Winter 2008

Effects of Leader Relationship Quality (LMX), Supervisor Support, and Upward Influence in National Science Foundation Industry /University Cooperative Research Centers

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EFFECTS OF LEADER RELATIONSHIP QUALITY (LMX), SUPERVISOR SUPPORT, AND UPWARD INFLUENCE IN NATIONAL SCIENCE FOUNDATION INDUSTRY/UNIVERSITY COOPERATIVE RESEARCH CENTERS

by

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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirement for the Degree of

DOCTOR OF PHILOSOPHY

INDUSTRIAL/ORGANIZATIONAL PSYCHOLOGY

OLD DOMINION UNIVERSITY
December 2008

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ABSTRACT

EFFECTS OF LEADER RELATIONSHIP QUALITY (LMX), SUPERVISOR SUPPORT, AND UPWARD INFLUENCE IN NATIONAL SCIENCE FOUNDATION INDUSTRY/UNIVERSITY COOPERATIVE RESEARCH CENTERS

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Old Dominion University, 2008
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The Industry/University Cooperative Research Center (I/UCRC) is a type of partnership between industries and universities supported by the National Science Foundation. These partnerships enable the transfer of leading-edge technology developed in universities to industrial firms. Leadership plays a powerful role in the success of these research partnerships by creating an environment that is conducive to innovation. Directors of I/UCRCs must be able to successfully lead upward, that is, develop and maintain strong relationships with the university administrators to whom they report, to obtain the necessary support to sustain the center and foster innovation. This study uses leader-member exchange (LMX) theory to examine the influence of the leadership relationship on I/UCRC center director satisfaction, commitment, and intentions to quit directing the center. Mediating effects of perceived supervisor support and upward influence effectiveness on the relationships between LMX and these affective outcomes are also examined. Structural equation modeling results suggest that both perceived supervisor support and upward influence effectiveness fully mediate the relationship between LMX and I/UCRC directors' satisfaction with their university administrator, but not satisfaction with center research, commitment to the center, or intentions to quit directing the center.

This is dedicated to Casey, who began this journey with me and will celebrate its end with me in spirit.

ACKNOWLEDGMENTS

There are many people to whom I owe my deepest and heartfelt gratitude, for without their support and guidance this work would not have been possible. First, I owe tremendous thanks to my advisor and chair, Dr. Donald Davis, for his individualized consideration and intellectual challenge over the past eight years. I also wish to thank my dissertation committee members, Dr. Debra Major and Dr. Eric Sundstrom, for their assistance in the design of this study as well as their recommendations which helped to shape this final product. Finally, I extend my gratitude to Dr. Terry Dickinson for his invaluable statistical assistance.

I wish also to thank my peers for their instrumental and emotional support over the years. In particular, I am profoundly grateful to Katherine Selgrade for her assistance with data analysis as well as for her enduring friendship.

Finally, I am deeply indebted to Peggy Kinard, Jackie Winston, and Mary Boswell for their administrative support throughout my graduate school career.

This research is based upon work supported by the National Science Foundation under grant EEC-0437631. I extend my gratitude to the Foundation for its financial support as well as to the following individuals for their assistance in the design and implementation of this study: Alex Schwartzkopf, Denis Gray, Beth Coberly, Edward Haug, Richard Muller, and Bruce Thompson. Finally, I am deeply grateful for the participation of all NSF I/UCRC center directors, co-directors, and site directors for their participation in this study.

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INTRODUCTION

Today's business environment has become increasingly competitive due, in part, to rapid technological change, shorter product life-cycles, and globalization (Ali, 1994; Bettis & Hitt, 1995). Organizations compete for survival by developing and commercializing new technologies (Ali, 1994; Steele, 1989) and by managing and reducing internal and external organizational boundaries (Davis, 1995). Research and development (R&D) efforts are critical to the creation of new products and technologies, and ultimately to the growth and long-term success of organizations. According to recent estimates, most of the nation's R&D is performed by private industry, accounting for over 70 percent of total R&D expenditures in 2004 (National Science Board, 2006). Industry is also the largest source of R&D funding in the U.S., providing $199 billion dollars, or nearly 64 percent, of total R&D funding in 2004 (National Science Board, 2006).

Until recently, most R&D activities were conducted inside the organization, but limited resources and expertise have prompted organizations to seek interorganizational collaborations to foster technological innovation (Hamel & Prahalad, 1994). One form of interorganizational collaboration is the industry-university research center (I/URC). I/URCs facilitate collaborative relationships between industrial firms and universities through formalized mechanisms for transferring knowledge and new technologies (Betz, 1996; SRI International, 1997). This alliance is beneficial to both industry and university for several reasons. Industry firms gain access to experts in their respective fields as well

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This dissertation adheres to the format of the *Journal of Applied Psychology*.

as to leading edge facilities and technologies (Santoro & Chakrabarti, 2001). Additionally, firms may enhance their reputation by associating with a prominent academic institution (Fombrun, 1996). Universities benefit from the alliance by receiving educational and employment opportunities for faculty and students as well as financial support from partner firms for basic research (National Science Foundation, 1982; National Science Board, 1996).

I/URCs are growing in popularity as a viable alternative to traditional in-house R&D. Moreover, they are becoming increasingly important to the innovation process. Certain elements of I/URCs, such as effective leadership, are key to ensuring the success and longevity of these centers. The purpose of this study is to examine the influence of leadership in a particular type of I/URC, the National Science Foundation Industry/University Cooperative Research Center. The following section describes these centers in more detail, including their funding requirements, reporting relationships, and organizational structure.

National Science Foundation Industry/University Cooperative Research Centers

Within the last 35 years, the National Science Foundation (NSF) has promoted university-industry collaborations through programs such as NSF industry/university cooperative research centers (NSF I/UCRCs). The NSF I/UCRC program began in 1972 to join academic research and industrial innovation. NSF provides financial support of up to $100,000 per year to each center for ten years, after which time centers are expected to become self-sustaining. During 2003 – 2004 reporting period in which this study took place, there were 46 NSF I/UCRCs involving 61 universities and 668 industry members. Many of these centers had more than one director overseeing its operations. For

example, if an I/UCRC involved multiple universities, each member university had its own site director. Several centers also had co-directors, meaning two or more faculty members at one university shared responsibility for overseeing the operation of the I/UCRC. The total operating budget across all centers was $70,540,756, with a mean operating budget of $1,603,199 per center (Gray, Schneider, & Lloyd, 2005). NSF I/UCRCs simultaneously benefit universities and industries. NSF I/UCRCs have strengthened the ability of universities to conduct high-quality, applied research as well as the ability of industries to compete on a global scale (Gray & Walters, 1998). The industry-university alliance is often very appealing to universities because they can raise additional funds for research without the bureaucratic red tape associated with funding from state or federal agencies (Santoro & Chakrabarti, 2001). These alliances may also allow industry firms to avoid research costs (Gray & Steenhuis, 2003), enhance their image by being associated with prominent academic institutions, and gain access to highly trained professors and leading-edge technologies (Santoro & Chakrabarti, 2001). At their fundamental level, NSF I/UCRCs function to (1) conduct industry-relevant engineering and scientific research, (2) provide education and training for graduate students in applied programs of research, and (3) promote the transfer of knowledge and technology between industry and university (Gray & Walters, 1998).

NSF I/UCRCs are boundary spanning structures that house and support transactions between industry and university. As such, they have several unique characteristics. First, NSF I/UCRCs are semi-autonomous research units situated within the university that function independently from academic units such as departments (Friedman & Friedman, 1986). This autonomy allows NSF I/UCRCs to work across

multiple disciplines. Second, NSF I/UCRCs focus on research that is relevant to multiple firms or industries, as opposed to a single sponsor. Finally, NSF I/UCRCs give industry members a prominent role in center management and operations (Gray & Walters, 1998). A unique feature is that all intellectual property created in centers is shared by industry members rather than being exclusively owned by the university. The role of industry members is discussed in further detail below.

Figure 1 illustrates an organizational chart for a typical, single site I/UCRC as adapted from Gray and Walters (1998). The center director works in concert with three distinct entities: an academic advisory committee, an industrial advisory board, and a

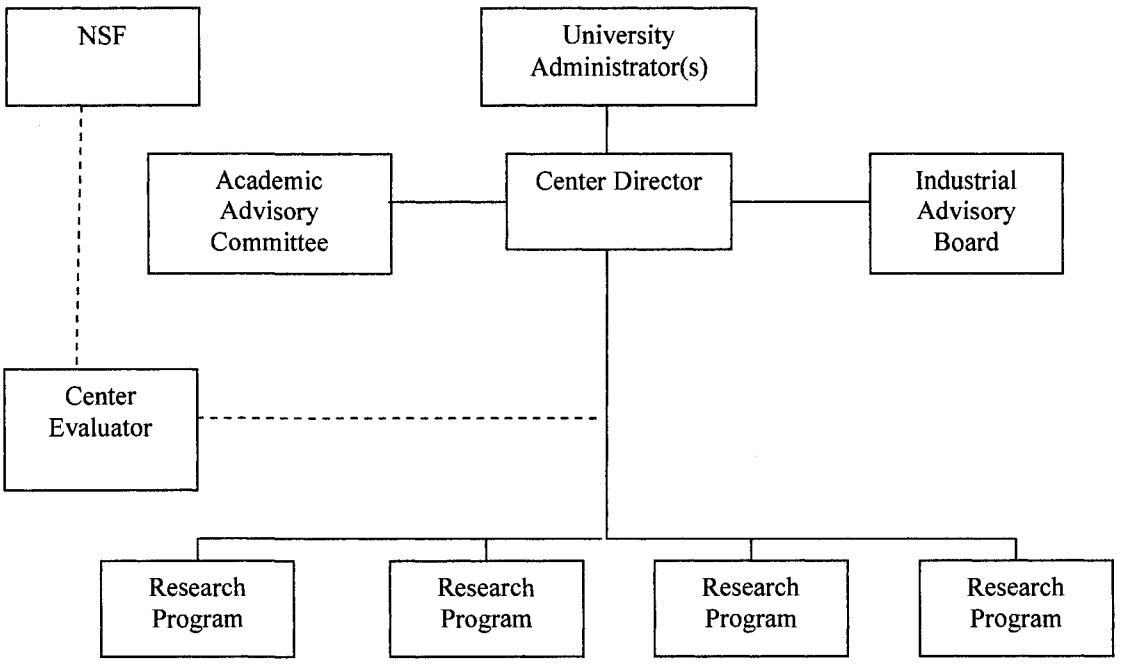

Figure 1. NSF I/UCRC organizational chart (Adapted from Gray & Walters, 1998)

university administrator(s). The center director is responsible for the management and administration of internal and external operations, as well as the boundaries between them, and governs all research programs of the center.

The academic advisory committee consists of academic department heads or deans involved in the center as well as university administrators. Its function is to provide input on center operations, policy, and research. The academic advisory committee plays a large role in establishing the center, for example, formulating center policies and procedures. As the center matures and center operations become routinized, however, the role of the academic advisory committee diminishes or disappears altogether (Gray & Walters, 1998).

The industrial advisory board consists of one voting representative from each sponsor organization and functions as a board of directors. The industrial advisory board meets twice per year and makes recommendations on center policy and research projects. Each company must pay a yearly fee, typically $30,000 to $50,000, for its membership in a NSF I/UCRC. Membership fees are the largest single source of income for a NSF I/UCRC and are used to fund research programs. NSF requires I/UCRCs to have at least ten industry members, or a combined total of at least $300,000 in company membership fees (Gary & Walters, 1998).

NSF I/UCRC directors also report to an official(s) within their university, typically a dean or department chair, who has position power to make decisions regarding research programs and allocation of resources. Gray and Walters (1998) point out that most university administrators limit their involvement in NSF I/UCRC operations to monitoring and oversight activities, but some assume a more active role in center

operations, such as assisting in recruitment of industry members. Therefore, there exists a wide continuum of university administrator involvement in I/UCRCs. At one end of the continuum are center directors who have a very close relationship with their administrator. In these instances, administrators stay informed on all aspects of center activities, including research activities. At the opposite end of the continuum are center directors who have no relationship with a university administrator because their centers operate autonomously despite being situated in the university. Research suggests that NSF I/UCRCs with university administrator(s) who are strong advocates for the center are more successful in terms of knowledge and technology transfer (Gray, Stewart, Gidley, & Blakeley, 1991).

The NSF I/UCRC program requires a center evaluator to collect information on center processes and outcomes. This information may be collected by observation as well as surveys of industrial advisory board members and faculty. The center evaluator uses the information collected to provide feedback on center operations (Gray & Walters, 1998). The reporting relationship between the center evaluator and center director is not an official one, as indicated in Figure 1 by the dashed line. The center evaluator serves as an advisor or external consultant to the center director, providing guidance concerning center development and management. The center evaluator also reports center activities to NSF, but this is not an official reporting relationship. The center evaluator serves as the eyes and ears of NSF in center operations. He or she reports information on IAB member perceptions and ratings of center operations as well as meeting effectiveness back to NSF.

Multi-university centers are a variant of the single site NSF I/UCRC in which two or more universities share responsibility for the center and its operations. Multi-university centers typically have one center director and a site- or co-director at each partner university. Based on 2003 - 2004 data, 28 of the 46 NSF I/UCRCs were multi-university centers. Multi-university centers confer certain advantages, including diversified technical capabilities and a broader program of research, which make them more appealing to industry. Moreover, industry members gain access to multiple research laboratories, equipment, and staff. Administrative functions and reporting relationships are more complex in multi-university NSF I/UCRCs. For example, in addition to a center director, multi-site universities typically have a center co-director as well as site directors at each partner university.

The success of NSF I/UCRCs depends on several factors. First, NSF I/UCRCs must forge strong relationships with members of their industrial advisory boards to ensure continued financial support of the center. Second, center directors must develop strong relationships with faculty and post-doctoral and graduate student researchers to ensure continued submission of proposals and timely completion of research projects. Third, center directors must develop and maintain strong relationships with university administrators to ensure continued, strong university support. This last relationship serves as the focal point of this study. Specifically, it seeks to understand how perceptions of the leadership relationship between center directors and university administrators affect center directors' satisfaction and commitment to the NSF I/UCRC.

This study advances current knowledge of the relationship between NSF I/UCRC directors and university administrators by investigating perceptions of the leadership

relationship, an area of study not addressed in previous I/UCRC research. This research study also contributes to the literature on leadership because of its focus on research center directors and their leaders, university administrators, a subject population often neglected by leadership researchers (Elkins & Keller, 2003). NSF I/UCRC directors occupy a unique position; they are simultaneously subordinates (followers) and superiors (leaders). The center director is a subordinate to university administrators, but a leader to center staff, including faculty and student researchers. The next section explores leadership in research and development settings.

Leadership in R&D

I/UCRCs are a special type of R&D organization. R&D organizations are responsible for transforming scientific and technological information into technological innovations in the form of ideas, products, or processes, and then exporting these innovations (Elkins & Keller, 2003). I/UCRCs use engineering and other scientific knowledge to develop products and/or processes to be used by industry members. Outputs of R&D organizations are characterized as "time-lagged, sporadic, and nonmarket" in nature (Narayanan, 2001). Similarly, new technologies or processes developed in the I/UCRC may take years before they are ready for use by industry members. The discussion that follows presents findings from research examining R&D organizations, however, given that I/UCRCs are a type of R&D organization, I believe that these findings are generalizable to I/UCRCs. Because there have been few research studies conducted and published on I/UCRCs, this study makes a new contribution to this body of literature.

