimensional model empirically on multiple independent samples is worthwhile as this will, in itself, serve to demonstrate construct validity. If, for example, we find similar findings across multiple independent samples in different policy contexts, the legitimacy of the scale may be further established. If, on the other hand, we find widely differing findings, this will only demonstrate areas for future research. Thus, our research agenda will be enhanced. If we are to reach consensus on the meaning of collaboration, it would be helpful to examine how the model presented in this study varies across widely different contexts, thereby allowing us to cross-validate the higher order relationships hypothesized in the model.

We need more studies like those of Chen (2004) and Graddy and Chen (2006) that use the scale in a different policy context and over time. The findings in the cross-validation of our model using Chen's data suggest strong support for the validity of the mutuality, norms, and governance dimensions, but the administration and autonomy dimensions warrant further refinement. By examining how the administration dimension varies across different contexts, for example, we may be able to better address when collaboration increases and when it decreases environmental uncertainty.

We, like other scholars (Huxham 1996; Ring and Van de Ven 1994; Wood and Gray 1991), are also convinced that the autonomy dimension remains an important part of the collaboration puzzle though it remains difficult to operationalize.[11] Again, examining the variation in this dimension across different contexts may help us better understand the nature of this tension between individual and collective interests and the factors that influence the extent to which one dominates under what conditions.

Refinement of this study using different data is equally important. Clearly, finding a way to minimize both the cross-sectional nature of our study and the selection bias would be a great contribution to the field of collaboration research. We need longitudinal studies of collaboration processes and we need to increase the variation in our samples to include not only existing collaborations but also those that have either "failed" or are marginal. Higher response rates are certainly warranted, but, more importantly, we need to find a way to increase the variation along the five key dimensions to strengthen our understanding of the ambiguous and fluid nature of collaboration. Scholars of collaboration continue to struggle with this particular aspect of collaboration (Gray and Wood 1991; Huxham 1996; Huxham and Vangen 2005; Thomson 2001; Wood and Gray 1991).

Another way to approach the four principal research areas identified by Wood and Gray (1991) is to explore the factors that influence the variations in all five underlying dimensions of collaboration. We would expect, for example, that each of these underlying dimensions would vary according to structure, context, and time. Results from our study and the differences that emerge in the cross-validation suggest that gaining a deeper understanding of how the dimensions vary across the life cycle of a collaboration (mature versus immature collaborative alliances) and the structure (symmetrical versus asymmetrical power relationships among collaboration partners) would lead to valuable insights about the nature of collaboration.

In their study of the relationship between collaboration processes and outcomes, for example, Thomson, Perry, and Miller (forthcoming) found that the significant statistical relationships and the direction of their effects do not extend across all process–outcome relationships. Only certain dimensions were statistically related to certain outcomes. At the .05 level of significance, for example, trust is significant and positively associated with only two of the five outcomes used in their analysis: perceived effectiveness and the quality of partner relationships. They also found that while length of time that the collaboration has existed (mature versus immature collaborations) is positive and statistically significant for four of the five outcomes, size has no significant effect on any of the five process–outcome relationships. Refining and testing the model on other independent samples and in different problem and policy domains and using the model to empirically test (with large samples) the many hypotheses already generated by the rich case research in this field will strengthen our capacity to build theory.

Practitioners can also benefit from the results of our study. In an environment increasingly characterized by complex interorganizational relationships, practitioners could benefit from having a clearer understanding of collaboration rooted in systematic empirical research. Collaboration is an idea that carries considerable rhetorical appeal. The conceptual model of collaboration, with its five dimensions operationalized in a survey format, holds the potential to make that rhetoric more concrete.

11 For an excellent discussion about the more complex issues implicit in collaboration—such as the relationship between shared and individual control (the essence of the autonomy dimension)—see Wood and Gray (1991, 156–161).

Several organizational directors in the sample, for example, voluntarily and independently asked if they could use the questionnaire with their partners in retreat settings. Furthermore, of the 440 respondents, 84% requested a summary of the findings and 78% requested a copy of the questionnaire to use with their collaboration partners. These percentages suggest practitioners' value empirical studies of this sort.

As an exploratory tool, the model and the questionnaire (with the original 56 indicators) could be used by practitioners in several ways. As a conceptual tool for reaching common understandings about collaboration in a retreat setting, each partner organization could fill out the questionnaire individually and return in a group to compare each other's answers. Discussions around the various questions might reveal significant differences in perspectives about the meaning of collaboration, generally, or within the context of the particular collaboration to which organizations belong. Another avenue for exploration is to consider how the original model (with 56 indicators) compares with the empirically validated model (with 17 indicators) and to speculate what this may mean for their particular collaboration.