Much of the work on management of innovation in R&D organizations was conducted in the 1980s. While this early work focused on management rather than leadership per se, it addressed people issues as well as technical issues. For example, Miller (1986) examines conflicts faced by R&D managers as they struggle to balance "managing people" and "managing a function." Van de Ven (1988) identifies human, process, structural, and strategic problems confronting R&D managers and advocates for institutional leadership to link internal and external components of the organization. In other words, leaders must engage in boundary spanning activities to promote innovation. Other research focuses more narrowly on leadership in R&D contexts.

Elkins and Keller (2003) summarize two decades of research on R&D leadership primarily involving transformational and dyadic leadership theories. In general, R&D project success is related to transformational leadership behaviors by project leaders (e.g., communicating an inspirational vision and providing intellectual stimulation) and high relationship quality (i.e., strong leader-member exchange) between project leaders and project members. Keller (1992) found that transformational leadership behaviors were positively related to project quality and budget/schedule performance in R&D organizations, however, this relationship was moderated by project type, that is, research projects versus development projects. Research projects are often directed at major technological innovations that require scientists to go beyond existing scientific and technical knowledge. Development projects tend to focus on improving existing technology. Transformational leadership appears to be more important for research projects or projects in early stages of innovation because group members are typically involved in more *revolutionary* or radical processes such as idea generation and

information gathering (Keller, 1995). Transactional leadership appears to be more important for development projects marked by *evolutionary* or incremental activities such as product or process modification (Keller, 1992). Waldman and Bass (1991) suggest that transformational leadership is necessary in early stages of the innovation process to create a vision and provide intellectual stimulation. However, they argue that transformational leadership is also important for development projects. In this later phase of innovation, project effectiveness becomes linked with charismatic leadership and championing behaviors of leaders. More recently, Lee (2008) found that transformational leadership is positively associated with innovativeness. In one of the few studies of affective outcomes in R&D settings, Berson and Linton (2005) found that transformational leadership behaviors by R&D managers are related to employee satisfaction.

Scott and Bruce (1994, 1998) found that leader-member exchange (LMX) is related to innovative behavior of R&D professionals and that reciprocal influence processes inherent in high LMX dyads are beneficial to innovation. Similar findings are reported by Amabile (1988) and Mumford and Gustafson (1988). Graen and Scandura (1987) hypothesize that high quality LMX relationships may empower subordinates to engage in innovative behavior. High quality LMX relationships in an R&D context may include the following characteristics: providing subordinates with challenging tasks (Liden & Graen, 1980), leader support of risk-taking (Graen & Cashman, 1975), resource acquisition by the leader (Graen & Scandura, 1987), providing recognition (Graen & Cashman, 1975), and supervisor advocacy (Duchon, Green, & Taber, 1986). Finally,

high quality LMX relationships facilitate a sense of creative self-efficacy (Tierney & Farmer, 2002) that can promote innovative behavior.

In summary, numerous empirical studies have demonstrated the importance of leadership to R&D organizations and to the process of innovation. The focus of these studies, however, has been on leadership directed toward subordinates. Relatively little is known about leadership directed toward superiors, despite the fact that the relationship between R&D managers and supervisors is critical to the process of innovation. Thamhain (2003) noted that R&D leaders must work with senior management to ensure an organizational environment that is conducive to innovation because many of the influences to innovative performance, such as organizational stability, resources, and management support, are controlled at that level. Research conducted by Lee, Wong, and Chong (2005) further explored upward leadership in R&D organizations and found that individuals who were "more integrated with others at the upper echelons or within the organization [have] significantly greater incremental R&D achievements," (p. 65). I/UCRC leadership research has similarly overlooked the upward relationship between directors and the leaders of their academic institutions. Instead, leadership research on I/UCRCs has focused primarily on relationships between center directors and members of industrial advisory boards (e.g., Bloedon & Stokes, 1994; Tarant, 2004) or relationships between center directors and faculty members or post-graduate students (e.g., Coberly, 2004; Cohen & Bradford, 1991; Cordero & Farris, 1992; Farris, 1988; McCall, 1981; Meagher, 2002). Relationships between center directors and industrial advisory boards tend to be peer-like. Relationships between center directors and faculty members or post-graduate students may be of a supervisor-subordinate nature; the center director is a

supervisor and faculty members and post-graduate students are subordinates. In some centers, the relationship between center directors and faculty members or post-graduate students may be more peer-like. Very little is known about the relationship between NSF I/UCRC directors and the university administrators to whom they report. It is this relationship that serves as the focal point for this study. LMX theory, then, is the cornerstone of this research because it takes a relationship-based approach to the study of leadership.

This study makes another unique contribution to the I/UCRC literature in that it examines affective outcomes from the center director perspective. Affective outcomes are rarely addressed in the R&D literature; most studies have examined only innovation or project-level outcomes. Further, no known studies have examined affective outcomes from the vantage point of the R&D director, in this case the I/UCRC director.
Figure 2 depicts the research model that guided this research. Quality of leadership relationship was expected to have direct and indirect relationships with satisfaction, commitment to the center, and intentions to leave the center. Perceptions of supervisor support and upward influence effectiveness were expected to partially mediate the relationships between LMX and satisfaction, commitment, and turnover intentions. The following sections will discuss each construct in more detail along with its relationship with other constructs illustrated in Figure 2.

Since LMX is a central construct in the proposed research model, it will be discussed first. The following section explores LMX theory in more detail and reviews empirical research findings.

LMX

LMX is a relationship-based theory of leadership put forth by Graen, Dansereau, and colleagues (Dansereau, Graen, & Haga, 1975; Graen & Cashman, 1975). LMX theory suggests that quality of relationship between superiors and subordinates varies across each leader-subordinate dyad. High LMX relationships are characterized by a high degree of mutual influence (Yukl, 1998), support, and trust (Liden & Graen, 1980).

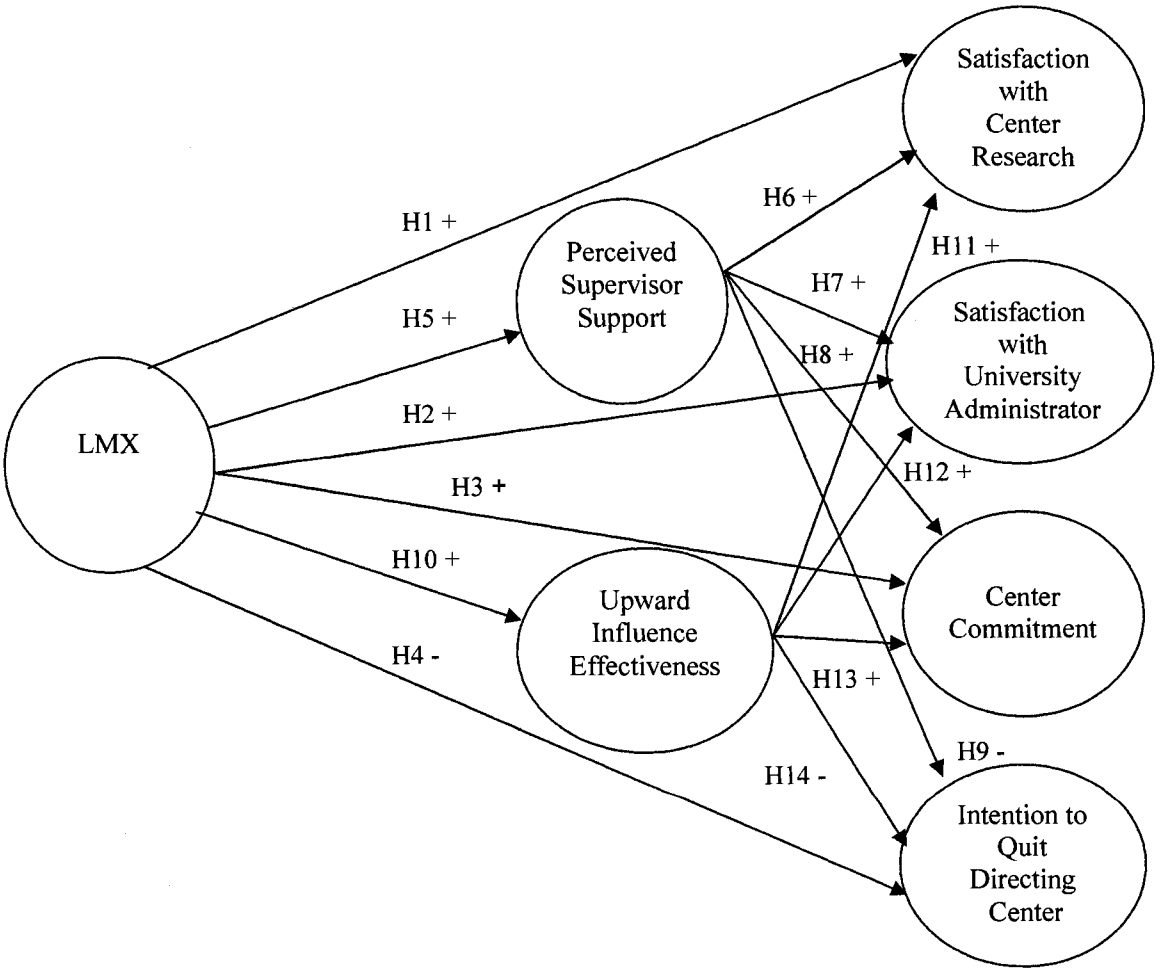

Figure 2. Research model indicating hypothesized direction of relationships

Followers act as "trusted assistants" to the leader and grow to perform beyond the formal requirements of their job descriptions (Graen & Uhl-Bien, 1995; Liden & Graen, 1980).

In contrast, less effective exchanges are characterized by a lack of trust, mutual respect, and obligation (Graen & Uhl-Bien, 1991, 1995). Lower quality LMX relationships limit performance to merely meet the demands expressed within the formal employment contract. In other words, performance meets expectations but does not exceed them (Liden, Sparrowe, & Wayne, 1997). In lower quality LMX relationships, subordinates merely do the least that is required to meet expectations.

Outcomes of LMX. The most frequently studied outcomes of LMX are at the subordinate level. For example, high quality LMX relationships are positively associated with subordinate outcomes such as satisfaction (Graen, Novak, & Somerkamp, 1982; Graen, Orris, & Johnson, 1973; Scandura & Graen, 1984), promotions (Wakabayashi, Graen, Graen, & Graen, 1988), performance ratings (Graen, Novak, et al., 1982; Liden & Graen, 1980; Scandura & Graen, 1984; Wayne & Ferris, 1990), organizational commitment (Basu & Green, 1997; Nystrom, 1990), and autonomy (Basu & Green, 1997). High quality LMX relationships are negatively related to subordinate turnover (Graen, Liden, & Hoel, 1982), job problems, and role conflict and ambiguity (Dunegan, Uhl-Bien, & Duchon, 1992). Among R&D professionals, high LMX quality is related to innovative behavior (Amabile, 1988; Mumford & Gustafon, 1988; Scott & Bruce, 1994, 1998).

Graen and Uhl-Bien (1995) discuss outcomes of LMX at dyad and organizational levels. They propose that higher quality exchanges will result in progressively higher degrees of mutual trust, respect, and obligation within the leader-subordinate dyad. At the

organizational level, LMX quality may affect task interdependencies, organization-level work processes and outcomes, and relationship effectiveness in other parts of the organization (Graen & Uhl-Bien, 1995).

This study examines individual-level outcomes of LMX. Specifically, it focuses on center directors' perceptions of the leadership relationship and their impact on center director satisfaction and commitment to the NSF I/UCRC as well as intentions to quit directing the I/UCRC. Based on the relationships between LMX and affective outcomes described in the extant literature, I propose the following hypotheses which are depicted as paths in Figure 2:

Hypothesis 1: High LMX quality will be positively related to satisfaction with the NSF I/UCRC research program.

Hypothesis 2: High LMX quality will be positively related to satisfaction with NSF I/UCRC university administrator.

Hypothesis 3: High LMX quality will be positively related to commitment to the NSF I/UCRC.

Hypothesis 4: High LMX quality will be negatively associated with intentions to quit directing the NSF I/UCRC.

Quality of leader-subordinate relationship may contribute to perceptions of the extent to which an employee feels supported by his or her leader. In the following section, I explore the construct, perceived supervisor support, and its relationship with LMX.

Perceived Supervisor Support

Perceived supervisor support (PSS) refers to employees' views concerning the degree to which supervisors value their contributions and care about their well-being (Kottke & Sharafinski, 1988). In order to understand PSS and its hypothesized relationship with LMX, it is necessary to discuss first a related concept, perceived organizational support (POS).

POS refers to employees' beliefs concerning the extent to which the *organization* values their contributions and cares about their well-being (Eisenberger, Fasolo, & Davis-LaMastro, 1990; Eisenberger, Huntington, Hutchinson, & Sowa, 1986; Rhoades & Eisenberger, 2002; Shore & Tetrick, 1991; Shore & Wayne, 1993). Supervisors act as agents of the organization, therefore, supervisors' favorable or unfavorable orientation toward employees is interpreted by the employee as indicative of the organization's support (Eisenberger et al., 1986).

POS is positively related to the quality of relationship between a supervisor and his or her subordinate, or LMX (Settoon, Bennett, & Liden, 1996), however the nature of that relationship is quite complex. Research suggests that positive, beneficial actions by the organization (or its representatives) directed toward employees contribute to the establishment of high-quality exchange relationships (e.g., Dansereau et al., 1975; Konovsky & Pugh, 1994), which in turn creates a felt obligation by the employee to reciprocate in positive, beneficial ways (e.g., Eisenberger et al., 1986; Shore & Wayne, 1993).

While both POS and LMX are grounded in social exchange theory (Eisenberger et al., 1986; Sparrowe & Liden, 1997), POS and LMX have been shown to be distinct

constructs (e.g., Masterson, Lewis, Goldman, & Taylor, 2000; Settoon et al., 1996; Wayne, Shore, & Liden, 1997) with different antecedents and outcomes (Settoon et al., 1996; Wayne et al., 1997). The focus of POS is on the exchange between the employee and the organization. LMX focuses on the quality of exchange between the employee and his or her supervisor (Wayne, Shore, Bommer, & Tetrick, 2002). Wayne et al. (1997) found empirical support for a reciprocal relationship between POS and LMX. They argue that POS influences LMX such that employees who have higher perceptions of organization support are more likely to desire and accept a high quality exchange with their supervisor. LMX influences POS because leaders tend to allocate more rewards to employees with whom they have established a high quality exchange relationship (Wayne et al. 1997; Wayne et al., 2002). When leaders allocate rewards to subordinates, subordinates perceive that the organization values their contributions and cares about their well-being. Other studies (Masterson, et al., 2000; Wayne et al., 2002), however, fail to support a reciprocal relationship between POS and LMX. These studies found a significant path from POS to LMX, but not from LMX to POS. In light of these mixed findings, Wayne et al. (2002) speculate that organizational context, such as when supervisors, rather than upper management, have wide control over rewards, may determine if LMX influences POS.

POS and PSS are distinct, but related, constructs (Kottke & Sharafinski, 1988). PSS targets the supervisor, rather than the organization, in evaluations of perceived support. Several studies have found a positive relationship between POS and PSS (e.g., Hutchison, 1997a, 1997b; Kottke & Sharafinski, 1988; Rhoades, Eisenberger, & Armeli, 2001). While these constructs may be related, their distinction is supported empirically.

Hutchinson (1997b) found that the POS measure provided a unidimensional construct that is unique from PSS and that POS made a unique contribution to outcome measures separate from that of PSS. Yoon and Lim (1999) provide factor analytic evidence supporting the distinction between supervisor support (i.e., PSS) and organizational support (i.e., POS). Finally, Eisenberger, Stinglhamber, Vandenberghe, Sucharski, & Rhoades (2002) identified a temporal component in the relationship between POS and PSS. Using a two-wave panel design with both PSS and POS measured at time 1 and time 2, these researchers found that PSS is antecedent to POS. One would expect that because employees work most closely with their supervisors, perceptions of supervisor support form before perceptions of organizational support. Over time, employees generalize their perceptions of supervisor support to the larger organization.

Relationship between PSS and LMX. The relationship between PSS and LMX is just beginning to become a focal point of research. According to Stinglhamber and Vandenberghe (2003), PSS is an indicator of the quality of the exchange relationship (i.e., LMX) between employees and supervisors. Like LMX, PSS is grounded in social exchange and social reciprocity norms (Eisenberger et al., 1986). Yet, Ayman and Antani (2008) describe a fundamental difference in what LMX and PSS are purported to measure. LMX is measured in terms of the subordinate's perception of the leader's instrumental support and loyalty. PSS, on the other hand, is measured in terms of the subordinate's perception of being valued by the leader. Therefore, they argue that LMX and PSS are distinct constructs and should be operationalized as such.

Wayne et al. (1997) speculate that organizational context, such as when supervisors have control over rewards, may determine if LMX influences PSS. In the

NSF I/UCRC setting, university administrators have wide discretion over needed resources. It is expected that the quality of leadership relationship will influence center directors' perceptions of administrator support. Center directors who report higher quality LMX relationships are expected to report higher PSS. Given that (1) PSS is an indicator of the quality of LMX and (2) LMX influences satisfaction, commitment, and turnover intentions, PSS is hypothesized to partially mediate the relationships among LMX, center research and university administrator satisfaction, commitment to the center, and intention to quit directing the center.

Hypothesis 5: PSS is expected to have a positive relationship with LMX quality.

Hypothesis 6: PSS is expected to partially and positively mediate the relationship between LMX and satisfaction with NSF I/UCRC research.

Hypothesis 7: PSS is expected to partially and positively mediate the relationship between LMX and satisfaction with NSF I/UCRC university administrator.

Hypothesis 8: PSS is expected to partially and positively mediate the relationship between LMX and commitment to the NSF I/UCRC.

Hypothesis 9: PSS is expected to partially and negatively mediate the relationship between LMX and director intentions to quit directing the NSF I/UCRC.

LMX operates partly through influence processes. In the NSF I/UCRC context, center directors must lead upward, that is toward university administrators. LMX requires effective upward influence, a topic which is discussed in more detail in the following section.

Upward Influence

Upward influence refers to enactment of proactive behaviors by individuals in lower levels of the organization to gain compliance from individuals at higher levels in the organization (Kipnis & Schmidt, 1988). Exercising upward influence is an essential aspect of organizational behavior and contributes substantially to individual and organizational effectiveness (Floyd & Wooldridge, 1997; Kipnis & Schmidt, 1988; Schilit & Locke, 1982). Moreover, upward influence is one of the most important determinants of managerial effectiveness (Yukl, 1998; Yukl & Falbe, 1990; Yukl, Kim, & Falbe, 1996).

Kipnis, Schmidt, and Wilkinson (1980) outlined six tactics used by subordinates to influence superiors: reason, bargaining, friendliness, assertiveness, higher authority, and coalition. This is considered to be one of the seminal works on upward influence. Based on further research, Kipnis and Schmidt (1982) developed a commercially available self-report questionnaire of influence behavior, Profiles of Organizational Influence Strategies (POIS). Yukl and Falbe (1990) cited numerous limitations with the Kipnis et al. (1980) measure of upward influence. Among these are potential for self-report biases, insufficient representation of influence tactics needed for effective leadership, and scale development using a student population. Yukl, Lepsinger, and Lucia (1991) developed the Influence Behavior Questionnaire (IBQ) in response to their criticisms of the Kipnis et al. (1980) measure. The 1991 version of the IBQ identified nine influence tactics. Over the last decade, Yukl and colleagues have refined their influence behavior typology through numerous validation studies. The most recent version of the IBQ contains eleven proactive influence tactics. These include rational

persuasion, consultation, inspirational appeals, collaboration, apprising, ingratiation, personal appeals, exchange, legitimating tactics, pressure, and coalition tactics (Yukl, Siefert, & Chavez, 2005).

Most of the research on upward influence has focused on outcomes of upward influence tactic. Yukl and Falbe (1990) and Yukl and Tracey (1992) found that influence tactics vary with direction of influence. Rational persuasion, consultation, and inspirational appeals were the most commonly used upward influence tactics compared to downward and lateral influence attempts. Conversely, pressure, exchange, and upward appeals tactics were used least frequently in upward influence attempts compared to downward or lateral influence attempts. While type of influence tactic used is beyond the scope of this study, it is interesting to note the relationship between effectiveness of tactic chosen and quality of leadership relationship. Chacko (1990) found that perceptions of a supervisor's leadership style affect what methods a subordinate uses to exercise upward influence. Shim and Lee (2001) found that the nature of the supervisor-subordinate relationship (i.e., LMX) affects upward influence tactic. Specially, more effective influence tactics are used in high-quality LMX relationships while less effective influence tactics are used in low-quality LMX relationships. The next section discusses in more detail the relationship between upward influence and LMX.

Upward influence and LMX. LMX quality is associated with choice of upward influence tactic (Krone, 1991; Shim & Lee, 2001) and with upward influence effectiveness (Deluga & Perry, 1991). In high quality LMX relationships, subordinates use more open and strategic persuasion, and significantly less manipulation, in their upward influence attempts compared to subordinates in low quality LMX relationships

(Krone, 1991). Higher quality LMX relationships have been found to be negatively related to the use of assertiveness, coalition, and higher authority tactics (Deluga & Perry, 1991). The relationship between LMX and upward influence effectiveness holds true in academic settings as well. McAlister and Darling (2005) found that effective influence tactics were used more often in high LMX relationships than in low LMX relationships. The use of effective influence tactics, then, resulted in greater upward influence effectiveness, results which mirror those found by Shim and Lee (2001).

Innovation is a sociopolitical process (Shim & Lee, 2001), therefore, the manner in which influence is exerted impacts the success of an R&D project (Frost & Egri, 1989; Shim & Lee, 2001; Van de Ven, 1986). Upward influence is critical to securing senior management support, hence its criticality to the present study. Senior management support, in turn, is related to innovation (Cooper & Kleinschmidt, 1995; Thamhain, 2003). Green (1995) found that top management support of R&D projects is related to expected contribution, size of investment, innovativeness, business advocacy, and potential for project termination. Miller (1986) points out that R&D managers spend most of their time negotiating for scarce resources, thus underscoring the importance of resources to the performance and success of R&D initiatives.

NSF I/UCRC directors must effectively exercise upward influence to ensure that they receive the resources needed to support innovation in their centers. Acquisition of needed resources may be linked to center satisfaction and commitment perceptions. Thus, the degree to which NSF I/UCRC directors can effectively exercise upward influence is hypothesized to partially mediate the relationship between LMX perceptions

and directors' satisfaction with the center, commitment to the center, and intentions to leave the center.

Hypothesis 10: High LMX quality will be positively related to upward influence effectiveness.

Hypothesis 11: Upward influence effectiveness will partially and positively mediate the relationship between LMX and satisfaction with the NSF I/UCRC research.

Hypothesis 12: Upward influence effectiveness will partially and positively mediate the relationship between LMX and satisfaction with the NSF I/UCRC university administrator.

Hypothesis 13: Upward influence effectiveness will partially and positively mediate the relationship between LMX and commitment to the NSF I/UCRC.

Hypothesis 14: Upward influence effectiveness will partially and negatively mediate the relationship between LMX and director intentions to quit directing the NSF I/UCRC.

METHOD

Participants

Participants included this study were directors of all NSF I/UCRCs in the United States in fall 2005. "Center director" is broadly defined for the purpose of this study to include center directors as well as center co-directors and site directors located at multi-site centers. At the time of data collection, there were 127 directors in total; this represents the entire population of I/UCRC center directors. All 127 directors were invited to participate in this study, but only 105 provided complete data, representing a response rate of 82.7%. Five directors answered "No" to the informed consent and one director indicated by phone his refusal to participate because of a recent weather-related disaster (i.e., Hurricane Katrina). After eliminating nine cases due to missing data on one or more scales, the final sample consisted of 96 directors (including 46 center directors and co-directors, and 48 site directors) representing 54 centers and 62 universities. The number of centers represented in my sample is larger than the official number reported by NSF during the 2003-2004 reporting period because I included several centers that were in the process of graduating from the NSF I/UCRC program. Because two directors had recently moved their centers to new universities, they reported on their relationship with their former university administrator. Average length of time directing center was 4.20 years, ranging from less than one year to ten years or more. Average length of time directors reported to their university administrator was 4.75 years, ranging from less than one year to ten years or more.

In addition to center director demographic information, I also collected demographic information on the universities they represent. I reasoned that resources

provided by a university administrator may be affected by university size. In order to control for this potential confound, I collected information on number of full-time students in fall 2004, number of full-time faculty in fall 2004, and size of research budget in 2004. These variables served as proxy variables for university size. Means and standard deviations for each of these variables are provided in Table 5 which is located in the results section.

Procedure

Prior to data collection, the Old Dominion University Institutional Review Board reviewed this study and approved its procedures. Each center, site, or co-director was assigned a unique password with which to access the survey. I sent an email invitation (see Appendix A) to each center director explaining the purpose of the survey along with the survey URL and password information. Invitations were sent to 127 directors.

An email reminder (see Appendix B) was sent to directors who had not completed the survey at the end of 2 weeks. After 3 weeks, directors received another reminder via email. After 4 weeks, I began calling each director who had not yet completed the survey. Each phone call was immediately followed by an email reminder. Directors received up to 10 phone calls each and 12 email reminders until they completed the questionnaire or asked to be removed from the study.

Measures

Measurement development and pilot testing. In the preliminary stages of this research, I conducted semi-structured interviews with four center directors in order to understand the key factors involved in the center director-university administrator relationship and how that relationship impacts center directors' satisfaction and

commitment as well as the overall success of the center. Each interview lasted approximately 45 to 60 minutes. Questions asked in these interviews are located in Appendix C. I then analyzed interview data for key themes and relationships among those themes. The model depicted in Figure 2 illustrates the relationships uncovered in the interviews as well as information supported by the R&D literature. This model was discussed with several center directors for confirmation of its applicability and importance. Next, I created a web-based survey for center directors containing each of the instruments found in Appendices D-I plus additional demographic questions. The survey contained a total of 61 items and was administered with Inquisite employing secure sockets layer (SSL) technology to ensure security of responses. Four center directors were invited to complete the instrument and provide comments. One director agreed to this request and provided feedback via a phone call. On the basis of his comments, one LMX item was alternately worded to clarify its meaning. The first item on the LMX-7 scale is worded, "Do you know where you stand with your administrator? Do you know how satisfied your administrator is with what you do?" The center director pointed out this could be interpreted as two separate questions and could be confusing for an individual to provide one answer to a question that could have two different answers. I changed the wording of the second part of the first item so that it was presented as an alternate way of getting at the very same information asked in the first part of the question. The revised item read, "Do you know where you stand with your administrator? In other words, do you usually know how satisfied your administrator is with what you do?" After making this minor modification, the survey was further pilot

tested using several graduate students to check for correct branching, sequencing of items and pages, and overall functionality.

With the exception of the center satisfaction and upward influence effectiveness scales, all scales employed in this study have been used in previous research and possess acceptable reliabilities. A more detailed description of each scale used in this study appears below.

LMX. Quality of relationship between center directors and university administrators, as perceived by center directors, was measured using the LMX-7 (Graen, Novak, et al.,1982), the most widely used instrument that assesses relationship quality between leaders and subordinates (Gerstner & Day, 1997). The LMX-7 consists of 7 items and uses a five point response scale with varied response options. Published Cronbach alpha estimate for the LMX-7 is .86 (Graen, Novak, et al. 1982). Composite reliability value for the scale in this study was .83. LMX-7 items appear in Appendix D.

Perceived supervisor support. The degree to which center directors perceive their university administrators are supportive was measured using the 8-item Survey of Perceived Organizational Support scale (Eisenberger et al., 1986). Consistent with an approach taken by Eisenberger et al. (2002), Hutchison (1997a, 1997b), and Kottke and Sharafinski (1988), I replaced the referent "organization" in the items with a word that isolates and identifies the supervisor to create the scale of perceived supervisor support. However, rather than substitute the word "supervisor" for "organization" as these researchers did, I chose the word "administrator" to make the items more meaningful to the participant. The PSS scale contains a 7-point response scale, ranging from strongly disagree (0) to strongly agree (6). Published Cronbach alpha estimate for the PSS is .98

(Kottke & Sharafinski, 1988). Composite reliability for this scale in this study was .85. PSS items are presented in Appendix E.

Upward influence effectiveness. The degree to which center directors feel their upward influence attempts are successful was measured using three questions from the target version of the Influence Behavior Questionnaire (IBQ; Yukl et al., 2005). The first item uses a six-point response scale and the remaining two items use a five-point response scale. All three items contain unique response options. Previous studies that have used these items (e.g., Yukl & Falbe, 1990; Yukl & Tracey, 1992) do not report reliability information because they were not represented as a scale. Composite reliability for the scale in this study was .91. Appendix F contains the upward influence effectiveness items.

Satisfaction with center. Satisfaction with center was measured with 22 items representing various characteristics of NSF I/UCRCs. The first 14 items were adopted from an earlier study of faculty satisfaction with I/UCRCs conducted by Coberly (2004). Five items were taken from the IAB member satisfaction questionnaire, which is administered semi-annually to all IAB members. Finally, three additional items were created specifically for this study to reflect certain aspects of the center environment applicable to center directors, such as budget, policy issues, and administrator support. All items used a five-choice response format that ranged from very dissatisfied (1) to very satisfied (5). Initial exploratory factor analysis results suggested this scale was actually measuring three distinct forms of satisfaction as they loaded onto three separate factors. The first factor relates to the satisfaction with research being conducted in the centers, including its quality and significance. The second factor relates to satisfaction

with the university administrator's oversight of the center, including provision of funding and other forms of support. The third factor relates to satisfaction with IAB members, including their financial support and quality of research programs. IAB membership is outside the scope of this study given that my focus is on the relationship between I/UCRC directors and their administrators. The premise of my research is how that relationship impacts director satisfaction with internal operations of the center and his or her university administrator. I reasoned that satisfaction with IAB members is determined largely by direct interactions between directors and IAB members, not the relationship between I/UCRC directors and their university administrators. I therefore removed the third factor of satisfaction from further analyses and retained the first two. Using these two factors, I created two separate outcome variables for satisfaction, satisfaction with center research and satisfaction with university administrator, using only the highest loading items from each factor (see Table 1). Table 2 presents eigenvalues and percentages of variance explained by these two factors.