The model and the questionnaire can also be used as a self-reflection tool for building interorganizational relationships. Differences in responses to questions like "How much [do] partner organizations take your organization's opinions seriously when decisions are made about the collaboration?," "How much [do] you feel partner organizations keep an eye on your organization's activities to make sure you are doing what you are supposed to be doing in the collaboration?," or "How much [do] you feel *what* your organization brings to the table is appreciated and respected by partner organizations?" might uncover underlying tensions among partners. With a professional facilitator in a retreat setting, this approach might prove useful in improving communication and openness among partners.

It is important that practitioners understand that the questionnaire used as an exploratory tool is not to be regarded as a statement about collaboration as an ideal. Rather, they should be regarded within the context of this particular sample. Collaboration participants that use these findings need to remember they are "statements" about where their particular collaboration stands in relation to the average collaboration in the sample, not in relation to some shining ideal.

Though collaboration is sometimes viewed as a meaningless concept by some practitioners who find the process hopelessly frustrating, it is nevertheless a persistent one, with rhetorical appeal (especially for policy makers and funders, public and private). Practitioners at the operational level of policy implementation tend to view collaboration with some skepticism as case research demonstrates (Huxham 1996; Huxham and Vangen 2000; Thomson 1999, 2001; Thomson and Perry 1998). The conceptual model of collaboration, with its five key dimensions operationalized on a questionnaire, holds the potential to make that rhetoric more relevant for participants in collaborative arrangements.

## CONCLUSIONS

An empirically validated theory of collaboration, one that can inform both theory and practice, demands a systematic approach toward understanding the meaning and measurement of collaboration. Without a more systematic approach, inferences about collaboration will depend on which theoretical perspective one takes. This, in turn, makes theory building difficult and evaluation of collaborative arrangements reliant on inconsistent subjective judgments of evaluators.

Scholars of public management agree that the role of theory is to produce knowledge that enhances the ability of managers to manage effectively, though they disagree on what constitutes "knowledge for practice" (Bozeman 1993; Kettl and Milward 1996; Lynn 1996). Lynn's (1996) stance that knowledge for practice needs to move beyond merely experiential knowledge to analytical knowledge—knowledge that brings "a critical, analytical intelligence to bear on the design and choice of institutional arrangements for achieving the goals of public policy"(13)—is equally relevant for scholars and practitioners of collaboration. We agree with Lynn's assertion that knowledge for practice will suffer without a more explicit focus on rigorous analysis.

It is important to acknowledge that because no "true" definition of collaboration actually exists, our approach falls within a collective action view of organizations that focuses on networks of symbiotically interdependent yet semiautonomous organizations that interact to construct or modify their collective environment, working rules, and options (Astley and Van de Ven 1983, 251). We readily admit, as do Astley and Van de Ven, that this view represents only a "partial view of reality" and as such, our research is meant to be one contribution to an ongoing debate about the meaning of collaboration.

Noted political scientist, Ostrom, challenges scholars to develop empirically validated theories of human organizing. "If the social sciences are to be relevant for analyses of policy problems," she writes, "the challenge will be to integrate efforts to map the broad terrain [of human organizing] and efforts to develop tractable models for particular [niches] in that terrain" (Ostrom 1990, 214–215). Few tractable models currently exist in the field of collaboration research. These findings offer scholars and practitioners one such model that may contribute to the broader research agenda—mapping the terrain for a family of models on collaboration. The comprehensive, systematic examination of the literature grounded in case research and fieldwork yields a definition that spans a broad range of theoretical perspectives, not just one as is often the case.

Furthermore, the construct validity of this definition, specified in a structural equation model, is successfully tested empirically against sample data. Over time, an empirically validated theory of collaboration may emerge by systematically developing "tractable models for particular niches" that, in turn, lead to families of models of collaboration. Such models can then be used to make predictions that are, as Ostrom puts it, "necessarily complex, interactive, and conditional" (Ostrom 1998, 13). We offer the particular model developed in the present study, tractable as it is, to the field of collaboration research for refinement, ongoing debate, and as a tool for scholars and practitioners to use in their own attempts to map the terrain of collaboration in research and in practice.

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