As will be discussed below, the parceling procedure I subsequently employed for structural equation modeling requires items to be unidimensional, in other words, to represent one underlying construct. Hence, it was necessary to specify these two factors of satisfaction as unique dependent variables. Further parceling and factor analysis evidence using LISREL for these two facets of satisfaction are provided in the measurement model portion of the results section below. Composite reliability for satisfaction with center research was .83 and for satisfaction with university administrator, .81. Satisfaction scale items are located in Appendix G.

Table 1
Summary of Items and Factor Loadings for Varimax Orthogonal Two-Factor Solution for Satisfaction with Center Scale

Item	Factor Loading 1	Factor Loading 2	Scale
1. Quality of the research program	.82	.21	SATRES
2. Relevance of the research program to industrial members' needs	.79	.25	SATRES
10. The significance of the work being done in the center	.85	.08	SATRES
19. Breadth of the research topics covered	.81	.14	SATRES
20. Focus of the research	.89	.10	SATRES
13. How supporting my administrator is in helping me achieve my goals	.13	.87	SATUA
15. Amount of funding the center receives from my university	.10	.65	SATUA
16. Amount of support I receive from my university administrator	.15	.90	SATUA
17. University policies regarding the center	.22	.73	SATUA
22. Your university administrator	.27	.85	SATUA

Note. SATRES = Item in Satisfaction with Center Resources scale. SATUA = Item in Satisfaction with University Administrator scale. Underscored items were used to create the subscale on which it loaded.

Table 2
Eigenvalues, Percentages of Variance, and Cumulative Percentages of Variance for Factors of the Satisfaction with Center Scale

Factor	Eigenvalue	% of Variance	Cumulative %
1	4.90	48.99	48.99
2	2.12	21.24	70.23

Commitment to center. Commitment to the I/UCRC was measured using the Organizational Commitment Questionnaire (OCQ; Mowday, Steers, & Porter, 1979; Porter, Steers, Mowday, & Boulian, 1974), the most widely used instrument to assess organizational commitment (Meyer, Stanley, Herscovitch, & Topolnytsky, 2001). The referent "organization" was replaced with "I/UCRC" to make the item more meaningful to the respondent. Mowday et al. (1979) report coefficient alpha values ranging from .82 to .93, with a median value of .90. More recently, Bozeman and Perrewe (2001) found coefficient alpha values ranging from .83 to .93. Composite reliability for the commitment scale in this study was .71. OCQ items are presented in Appendix H.

Intention to quit directing the I/UCRC. Center director intentions to quit directing the I/UCRC were measured using three items from the Michigan Organizational Assessment Questionnaire (MOAQ; Cammann, Fichman, Jenkins, & Klesh, 1983). Coefficient alpha is reported as .83 (Cammann et al., 1983). Composite reliability for the scale in this study was .77. Appendix I contains the intention to quit items. One item, "Deciding to direct this I/UCRC was a definite mistake on my part," was subsequently

eliminated from the scale as the meaning of this item was judged to be qualitatively different compared to the other two items in that it does not reflect an active *intention* to quit directing the center.

Demographic information. Center directors were also asked to report the number of years they have directed the center and number of years they have reported to their university administrator. As described above, demographic data were also collected from each university represented in the study sample, including number of full-time students in fall 2004, number of full-time faculty in fall 2004, and size of research budget in 2004. The purpose of collecting these data was to control for possible effects of university size on the relationships depicted in Figure 2. Presumably, centers located in larger universities have access to more resources, including funding, than centers located in smaller universities. Resource allocation could be a potential confound in that directors who have access to more resources may enjoy greater success of their centers, which could in turn lead to higher satisfaction and commitment and fewer intentions to quit directing the center. Means and standard deviations for all demographic variables, along with their observed correlations, appear in Table 5 in the results section. Because there were no significant correlations among the variables that served as indicators of university size (i.e., student enrollment, number of faculty, and size of research budget) and the variables included in the present study, they were removed from further analysis. Since the degree of shared variance between university size variables and the variables of interest in this study was non-significant, I reasoned that the effect of these variables on the research model was negligible and therefore did not need to be statistically controlled. Significant relationships, however, were observed for length of time reporting to

university administrator on both LMX quality and upward influence effectiveness. The influence of time on the LMX relationship is supported by existing literature in that the quality of the relationship must necessarily evolve over a series of exchanges, which requires time.

Data Analysis Overview

Structural equation modeling (SEM) was used to test the hypothesized relationships and the overall fit of the hypothesized model. This data analytic strategy required the use of a parceling procedure to create indicators for the variables in the model because the number of observed variables far exceeded the number of subjects in this study. In addition, I used a measurement model, structural model, and resulting fit indices to examine the hypothesized model and relationships. Each facet of this analytic procedure is described below.

Both the measurement and structural models were tested from the y-side. In doing so, LISREL treats all manifest variables in a y-side model as endogenous. Given the relatively small sample size associated with this study, I decided to use an analytic strategy that minimized the number of matrices needed. Testing models from the y-side only requires one set of matrices (i.e., only a lambda-y matrix is used rather than lambda-x and lambda-y matrices) (Joreskog & Sorbom, 1996).

Item parceling. Because the number of observed variables (i.e., items from each scale) in the hypothesized model (see Figure 2) exceeds the number of subjects, a parceling strategy was used in analyzing data. A parcel is defined as "an aggregate-level indicator comprised of the sum (or average) of two or more items, responses, or behaviors," (Little, Cunningham, Shahar, & Widaman, 2002). Having more parameters

than observations is problematic because it produces unreliable parameter estimates. Marsh and Hocevar (1988) argue that the item:subject ratio must be explicitly considered because lower ratios may lead to instability of the factor solution, particularly if the psychometric properties of the items are poor. In fact, several researchers (e.g., Bagozzi & Edwards, 1998; Bagozzi & Heatherton, 1994) advocate using parcels when sample sizes are relatively small because fewer parameters are needed to define a construct.

Although the practice of parceling is controversial and has been subject to criticism, Little et al. (2002) suggest the various indices of model fit are more acceptable when parcels, rather than items, are modeled because of several psychometric and estimation advantages. Compared with item-level data, models based on parcel data (a) are more parsimonious (i.e., have fewer parameters both in defining a construct and in representing an entire model), (b) have fewer chances for residuals to be correlated or dual loadings to emerge because fewer indicators are used and unique variances are smaller, and (c) lead to reductions in various sources of sampling error (MacCallum, Widaman, Zhang, & Hong, 1999).

Little et al. (2002) also argue in favor of item parcels from a psychometric perspective. Compared with aggregate-level data (i.e., parcels), item-level data are subject to the following disadvantages: lower reliability, lower communality, a smaller ratio of common-to-unique factor variance, and a greater likelihood of distributional violations (Bandalos & Finney, 2001; Little et al., 2002). Items also have fewer, larger, and less equal intervals between scale points compared to parcels (Bagozzi & Heatherton, 1994; Kishton & Widaman, 1994; MacCallum et al., 1999). Parcels are more likely to resemble continuous variables, and therefore will be distributed more normally than

individual items.

Bandalos (2002) provides support for using a parceling strategy, as analyses revealed that the use of item parcels resulted in better fitting solutions, as measured by RMSEA, comparative fit index (CFI), and chi-square test, when items had a unidimensional structure. Parceled solutions also resulted in less biased estimates of structural parameters under these conditions compared to solutions based on individual items. In fact, most methodologists advocate that a set of items to be parceled should be unidimensional and relatively free from unwanted sources of shared variance (cf. Bagozzi & Edwards, 1998; Bandalos & Finney, 2001; Kishton & Widaman, 1994).

This necessary condition of unidimensionality has been cited as one argument against parceling, for this assumption often goes untested (Bandalos, 2002). Bandalos and Finney (2001) conducted a review of published studies using parceling techniques and found only 32.3% made any reference to the unidimensionality of the items being parceled. Marsh and O'Neill (1984) list other disadvantages of parcels, including losing information about the individual items and dependence of parameter estimates and factor scores on the particular items parceled together. Bandalos and Finney (2001) add to the list of disadvantages the possibilities of obscuring the true factor structure of the items and obtaining biased estimates for other parameters, effects which have been demonstrated in studies by Hall, Snell, and Singer-Foust (1999) and Bandalos (2002).

Techniques for constructing parcels. Methodologists advise pursuing a parceling strategy only when researchers can present a clear rationale for doing so. While various techniques exist for building parcels, they all share one prerequisite: unidimensionality. Bandalos (2002) argues against parceling in cases where items are multi-dimensional or

when their factor structure is unknown. Further, Bandalos and Finney (2001) recommend use of parcels only in studies of relationships among latent constructs, not in scale development.

An early approach to parceling put forth by Comrey (1970) was to parcel based on similarity of item content. Other methods for parceling are empirically based. For example, Cattell (1956, 1974; Cattell & Burdsal, 1975) advocated the technique of radial item parceling. In this method, the researcher conducts an initial factor analysis and then combines the pairs of items based on their congruence coefficients. Subsequent studies of the radial parceling technique found that items from different factors were often parceled together (Barrett & Kline, 1981; Bandalos & Finney, 2001).

Kishton and Widaman (1994) describe a random procedure for assigning items to parcels. The rationale for random assignment of items to parcels is that it should, on average, lead to parcels that contain roughly equal common factor variance (Little et al., 2002). However, if the items contain unequal variances because the metrics differ across items, the resulting parcel would be biased in favor of the items with the larger variances (Little et al., 2002).

Another method for creating parcels, *item-to-construct balance*, is described by Little et al. (2002). This approach involves alternating assignment of items to parcels based on item factor loadings, with the result being parcels that are nearly parallel, or balanced, indicators of the latent variable. For example, to form 3 parcels, one would take the three highest loading items and designate them as anchors for the first three parcels, respectively. Then, one would take the next three lowest loading items and assign them in reverse order to the three parcels, respectively. Thus, the highest loaded item from the

each anchor items would be matched with the lowest loaded item in the second round of assignments. This procedure continues by placing lower loaded items with higher loaded parcels until all items have been assigned to a parcel. In some cases, parcels may have different numbers of items in order to achieve reasonable balance (Little et al., 2002).

Finally, the congeneric method is another approach to creating parcels, whereby the most similar items are isolated in terms of their relationship to the latent factor. More specifically, items with the most similar standardized factor loadings are placed into the same parcel. Two assumptions must hold in order for this parceling procedure to be viable. First, items must be unidimensional, or represent one underlying construct, to ensure that they will correlate reasonably well within each parcel. Second, items within each parcel should be judged for homogeneity, or consistency in meaning (Kishton & Widaman, 1994; Little et al., 2002). Parceling should result in items that are homogeneous within parcels, and congeneric across each parcel. The congeneric parceling method was employed in this study for two reasons: (1) it reduces measurement error by isolating the *best* items for measurement of the latent factors (i.e., those with the highest factor loadings) and (2) it combines information from multiple items to increase the likelihood of accurately measuring the latent product term leading to less bias in the product coefficient (Fletcher, 2005). More recently, Fletcher and Perry (2007) suggest the congeneric parceling method is superior to the item-to-construct balance approach because it reduces error in the estimated structural coefficients and is procedurally more efficient.

To create the parcels used in this study, I conducted a series of maximum likelihood exploratory factor analyses using LISREL. For each scale, a single factor was

specified to fit all the items, thus forcing the criterion of unidimensionality for each scale. Factor loadings were then examined to determine which items to retain. Comrey and Lee (1992) suggested the following criteria for classifying factor loadings: .71 (and above) are considered excellent, .63 very good, .55 good, .45 fair, and .32 (and under) poor. Items that demonstrated loadings of less than .45 or were nonsignificant were dropped before forming subscales. I then examined the remaining items for both similarity of factor loadings and underlying meaning when deciding where to delineate each parcel. In other words, items with similar magnitudes of factor loadings that were logically related to each other were collapsed into a single parcel, as suggested by T. D. Dickinson (personal communication, September 23, 2006). Confirmatory factor analysis results for each latent variable are displayed in Appendix L. Items used in subscales and eliminated items appear in Table 3.

Reliability. Most of the scales used in this study have been employed in previous research, so acceptable reliabilities were already established. Testing the measurement model in SEM, however, is another way to assess reliability of scales using a composite measure. Composite reliability is often preferred over Chronbach's alpha, the traditional way of calculating reliability, because it gives a truer indication of internal consistency by taking into account the possibility that the indicators may have different factor loadings and error variances (Devellis, 1991; Raykov, 1997; Wert, Linn, & Joreskog, 1974). In the present study, standardized reliability estimates were used to assess reliability of subscales and factors. Standardized reliability was calculated as:

$$r = \frac{\left(\sum_i^p \lambda_{ij}\right)^2}{\left(\sum_i^p \lambda_{ij}\right)^2 + \sum_i^p V(\delta_i)}$$

Table 3
Summary of Parcel Construction and Item Elimination

Component Scale	Parcel 1 Items	Parcel 2 Items	Parcel 3 Items	Removed Items
LMX	7, 4, 2	6, 3	1, 5	
Perceived Supervisor Support	6, 7, 4	1, 5	8, 2, 3	
Upward Influence Effectiveness*	1	2	3	
Satisfaction with Center Research	20, 10	1, 19, 2		3, 4, 8, 9, 18, 7, 14, 5, 6, 11, 12, 21
Satisfaction with University Administrator	16, 22	13, 17, 15		
Center Commitment	2, 1, 14, 6	10, 5, 8	15, 11, 13	3, 4, 7, 9, 12
Intention to Quit Directing Center*	2	3		1

*Note. Individual items used for Upward Influence Effectiveness and Intention to Quit Directing Center scales.

where λ_{ij} is the factor loading parameters, and $V(\delta_i)$ is the error variance, and p is the number of observed variables of the construct (Wert et al., 1974). Guidelines for minimum acceptable reliabilities range from .60 (Devillis, 1991) to .70 (Nunnally, 1978). Alternatively, Fornell and Larcker (1981) suggest .70 as an acceptable threshold for composite reliability, with each indicator reliability above .50. Reliabilities for both indicators and scales are shown in Table 4. Composite indicator reliabilities ranged from .54 to .92 and composite scale reliabilities ranged from .71 to .91.

Measurement model. LISREL 8.71 (Joreskog & Sorbom, 1996) was used to test hypotheses, for it allows for the simultaneous identification of latent variables and structural equation coefficients. Testing the measurement model prior to testing the structural model has been recommended by several researchers (e.g., Anderson & Gerbing, 1988; James, Mulaik, & Brett, 1982) because the measurement model serves as a foundation for subsequent testing of the structural model. According to Joreskog and Sorbom (1993, p. 113), "The testing of the structural model, i.e., the testing of the initially specified theory, may be meaningless unless it is first established that the measurement model holds. If the chosen indicators for a construct do not measure that construct, the specified theory must be modified before it can be tested." Maximum likelihood estimate was used to test goodness of fit of the measurement model (Jöreskog & Sörbom, 1996).

Structural model. LISREL 8.71 was used to test the proposed model (see Figure 2), for it can simultaneously evaluate the relationship among independent latent variables and dependent latent variables, and then estimate the goodness of fit of the structural

Table 4

Factor Loadings, Standard Errors, t-values, R^2, and Composite Reliability Coefficients in the Measurement Model

Variable	Factor Loading (Standardized)	*t*-value	Theta Delta (Standardized)	R^2	Reliability of Indicator	Reliability of Scale
LMX						.83
LMXP1	.96	12.54	.09	.92	.92	
LMXP2	.90	11.34	.18	.82	.81	
LMXP3	.88	10.84	.23	.77	.76	
Perceived Supervisor Support						.85
PSSP1	.95	12.44	.10	.91	.93	
PSSP2	.92	11.62	.16	.84	.82	
PSSP3	.92	11.66	.16	.84	.80	
Upward Influence Effectiveness						.91
UIE1	.87	10.51	.24	.76	--	
UIE2	.90	11.01	.20	.80	--	
UIE3	.88	10.72	.22	.78	--	
Satisfaction with Center Research						.83
SATRESP1	.86	9.73	.27	.73	.84	
SATRESP2	.96	11.48	.08	.92	.82	

Note. $N = 96$. Abbreviations are: LMX = Leader-Member Exchange, UIE = Upward Influence Effectiveness, SATRES = Satisfaction with Center Research, SATUA = Satisfaction with University Administrator, COM = Commitment, DIRTOI = Intention to Quit Directing Center. All *t*-values are significant at $p \leq .05$.

(Table 4 continued)

Variable	Factor Loading (Standardized)	*t*-value	Theta Delta (Standardized)	R^2	Reliability of Indicator	Reliability of Scale
Satisfaction with University Administrator						.81
SATUAP1	.90	10.86	.23	.80	.89	
SATUAP2	.87	10.33	.25	.75	.72	
Center Commitment						.71
COMP1	.88	10.56	.22	.78	.86	
COMP2	.86	10.16	.26	.74	.73	
COMP3	.75	8.21	.45	.56	.54	
Intention to Quit Directing Center						.77
DIRTOI1	.86	8.34	.26	.74	--	
DIRTOI2	.73	7.07	.47	.53	--	

Note. $N = 96$. Abbreviations are: LMX = Leader-Member Exchange, UIE = Upward Influence Effectiveness, SATRES = Satisfaction with Center Research, SATUA = Satisfaction with University Administrator, COM = Commitment, DIRTOI = Intention to Quit Directing Center. Indicator reliabilities not calculated for UIE and DIRTOI because individual items were used as indicators when constructing both scales. All *t*-values are significant at $p \leq .05$.

model (Hair, Anderson, Tatum, & Black, 1995). LISREL also provides regression coefficients for each hypothesized relationship among latent variables (i.e., parameter estimates) (Jöreskog & Sörbom, 1996). Significance levels of individual parameter estimates for paths in the model were determined using the *t* distribution. A path with a *t*-value greater than 2.00 is considered significant at $p < .05$. The overall chi-square statistic and several goodness of fit indices were used to assess model fit.

Fit indices. The Chi-square statistic is the only statistical test of significance (i.e., overall fit) for testing the measurement and structural models (Schumacker & Lomax, 2004). The Chi-square statistic measures the distance (i.e., discrepancy) between the covariance matrix generated from sample data and the covariance matrix created based on the specified theoretical model. A non-significant Chi-square indicates a good fit, thus indicating little difference between the sample variance-covariance matrix and the reproduced covariance matrix implied by the specified theoretical model. Three other fit indices were also used to assess model fit: root mean square error of approximation (RMSEA), the non-normed fit index (NNFI), and the comparative fit index (CFI). RMSEA values that are less than or equal to .05 suggest a close fit while values between .06 and .08 suggest acceptable or reasonable fit (Browne & Cudeck, 1993; Hu & Bentler, 1999). Values of .90 or greater for the NNFI (Tucker & Lewis, 1973) and CFI (Bentler, 1990) indicate reasonable fit for the model. RMSEA, NNFI, and CFI indices were used to assess model fit because they are unbiased estimators and unaffected by sample size (Hu & Bentler, 1995). Given the relatively small sample size in this study (N = 96), it is most appropriate to use fit indices that are independent of sample size.

Nested models. Structural equation modeling researchers strongly advocate the practice of evaluating multiple alternative models as opposed to a single model. Bollen and Long (1993) argue that comparing alternative models allows researchers to determine the model with the best relative fit, rather than attempt to assess a single model's fit in an absolute sense or in the absence of an established baseline for reference. According to Hoyle (1995), nested models are models that contain the same parameters but the set of free parameters in one model is a subset of the free parameters in the other. In other words, one variable or parameter estimate is added in each successive model. In this study, I tested a series of three nested structural models. The baseline model contained no mediators and only estimated the relationship between LMX and each of the four criterion variables: satisfaction with center research, satisfaction with university administrator, commitment to center, and intention to quit directing the center. Next, a mediation model was tested in which the mediating effects of UIE were estimated. Finally, the full hypothesized model was tested in which the mediating effects of both UIE and PSS were estimated. To determine which model best fit the data, I conducted a series of χ^2-difference tests (Hoyle & Panter, 1995) in which the difference between the resulting χ^2 and degrees of freedom was calculated for each nested model. If the change in χ^2 ($\Delta\chi^2$) was significant given the change in degrees of freedom (Δdf), that particular model represented the best fit to the data.

RESULTS

Prior to analysis, I screened the data for missing values, outliers, normality, linearity, and homoscedasticity as recommended by Tabachnick and Fidell (2001). Data fell within acceptable ranges for each of these screenings with the exception of missing data. Percent of missing data exceeded the maximum recommended 5%, so I eliminated nine cases from the original 105 where data were missing for one or more complete scales, leaving a total sample size of 96. For cases with missing data for only one or a few items within a scale, I used mean substitution to calculate a value for the missing data points In total, I replaced 40 out of a total of 7,008 possible data points, which is less than 1%.

Power

Adequate power is necessary in order to determine if there is a significant difference between the null and alternate hypotheses. The size of the sample used in this research raises concerns, but sample size is just one of several variables that influence power estimates. Typically, structural equation modeling (SEM) requires rather large sample sizes in order to calculate parameter estimates with smaller variances. That is, with more power, parameter estimates in SEM are more stable and therefore, contribute more meaningfully to the overall determination of model fit.

Researchers have offered varying guidelines for determining minimum sample sizes needed for SEM analyses. For example, Bentler and Chou (1987) suggest that the minimum ratio of participants to parameters (N:t) should be 5:1 when conducting a latent variable SEM analysis. Nunnally (1978) recommends at least 10 subjects for every hypothesized factor to achieve adequate statistical power. MacCallum, Browne, and

Sugawara (1996) developed an approach for estimating power using an effect size defined in terms of null and alternative values of the root-mean-square error of approximation (RMSEA) fit index proposed by Steiger and Lind (1980). This index indicates discrepancy in terms of systematic lack of fit in the model per degree of freedom, thus it is sensitive to the number of model parameters. MacCallum et al. (1996) show that the effects of small sample size on power estimates can be compensated for by larger degrees of freedom.

A unique contribution of the MacCallum et al. (1996) method is that it tests "close fit" and "not close fit" hypotheses rather than testing for exact fit. These researchers argue that SEM models are only close approximations of real-world relationships and effects, and even if a model represents a fairly close approximation to the real world, the test of exact fit will result in rejection of the model if N is large enough. That is, sample sizes used in SEM must be relatively large just to obtain precise parameter estimates and satisfy asymptotic distributional approximations; thus they will often be large enough to reject good models via the test of exact fit. Therefore, they conclude that the test of exact fit is not particularly useful in practice. They rely instead on the notion of model discrepancy in the population, or RMSEA, which is determined by systematic lack of fit of the model. MacCallum et al. (1996) use e to indicate discrepancy per degree of freedom and is thus sensitive to the number of model parameters. In their method of estimating power, the null hypothesis (H_0) refers to a hypothesized value of RMSEA (e_0). If H_0 is false, the actual value of RMSEA is e_a, which represents the degree of lack of fit in the population. The difference between e_0 and e_a represents the effect size, or the degree to which H_0 is incorrect. To estimate power according to the MacCallum et al,

(1996) method, one uses sample size, degrees of freedom, and the selected alpha, e_0, and e_a values. Some portions of the model being tested, specifically the y-side relationships, are strongly supported by previous research, so "close fit" criteria were selected, using values for e_0 and e_a of .05 and .08, respectively. Degrees of freedom (df) are calculated using the formula, df = (p(p+1)/2) - q, where p represents the number of observed variables, and q is the number of estimated parameters). The hypothesized model has 18 observed variables and 54 estimated parameters, yielding 117 degrees of freedom. Given 117 degrees of freedom, an alpha level of .05, a sample size of 96, and an expected "close fit" of the model, power to test the hypothesized model is estimated to be .65. While relationships among affective outcomes are well-researched, the proposed model includes several unique variables such as satisfaction with university administrator and satisfaction with resources as well as mediating effects of perceived supervisor support and upward influence effectiveness that are less understood and have not been subject to the level of empirical scrutiny compared to the affective outcomes. Given these considerations, I also considered a "not close" fit of the hypothesized model using values for e_0 and e_a of .05 and .01, respectively. Following the same mathematical calculations above, that test yielded a power estimate of .45.

MacCallum et al. (1996) also present a procedure for computing minimum sample size for tests of fit based on the RMSEA index. Using values for e_0 and e_a of .05 and .08, respectively (i.e., representing close fit), 119 subjects would be needed to achieve a power of .80 for the hypothesized model. Given that there were only 128 center and site directors at the time this study was conducted, this number would have represented a 93% usable response rate, a percentage that is rare in survey research.

Descriptive Analyses

Means, standard deviations, and correlations among the latent variables are shown in Table 5. Means, standard deviations, and correlations among the parcels are included in Appendix J. Because the covariance matrix was used in SEM analysis, I have included the LISREL-produced covariance matrix in Appendix K.

Test of the Hypothesized Model

As discussed in the method section, a two-stage strategy was used for data analysis. Confirmatory factor analysis was first used to assess fit of the measurement model then used to assess fit of the structural model.

Analysis of fit of the measurement model. Maximum likelihood confirmatory factor analysis was conducted prior to analysis of the structural model. Results of the confirmatory factor analyses are shown in Appendix L. Thirteen parcels were created using a congeneric approach. Three parallel parcels represent indicators of each construct, with the exception of satisfaction with center research and satisfaction with university administrator, which are each represented by two parcels. Scales and their corresponding parcels were shown in Table 3 in the method section.

The measurement model consisted of three parcels representing LMX, three parcels for PSS, three indicators (observed variables) for upward influence effectiveness, two parcels for satisfaction with center research, two parcels for satisfaction with university administrator, three parcels for commitment to center, and two indicators (observed variables) for intention to quit directing the center (see Figure 3).

Table 5
Means, Standard Deviations, and Intercorrelations among Demographic and Latent Variables

Variable	Mean	SD	1	2	3	4	5	6	7
1. Center Type	.82	.39	--						
2. Director Type	.50	.50	-.48**	--					
3. Fall 2004 Full-time Student Enrollment	27,667.65	12,810.42	.09	-.05	--				
4. Fall 2004 Full-time Faculty	1,388.11	755.97	-.02	.08	.79**	--			
5. Fall 2004 Research Funding	255.46	231.98	-.01	.07	.53**	.78**	--		
6. Years Reporting to Current University Administrator	4.75	2.77	.05	.03	.14	.23*	.27**	--	
7. Director Tenure (in Years)	4.20	3.02	-.15	-.21*	-.25*	.19	.21*	.37**	--

Note. $N = 96$. Center Type coded as 0 = single-site I/UCRC and 1 = multi-site I/UCRC; Director Type coded as 0 = site director and 1 = center director; Fall 2004 Research Funding reported in millions of U.S dollars. * $p \leq .05$. ** $p \leq .01$.

(Table 5 continued)

Variable	Mean	SD	1	2	3	4	5	6	7
8. LMX	3.65	.93	.18	-.05	.05	-.04	-.05	.26*	.17
9. Perceived Supervisor Support	5.65	1.35	.19	-.05	.02	-.08	-.09	.18	.14
10. Upward Influence Effectiveness	3.47	1.03	.03	-.06	.01	-.02	.03	.22*	.11
11. Satisfaction with Center Research	4.25	.63	-.13	-.10	-.03	.03	.14	.07	.19
12. Satisfaction with University Administrator	3.70	.88	.04	.01	.05	.02	-.04	.15	.17
13. Commitment to Center	3.94	.50	-.10	.11	-.12	-.07	-.05	-.03	.15
14. Intention to Quit Directing Center	2.24	1.58	-.01	-.14	.07	-.05	-.04	-.04	-.01

Note. $N = 96$. Center Type coded as 0 = single-site I/UCRC and 1 = multi-site I/UCRC; Director Type coded as 0 = site director and 1 = center director; Fall 2004 Research Funding reported in millions of U.S dollars. * $p \leq .05$. ** $p \leq .01$.

(Table 5 continued)

Variable	Mean	SD	8	9	10	11	12	13	14
8. LMX	3.65	.93	--						
9. Perceived Supervisor Support	5.65	1.35	.87**	--					
10. Upward Influence Effectiveness	3.47	1.03	.74**	.70**	--				
11. Satisfaction with Center Research	4.25	.63	.22*	.25*	.27**	--			
12. Satisfaction with University Administrator	3.70	.88	.65**	.73**	.68**	.48**	--		
13. Commitment to Center	3.94	.50	.23*	.24*	.31**	.62**	.43**	--	
14. Intention to Quit Directing Center	2.24	1.58	-.15	-.17	-.15	-.31**	-.18	-.58**	--

Note. $N = 96$. Center Type coded as 0 = single-site I/UCRC and 1 = multi-site I/UCRC; Director Type coded as 0 = site director and 1 = center director; Fall 2004 Research Funding reported in millions of U.S dollars. * $p \leq .05$. ** $p \leq .01$.

The measurement model fit reasonably well, χ^2 (114) = 140.18, $p < .05$. Although the χ^2 is significant, the χ^2 to *df* ratio equals 1.23, which is below the cutoff value of 2.00 as recommended by Tabachnick & Fidell (2001). The other fit indices indicate that the measurement model is a good fit: RMSEA = .03, NNFI = .99, CFI = .99.

Standardized factor loadings, corresponding *t*-values, error variances (Theta Delta values), and reliabilities for each indicator in the measurement model as well as scale reliabilities are displayed in Table 4. Figure 3 displays the measurement model with completely standardized factor loadings and error variances. All factor loadings are relatively high (most greater than .85) with two exceptions: Commitment to Center Parcel 3 (.75) and Intention to Quit Directing Center observed variable 2 (.73). In addition, each loading has a *t*-value greater than 2.00, demonstrating that each indicator loads significantly on its corresponding latent variable. Squared multiple correlations (R^2) in the measurement model, which indicate parcel or item reliability, range from .53 to .92.

Nested model 1. The first nested model consisted of the direct effect of LMX on the following criterion variables: PSS, UIE, satisfaction with center research, satisfaction with university administrator, commitment to center, and intention to quit directing the center. No mediating variables were included in this first model. This model is a good fit to the data, χ^2 (125) = 169.59, $p < .01$, RMSEA = .05, NNFI = .98, CFI = .99. The χ^2 to *df* ratio (1.36) is less than the recommended 2.00. Nested model 1 and its standardized parameter estimates are displayed in Figure 4.

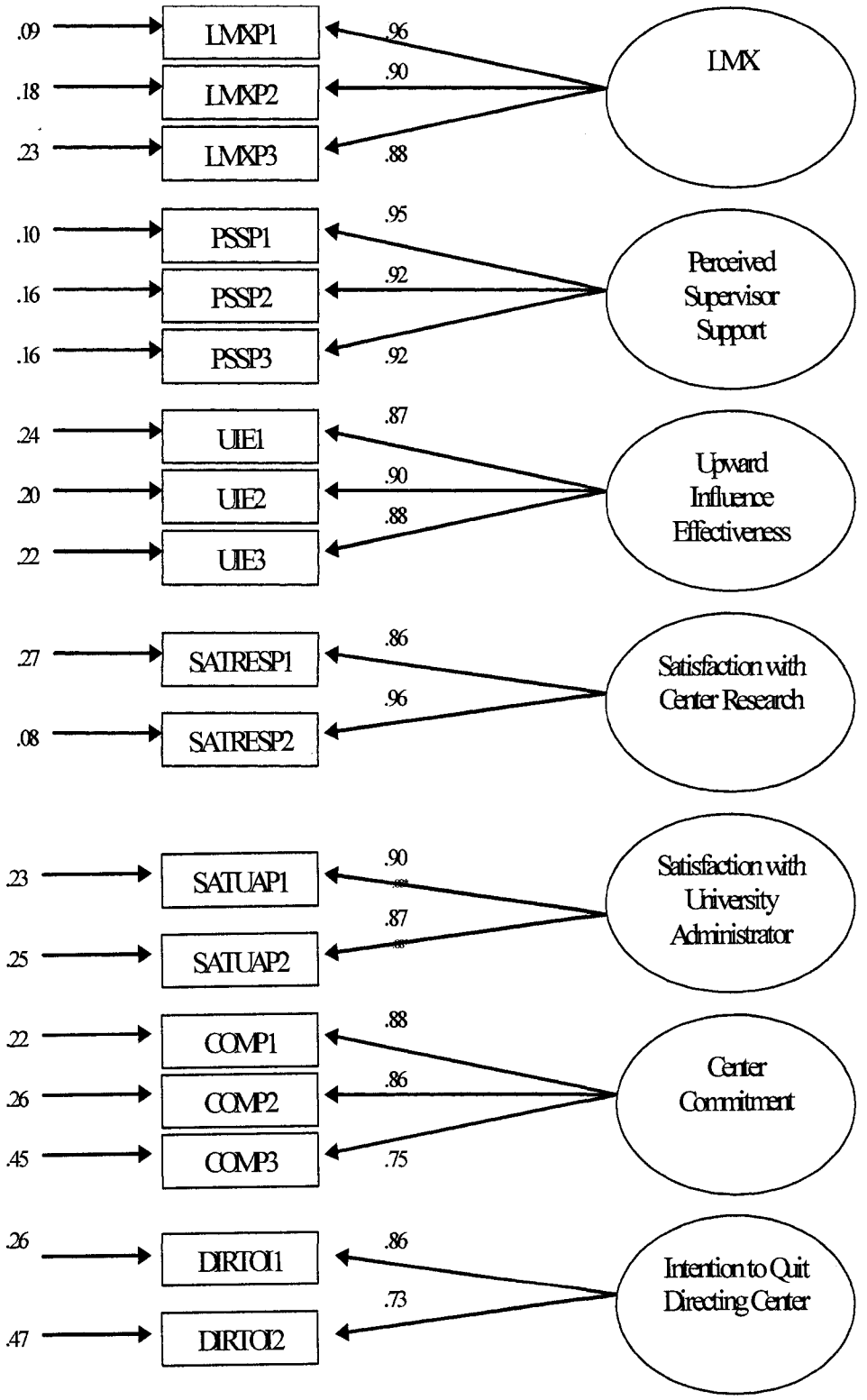

Figure 3. Latent variable measurement model with completely standardized estimates. All paths are significant at $p \leq .05$.

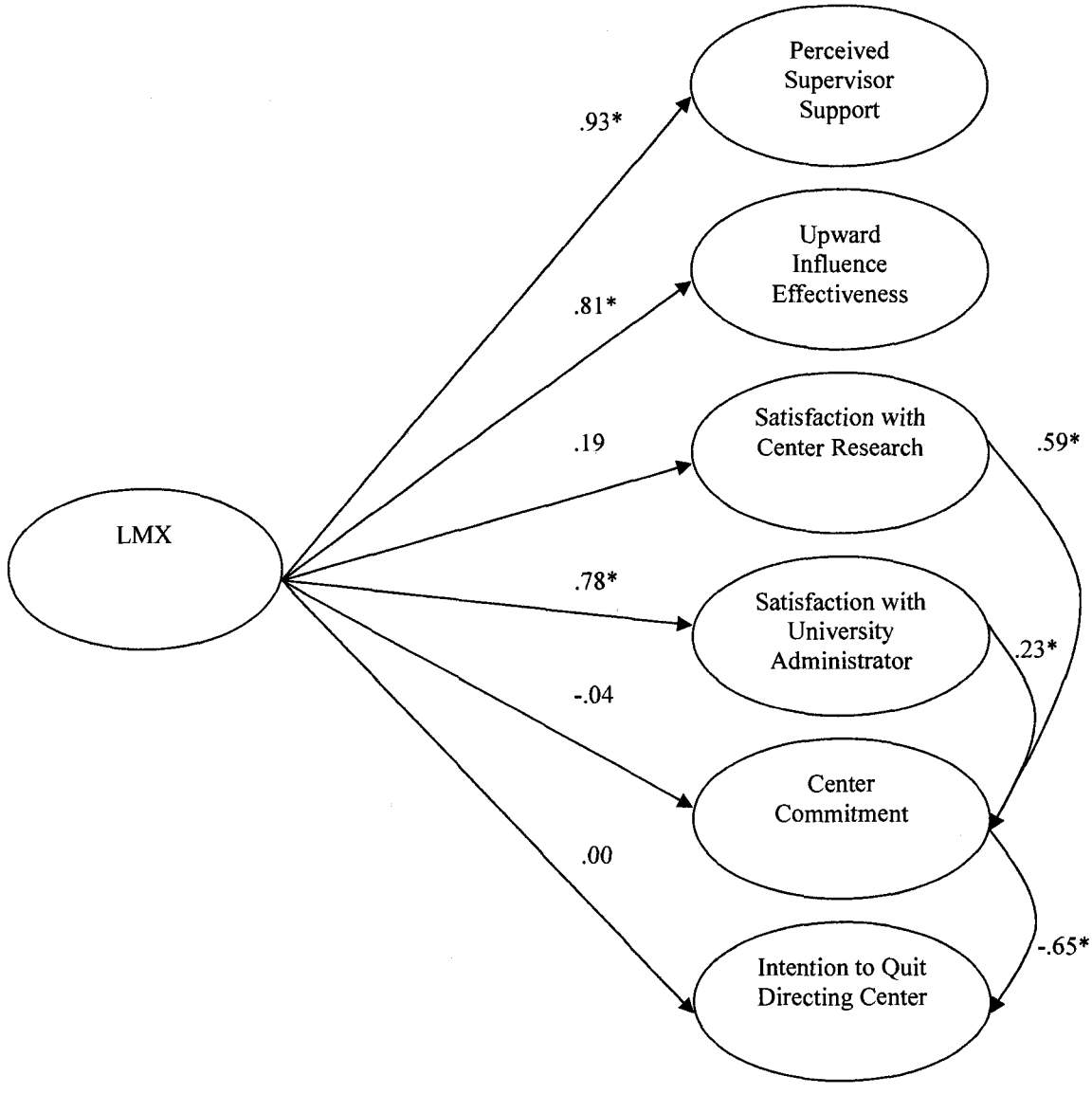

Figure 4. Nested model 1 (no mediators model). Standardized path coefficients displayed. N = 96, $*p \leq .05$.

Nested model 2. The second model tested included one mediation effect, that of UIE partially mediating the relationship between LMX and the four criterion variables, satisfaction with center research, satisfaction with university administrator, commitment to center, and director intention to quit directing the center. PSS was not selected to be the mediator tested in this step because of its high correlation with LMX (r = .87). The mediation model fit reasonably well, χ^2 (121) = 160.01, p = .01, RMSEA = .04, NNFI = .99, CFI = .99, χ^2/df = 1.32. Nested model 2 and its standardized parameter estimates are displayed in Figure 5. A χ^2-difference test shows that the UIE partial mediation model is a better fitting model than nested model 1 that includes only direct effects and no mediation (see Table 6).

Nested model 3: Hypothesized model. The final model tested represents the hypothesized model, the partial mediating effect of both UIE and PSS on the relationship between LMX and the four criterion variables, satisfaction with center research, satisfaction with university administrator, commitment to center, and director intention to quit directing the center. This model fit the data reasonably well, χ^2 (117) = 144.86, $p <$ .05, RMSEA = .03, NNFI = .99, CFI = .99, χ^2/df = 1.24. Figure 6 displays the model and its standardized parameter estimates. A χ^2-difference test shows that nested model 3, the two partial mediator model, is a better fitting model than nested model 2, the UIE only mediator model, $\Delta\chi^2(4)$ = 15.15, $p \leq .05$ (See Table 6). This result lends support to the hypothesized model. Fit statistics and χ^2-difference tests for the series of nested models are summarized in Table 6. Given the model comparisons, the two partial mediator model is the best-fitting model and will serve as the basis for the findings reported below.

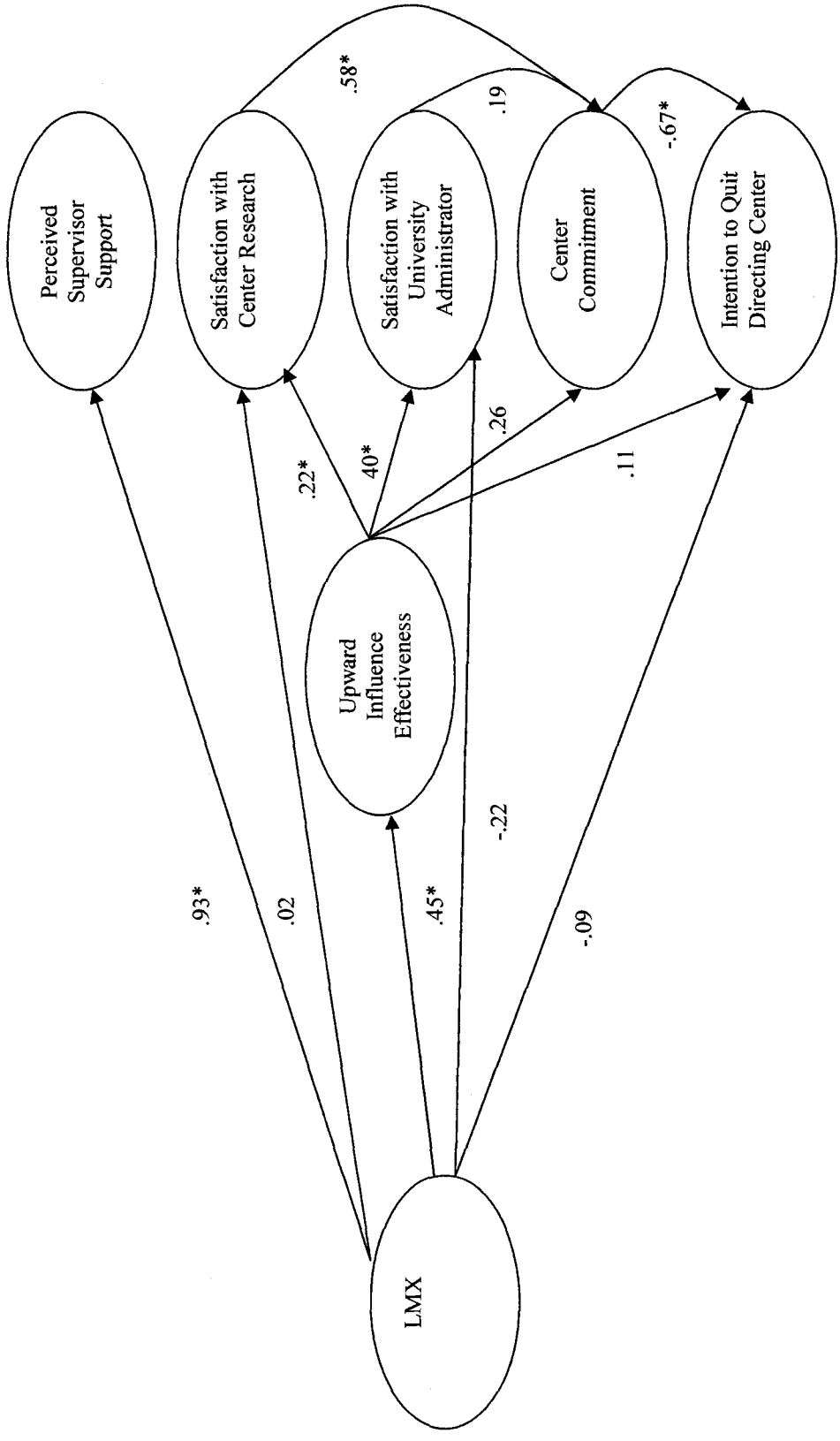

Figure 5. Nested model 2 (UIE only mediated model). Standardized path coefficients displayed. N = 96, * $p \leq .05$.

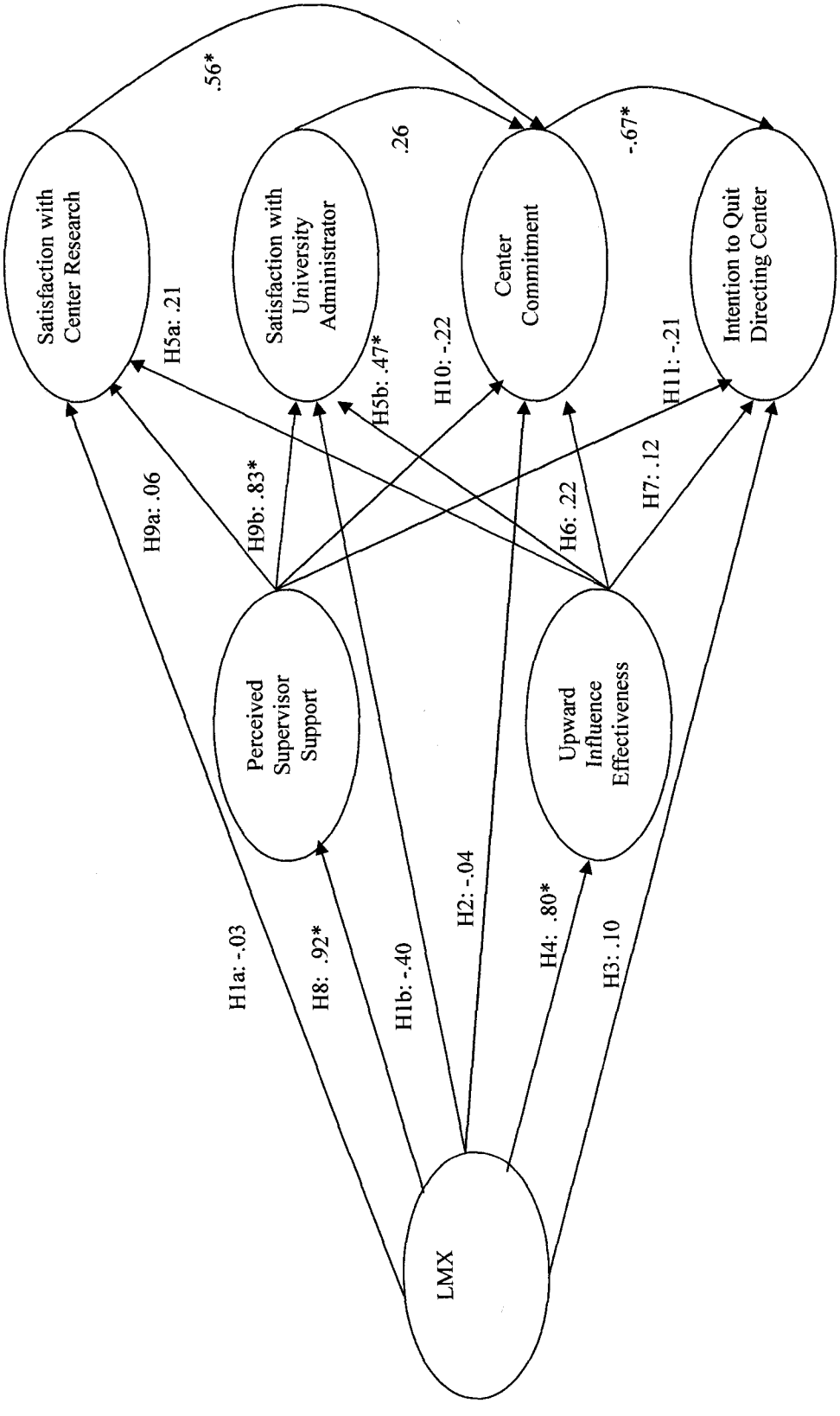

Figure 6. Nested model 3: Hypothesized model (PSS and UIE mediated model). Standardized path coefficients displayed. N = 96, * $p \leq .05$.

Table 6
Comparison of Nested Models with Hypothesized Model

Model	χ^2	*df*	$\Delta\chi^2$	Δdf	CFI	NNFI	RMSEA
Nested Model 1	169.59**	125	--	--	.99	.98	.05
Nested Model 2	160.01**	121	9.58*	4	.99	.99	.04
Hypothesized Model	144.86*	117	15.15*	4	.99	.98	.04

Note. $N = 96$. CFI = comparative fit index; NNFI = non-normed fit index; RMSEA = root mean square error of approximation. * $p \leq .05$. ** $p \leq .01$.

While the absolute numerical difference between models 2 and 3 may be negligible, the value of model 3 lies in its explanatory power. In other words, model 3 opens the "black box" of leadership behavior on individual affective variables and attempts to explain how those relationships work through mechanisms of perceived supervisor support and upward influence effectiveness.

None of the direct relationships hypothesized between LMX and the four outcomes, satisfaction with center research (Hypothesis 1), satisfaction with university administrator (Hypothesis 2), center commitment (Hypothesis 3), and director intention to quit directing the center (Hypothesis 4) was supported by model 3. However, the direct effect of LMX on both PSS (Hypothesis 5) and upward influence effectiveness (Hypothesis 10) was supported. As expected, the mediating effect of PSS on satisfaction with university administrator (Hypothesis 7) was supported, but other hypothesized relationships were not supported by this model, including satisfaction with center research (Hypothesis 6), center commitment (Hypothesis 8), and director intention to quit directing the center (Hypothesis 9). Finally, upward influence effectiveness was found to mediate the relationship between LMX and satisfaction with university administrator (Hypothesis 12) as predicted. However, upward influence effectiveness did not mediate relationships between LMX and satisfaction with center research (Hypothesis 11), center commitment (Hypothesis 13) and director intention to quit directing the center (Hypothesis 14), respectively. Because the direct effect of LMX on satisfaction with university administrator is no longer significant when the two mediators are included in the model and the direct effects of both these mediators on satisfaction with university administrator are significant, I conclude that both perceived supervisor support and

upward influence effectiveness *fully* mediate the relationship between LMX and satisfaction with university administrator. Additional evidence is provided through the indirect effects summarized below.

Indirect effects in the hypothesized model are presented in Table 7. LMX had a significant indirect effect on satisfaction with university administrator (1.14), suggesting that both PSS and upward influence effectiveness fully mediated that relationship. There were also significant indirect effects between upward influence effectiveness on intention to quit directing the center (-.30) and between satisfaction with center research and intention to quit directing the center (-.37).

One finding of note concerns a potential suppressor effect observed in model 3. The sign of the path coefficient between LMX and satisfaction with university administrator becomes negative (β = -.40, *n.s.*) when PSS was added to the model. It was observed to be positive in both models 1 (β = .78, $p \leq .05$) and 2 (β = .45, $p \leq .05$). The classic definition of a suppressor variable as put forth by Conger (1974) is a variable that increases the predictive validity of another variable (or set of variables) by its inclusion in a regression equation. The inclusion of the suppressor in the model removes, or suppresses, the unwanted variance in the predictor variable and this enhances the relationship between the predictor and the criterion variable. The sign of the path coefficient from LMX to satisfaction with university administrator became negative with the introduction of perceived supervisor support in model 3, thus I reasoned the inclusion of this variable created the suppression effect. Following procedures outlined by Cohen, Cohen, West, and Aiken (2003), I tested for suppression effect, using the formula $r_{12} < (r_{x1y})(r_{x2y})$. The correlation between LMX (X_1) and satisfaction with university

Table 7
Standardized Indirect Effects among the Dependent Latent Variables in the Hypothesized Model

	LMX	Perceived Supervisor Support	Upward Influence Effectiveness	Satisfaction with Research	Satisfaction with University Administrator	Center Commitment	Intention to Quit Directing Center
LMX	--	--	--	--	--	--	--
Perceived Supervisor Support	--	--	--	--	--	--	--
Upward Influence Effectiveness	--	--	--	--	--	--	--
Satisfaction with Research	.22	--	--	--	--	--	--
Satisfaction with University Administrator	1.14*	--	--	--	--	--	--
Center Commitment	.28	.25	.24	--	--	--	--
Intention to Quit Directing Center	-.26	-.02	-.30*	-.37*	-.17	--	--

Note. * $p \leq .05$.

administrator (Y) was .65, between perceived supervisor support (X_2) and satisfaction with university administrator was .73, and between LMX (X_1) and perceived supervisor support (X_2) was .87. The correlation between LMX (X_1) and perceived supervisor support (X_2) was not found to be less than the product of the correlations between LMX (X_1) and satisfaction with university administrator (Y) and perceived supervisor support (X_2) and satisfaction with university administrator (Y). In other words, the formula $r_{12} < (r_{x1y})(r_{x2y})$ did not hold true under these conditions (.87 is not less than .48), hence, I found no empirical evidence of a suppressor effect.

I also examined the possibility of a negative suppressor effect in model 3 that would explain the negative, nonsignificant value of the path coefficient from LMX to satisfaction with university administrator ($\beta = -.40$). In negative suppression, two independent variables have a positive zero-order correlation with the dependent variable and are positively correlated with each other, but one of them receives a negative regression weight (Maassen and Bakker, 2001). This is the situation that appears in model 3. LMX and PSS are positively and significantly related to satisfaction with university administrator and each other, but the path coefficient for LMX becomes negative when PSS is introduced into the analysis. Maassen and Bakker (2001) deduced a formula by which to determine the existence of a negative suppression effect using the relationship between correlation coefficients. Specifically, if a negative suppression effect exists, $r_{12} > (r_{13}/ r_{23})$ where r_{12} is the correlation between LMX and PSS (.87), r_{13} is the correlation between LMX and satisfaction with university administrator (.66) and r_{23} is the correlation between PSS and satisfaction with university administrator (.74). When the appropriate values were inserted into the formula above, the inequality did not hold

true (.87 is not greater than .89). Therefore, while the relationships among LMX, PSS, and satisfaction with university administrator seem to be trending toward a negative suppressor effect, empirical calculations do not support this conclusion.

One finding that could explain the path coefficient assuming a negative sign once PSS was added to the model is that LMX and PSS are highly correlated ($r = .87$). I ran a maximum likelihood factor analysis with varimax rotation and found that PSS and LMX load onto one factor, explaining 69% of the variance in these two variables. Table 8 below contains factor loadings for each LMX and PSS item. All items have fairly high factor loadings, with no item below .72.

Table 8
LMX and PSS Item Factor Loadings

Item	Factor Loading
LMX 1	.78
LMX 2	.82
LMX 3	.81
LMX 4	.89
LMX 5	.72
LMX 6	.79
LMX 7	.92
PSS 1	.81
PSS 2	.76
PSS 3	.74
PSS 4	.88
PSS 5	.80
PSS 6	.90
PSS 7	.90
PSS 8	.77

Finally, Table 9 displays the squared multiple correlations (R^2) for the structural equations matrix. These values represent the amount of variance in each variable that was explained by the model. The hypothesized mediators, PSS and upward influence effectiveness, had 85% and 64% of their respective variances explained by their relationship with LMX. Among the affective outcomes, only 5% of the variance in satisfaction with center research was explained by the model. Results were more promising for satisfaction with university administrator (73% of variance explained), center commitment (52% of variance explained), and intention to quit directing the center (43% variance explained).

Table 9

Squared Multiple Correlations (R^2) for Structural Equations in the Hypothesized Model

LMX	Perceived Supervisor Support	Upward Influence Effectiveness	Satisfaction with Center Research	Satisfaction with University Administrator	Center Commitment	Intention to Quit Directing Center
---	.85	.64	.05	.73	.52	.43

Note. $N = 96$. The squared multiple correlation (R^2) indicates the percent of variance in a variable that is being explained by the set of its predictors. LMX= Leader-Member Exchange.

Summary of Results

The best-fitting model to the data according to a series of χ^2-difference tests is the hypothesized model in which PSS and upward influence effectiveness partially mediate the relationship between LMX and satisfaction, commitment, and turnover outcomes.

LMX is significantly related to PSS and upward influence effectiveness, but the only mediating effects supported by the results pertain to one criterion variable, satisfaction with university administrator. Both perceived supervisor support and upward influence effectiveness fully mediate the relationship between LMX and satisfaction with university administrator. In other words, quality of the relationship does not by itself determine center director's satisfaction with his/her university administrator. Rather, the quality of the relationship between a center director and his/her university administrator influences or enhances the degree to which the director feels supported by the administrator and the success of his/her influence attempts. In high quality LMX relationships, the director feels supported by his/her administrator and is more likely to be effective when trying to exert upward influence. Directors who feel supported and are able to successfully influence his/her administrator will then be more satisfied with his/her university administrator.

DISCUSSION

The purpose of this study was to explore the effect of leadership relationship quality between I/UCRC center directors and their university administrators on center director affective outcomes, including satisfaction, commitment, and turnover intentions. To date, little research has been conducted and published on leadership in I/UCRCs. This study, therefore, begins to address this gap in the I/UCRC literature.

First, to my knowledge, this is the first study that has examined the relationship between I/UCRC directors and their university administrators. Previous I/UCRC research focused on the relationship between center directors and faculty members who were responsible for conducting the research (Coberly, 2004). Second, this study is the first to use LMX to operationalize the relationship between center directors and university administrators. Previous research in the wider R&D realm has used either LMX or transformational and transactional leadership theories to explore outcomes among R&D professionals, including the effect of LMX on innovative behavior (e.g., Basu, 1991; Scott & Bruce, 1994; Tierney & Graen, 1993). Other research has examined the role of transformational and transactional leadership on quality climate and total quality management (e.g., Anderson, Rungtusanatham, & Schroeder, 1994; Dean & Bowen, 1994; Kathuria & Davis, 2001; Sousa & Voss, 2002; Waldman, 1994) with the general consensus being that transformational leadership among top management enhances quality management.

Another major contribution of this study concerns the nature of outcomes studied. Again, to my knowledge, this is the first study that has examined affective outcomes related to the subjective experience of directing an I/UCRC and overseeing its research

programs and staff *from the perspective of the director*. Coberly (2004) examined satisfaction and commitment to I/UCRCs from the perspective of faculty members. Research into R&D settings in general has incorporated measures of affective outcomes. For example, Berson and Linton (2005) examined the effects of transformational and transactional leadership on job and overall employee satisfaction in an R&D setting and found that transformational leaders had a more positive impact on employee satisfaction than managers who employed a transactional leadership style.

A final contribution of this study is its examination of the relationship between LMX and PSS. I treated these as independent constructs, operationalized as distinct variables and examined their interrelationship. Specifically, I wanted to understand how LMX operates by examining it in relation to a lesser-researched construct in the leadership literature, PSS.

Overall, results from this study suggest that the mediating effects of PSS and upward influence on the relationship between I/UCRC director and university administrator relationship were supported for only one outcome, satisfaction with university administrator. Remaining affective outcomes, including satisfaction with center research, center commitment, and intention to quit directing the center were neither directly related to relationship quality nor indirectly related to relationship quality through the effects of PSS and upward influence effectiveness. I will discuss these findings in more detail below.

Direct Effects of LMX on Upward Influence Effectiveness and PSS

Consistent with previous research, relationship quality, as measured by LMX, was found to be significantly related to upward influence effectiveness. Deluga and Perry

(1991) found that higher quality LMX was associated with upward subordinate influence effectiveness. Project champions, or individuals who are committed to and advocate for a particular project, are shown to have a strong influence on their target's behavior if the champions have a positive personal relationship with that individual (Markham, 1998). In the context of the present study, directors who have a better relationship with their university administrators are more likely to feel their influence attempts are successful. One reason upward influence is so important in the I/UCRC context is that university administrators often hold enormous discretion over center resources, particularly operating budgets, with which to conduct research programs.

Findings from this study are mixed with regard to the distinction between LMX and PSS, a question that has been raised in previous research (e.g., Eisenberger et al., 1986; Stinglhamber & Vandenberghe, 2003). On one hand, their high degree of intercorrelation and shared variance suggest they are not unique constructs. That is, they share a substantial degree of variance, leaving little unique variance in either construct. On the other hand, the addition of PSS in nested model 3 results in a better fitting model overall than either model 1 or model 2, suggesting that PSS adds something unique and explanatory to the relationships studied that LMX cannot do alone.

Wayne et al. (1997) speculate that organizational context, such as when supervisors have control over rewards, may determine if LMX influences PSS. In the NSF I/UCRC setting, university administrators have wide discretion over needed resources, but this may not the sole basis, or even the most suitable one, for assessing PSS in this context. University administrators do not hold reward power in the traditional sense for center directors, but they potentially hold other resources that may be important

to center functioning and success. Given the unique characteristics of the center director-university administrator relationship, center director PSS may not be determined from reward power, but rather from other factors such as budget allocation, cost control, and autonomy over their centers.

Direct Effects of LMX on Satisfaction, Commitment, and Intention to Quit Directing the Center

There exists a substantial body of organizational research that supports the direct effect of LMX on worker satisfaction, commitment, and turnover intentions (cf. Gerstner & Day, 1997). In the present study, results for the effect of relationship quality on director affective outcomes are surprising in that none of the hypothesized direct relationships between LMX and the outcomes was significant in model 3. One may conclude based on these findings that a third variable, such as a mediating variable, may explain the relationship between LMX and the four affective outcomes investigated in this study. As will be discussed below, full mediation effects of PSS and upward influence effectiveness on at least one of these dependent variables, satisfaction with university administrator, explains the lack of a direct relationship between it and LMX.

Mediating Effects of PSS on Satisfaction, Commitment, and Intention to Quit Directing the Center

PSS was hypothesized to partially mediate the relationships between director-university administrator relationship quality and satisfaction with center research, satisfaction with university administrator, center commitment, and intention to quit directing the center. Results show that only one of the hypothesized paths was significant; PSS was found to fully mediate the relationship between LMX and

satisfaction with university administrator. That is, LMX quality alone is not sufficient for a center director to feel satisfied with his/her university administrator. Instead, the degree to which a director feels supported and valued by his/her university administrator over the course of their relationship determines how satisfied that director is with his/her administrator. This finding lends support to the argument that LMX and PSS are distinct constructs. Interestingly, satisfaction with administrator does not predict director commitment to the center.

Results do not support the hypothesis that PSS mediates the relationship between LMX and intentions to quit directing the center. Results also fail to support the hypothesis that PSS mediates the relationship between relationship quality and commitment to the center. Eisenberger et al. (2002) suggest that the relationship between PSS and turnover is mediated by perceived organizational support, or POS. Supervisors are seen as agents of the organization and are therefore identified with the organization. Therefore, employees view the way a supervisor interacts with him/her as an indication of the organization's support (Eisenberger et al., 1986; Levinson, 1965). Although POS was not included in this study, it may be reasonable to expect that POS acts as an antecedent or moderating variable to the relationships among LMX, PSS, and intentions to quit directing the center. Alternatively, attitudinal commitment to the center and intentions to quit directing the center may be independent of the director-university administrator relationship. For example, three out of 13 directors in this sample who chose to move their centers to another university indicated they did so because of a poor relationship with their university administrators. The point here is that they did not quit directing the center, which would indicate their commitment to the center was still intact.

They just moved it to another location where the conditions for a director-university administrator relationship were more favorable. Another plausible explanation for the nonsignificant relationships between LMX and center commitment as well as intentions to quit directing the center is that the relationship with industry members (i.e., members of the industrial advisory board) and/or faculty members more directly impacts these outcomes than his/her relationship with the university administrator.

Mediating Effects of Upward Influence Effectiveness on Satisfaction, Commitment, and Intention to Quit Directing the Center

Similar to PSS, upward influence effectiveness was hypothesized to partially mediate the relationships between director-university administrator relationship quality and satisfaction with center research, satisfaction with university administrator, center commitment, and intention to quit directing the center. Results show that only one of the hypothesized paths was significant; the relationship between LMX and satisfaction with university administrator is fully mediated by upward influence effectiveness. In other words, directors who have a higher quality LMX relationship with their university administrators are more likely to be successful in their influence attempts, thus supporting findings reported by Deluga and Perry (1991). Successful influence attempts, in turn, lead to overall satisfaction with the administrator. In sum, directors are satisfied with their administrators when they are able to successfully influence them in exchange for something they need, and in order to successfully influence their administrators, they must have a high quality relationship in place.

Exercising influence is an important leadership skill because it is one of the primary means by which managers secure needed resources from a limited or finite

amount of that resource. Those who are able to successfully influence the "stewards" of these scarce resources are more likely to enjoy favorable outcomes compared to those who are unable successfully influence them. Ancona and Caldwell (1990) and Germmill and Wilemon (1994) note the importance of upward influence in securing resources and support to the success of R&D organizations. Further, Van de Ven (1986) contends that the success of an R&D project, and innovation in general, is determined by how influence is exercised. In the I/UCRC context, resources may refer to money, space, laboratory equipment, and other materials needed for continued operation of research programs. It stands to reason, then, that I/UCRC directors who are able to successfully influence their university administrators for needed resources enjoy higher productivity and innovation compared to those who do not have needed resources.

Relationships Among Affective Outcomes

Industrial-organizational psychology research literature is rife with studies that have examined the causal mechanisms of satisfaction, commitment, and turnover intentions. The most commonly accepted sequence is satisfaction creates commitment which in turn leads to lower intentions to leave the organization (cf. Mathieu & Zajac, 1990). This same sequence is supported by this study, but interestingly, the target of director satisfaction is what makes this finding unique.

Although I did not hypothesize nature or direction of relationships among the four criterion variables because these are well-known in the extant literature, I specified paths among these in the three nested structural models to provide a more comprehensive explanation of the phenomena under study and to enhance model fit. Specifically, I posited that satisfaction with center research and satisfaction with university

administrator would separately predict commitment to the I/UCRC. Numerous studies on the satisfaction-commitment link have demonstrated that job satisfaction is an antecedent to organizational commitment (Lincoln & Kalleberg, 1990; Mowday, Porter, & Steers, 1982; Mueller, Boyer, Price, & Iverson, 1994; Williams & Hazer, 1986). I also specified a path between center commitment and director intention to quit directing the center, suggesting that commitment negatively predicts intention to quit directing the center. A substantial body of research shows that organizational commitment is negatively related to intention to quit. (Horn & Griffith, 1995; Mathieu & Zajac, 1990; Mowday et al., 1982). Moreover, Griffeth, Hom, and Gaertner (2000) indicate that organizational commitment predicts turnover better than job satisfaction. Results suggest that most of my assumptions regarding the relationships among affective outcomes hold true in the present sample. Satisfaction with center research predicts center commitment, which in turn, negatively predicts intention to quit directing the center. However, the satisfaction-commitment relationship was not supported for the second form of satisfaction examined in this study, satisfaction with university administrator, as there was no significant relationship between these two variables.

Results of this study suggest it is satisfaction with *center research* that determines center commitment, not satisfaction with university administrator. Perhaps the intellectual satisfaction that comes with the semi-autonomous operation of the center research program influences I/UCRC director commitment. Analyses also support the contention that when directors are satisfied with the quality and nature of the research the center is conducting, they are more committed to the center. As a result of their commitment to the center, they are less likely to harbor intentions to quit directing it.

These findings are consistent with conclusions drawn by Thamhain (2003) in a study examining R&D performance. He noted that attributes of the work itself, including personal interest, pride and satisfaction with the work, professional work challenge, and accomplishments and recognition, had the strongest effect on the innovative performance of an organization.

Limitations

One major limitation of this study was its sample size. After elimination of missing data, the final sample size was 96, less than half of the 200 subjects ideally needed for SEM. There are numerous recommendations and guidelines for conducting SEM analyses with relatively small sample sizes (e.g., Tabachnick & Fidell, 2000), however, because there were only 127 center and site directors at the time this study was conducted, the sample could never have reached the ideal size for SEM. I employed suggested techniques for working with small sample sizes, such as running the model from the Y-side, and focused my research questions on a very specific set of variables to limit the complexity and associated calculations of the model. Future research will want to repeat these analyses with a larger sample size as more research centers and directors are added to the I/UCRC program.

Another limitation of the current study is that all variables were measured using self-reports from the same individual. That is, the present study was concerned with *center director perceptions* of the leadership relationship, upward influence effectiveness, and supervisor support and how these relate to *center director perceptions* of satisfaction, commitment, and turnover. The endogenous and exogenous variables represented in this research are, by their very nature, grounded in perception, so by necessity I had to use

self-report measures to capture them. In other words, it was not feasible to measure predictors or outcomes using another source and still capture the essence of the research question.

It has been historically believed that measuring variables using the same method inflates the relationships among them. This common method bias introduces measurement error, which threatens the validity of the conclusions about the relationships between measures (Campbell, 1982; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Measurement error contains both a systematic and a random component. In common method bias, the method variance component of error is shared across variables assessed with a particular method, thus introducing systematic error that inflates the relationships over the relationships that should be observed on the basis of the underlying theoretical constructs of interest (Spector, 2006). Systematic measurement error is particularly serious because it provides an alternative explanation for the observed relationship between two constructs that is independent of the one hypothesized (Podsakoff et al., 2003), thus leading to potentially misleading conclusions (Campbell & Fiske, 1959). Other researchers have begun to cast doubt on the scope of common method effects (Crampton & Wagner, 1994) and even the concept altogether (Spector, 1987, 2006).

Through their analysis of 11,710 published correlations, Crampton and Wagner (1994) found that percept-percept inflation, defined as the inflation in correlations among data due to constancy in the means of data collection (Spector, 1987, 1992), has not had the wide-ranging effects critics have argued. Rather, they found the inflationary effects of common method bias to be associated only with certain domains of research such as job satisfaction, turnover intentions, personality, ability, turnover, role characteristics,

performance appraisal, and leader initiation of structure. The present study includes several variables that fall into the domain of research susceptible to inflationary effects, including satisfaction and turnover intentions. Therefore, it is possible that the correlations among the four affective outcome variables in this study are inflated and thus exaggerated observed relationships reported in SEM analysis.

In contrast, Spector (2006) has argued that common method bias is nothing more than an urban legend and is a term that should be abandoned altogether, for it has not been concluded that method alone introduces measurement bias. He cites a study by Boswell, Boudreau, and Dunford (2004) in which 5 self-report variables were examined from the same questionnaire given to 1,601 individuals assessing attitudes, motives, and perceptions. Out of 10 reported correlations, 4 were nonsignificant, and among the significant correlations, 3 were .10 or less and the largest was .20. Spector emphasizes that if common method bias automatically introduces shared error into the measurement of variables, one should find a baseline level of correlation among all variables. In this case, the fact that there were several nonsignificant correlations as well as relatively low-order significant correlations suggests that there was no baseline of correlations and little evidence of *inflated* correlations. Spector (1986) also argues that inferences about common method bias are based on a comparison of monomethod versus multimethod correlations on measures of the same constructs and assume that correlations based on mixed methods are more accurate. Yet, it is possible that these methods are not measuring the same construct in the same way, and thus are not equally valid (Frese & Zapf, 1988). That is, correlations from studies that use a multimethod approach may be underestimating the true relationships among variables, thus making estimates of

common method bias inflated. While all variables in this study were measured using the same self-report measure, according to Spector (1986), this should be no cause for concern.

Conclusions and Future Research Directions

According to Graen & Scandura (1987), high LMX relationships can be characterized as those in which the subordinate is allowed greater autonomy and decision-making latitude, better access to organizational resources, and more time for unstructured tasks. I/UCRC directors are semi-autonomous professionals who are essentially charged with leading their own enterprise. Therefore, the degree to which they are allowed to operate autonomously and exercise decision-making authority may be a function of the quality of relationship with their administrator. This study found that directors who have a higher quality relationship with their administrators feel valued by their administrators and that their upward influence attempts are more successful. These perceptions, in turn, lead to greater satisfaction with the administrator. While satisfaction with administrator was not found to influence center commitment and intention to quit directing the center, anecdotally, it was found that *dissatisfaction* with administrator was enough to make some directors move it to another university.

The present study documents the importance of the relationship between center directors and their university administrators. In the absence of a high quality relationship, it may be difficult for center directors to feel valued and exercise influence needed to obtain vital resources for the center.

Future research should attempt to replicate these findings with a larger sample of center directors to determine if new relationships emerge that were reported as

nonsignificant in this sample. In addition, it would be worth further expanding the "black box" of leadership relationship by introducing trust into the model. Trust has been shown to play a central role in leadership relationships and is linked to job satisfaction and performance, goal attainment, satisfaction with the leader, organizational commitment, and intention to leave the organization (Dirks & Ferrin, 2002). Quality of leadership relationship, or LMX, could be better understood by more precisely identifying and isolating the mechanisms that help create it, such as PSS and trust.

Future research may want to explore the types of faculty positions held by university administrators and how the institutional power affiliated with them affects their relationship with center directors. Finally, it may interesting to examine personality traits of center directors to understand if they match an "entrepreneurial profile" that could render the upward leadership relationship less important in the I/UCRCs compared with other organizations.

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APPENDIX A

Invitation Email Sent to Center Directors

Dear [Insert Director Name Here]:

We are conducting a study funded by the National Science Foundation. The purpose of this survey is to understand the factors that shape the relationship between I/UCRC directors and university administrators and how that relationship affects the performance of I/UCRCs. You have been selected to participate in this survey because you are a director, co-director, or site director for an I/UCRC.

The URL for the survey is https://periwinkle.ts.odu.edu/surveys/3TAU2K. On the first page of the survey you will be asked to enter a password. Your password is XXXXX . Please copy this password and paste it in the box.

We also ask that you reply to this email with the name and email address of the university administrator to whom you report. We will send a version of the survey to that person. University administrators will be asked to describe their perceptions of the I/UCRC that you direct and their relationship with you. If you report to more than one university administrator, please select the one who oversees your center and with whom you work most closely. If you are a site director at a multi-university center, please provide contact information for the university administrator located at your university.

Your answers to the survey will be confidential; your responses will not be shared with anyone. Your cooperation and participation in the survey is extremely important. We urge you take the time to complete it as quickly as possible.

Sincerely,
Janet L. Bryant
Donald D. Davis
Old Dominion University

APPENDIX B

Reminder Email Sent to Center Directors

Dear [Insert Center Director Name Here]:

We recently sent an email about a survey that we are administering. The purpose of the survey is to understand the factors that shape the relationship between I/UCRC directors and university administrators and how that relationship affects the performance of I/UCRCs. We ask you to complete this survey because you are a director, co-director, or site director for an I/UCRC.

The URL for the survey is https://periwinkle.ts.odu.edu/surveys/3TAU2K. On the first page of the survey you will be asked to enter a password. Your password is XXXXX. Please copy this password and paste it in the box.

We also ask that you reply to this email with the name and email address of the university administrator to whom you report. We will send a separate version of the survey to that person. University administrators will be asked to describe their perceptions of the I/UCRC that you direct and their relationship with you. If you report to more than one university administrator, please select the one who oversees your center and with whom you work most closely. If you are a site director at a multi-university center, please provide contact information for the university administrator located at your university.

Your answers to the survey will be confidential; your responses will not be shared with anyone. Your cooperation and participation in the survey is extremely important. The National Science Foundation I/UCRC program, which has funded this research, is very interested in the results of the survey. The time commitment is minimal; the survey will only take 10 to 15 minutes to complete. We ask that you complete it as soon as possible. Thank you for your cooperation.

Sincerely,

Janet L. Bryant
Donald D. Davis
Old Dominion University

APPENDIX C

Initial Interview Questions

Instructions:

We are conducting a study examining leadership relationships between I/UCRC directors and university administrators to whom they report. The goal of our research is to understand what factors contribute to effective and ineffective leadership relationships and how these relationships impact the success of I/UCRCs.

We would like to ask you a few general questions about relationship between center directors and university administrators. Your responses will be kept confidential. Your participation is strictly voluntary. You may elect to skip any question. You may also end the interview at any point. Please avoid using names of center directors and university administrators in your responses.

Questions:

1. I would like for you to recall an instance of effective leadership behavior (either by you or another center director). We define leadership as providing guidance, direction, and support to others. Please describe what led up to the situation (provide context). Exactly what did the person do or not do that was especially effective? What was the outcome or result of this action? Why was this action effective?
2. Can you think of other examples of effective leadership behavior? (Follow up with above questions.)

APPENDIX C, Continued

3. I would like for you to recall an instance where you or another center director was effective in influencing a superior (e.g., university administrators). We refer to influence as behaviors that persuade another, such as a university dean, to do something that he or she would not ordinarily do. Please describe what led up to the situation (provide context). Exactly what did you or the other center director do or not do that was especially effective? What was the outcome or result of this action? Why was this action effective?
4. Can you think of other examples in which you or another center director effectively influenced a superior? (Follow up with above questions.)
5. I would like for you to recall an instance of ineffective leadership behavior, either by you or another center director. Recall that we are defining leadership as providing guidance, direction, and support to others. Please describe what led up to the situation (provide context). Exactly what did you or the other center director do or not do that was especially ineffective? What was the outcome or result of this action? Why was this action ineffective?
6. Can you think of other examples of ineffective leadership behavior? (Follow up with above questions.)
7. I would like for you to recall an instance where you or another center director was ineffective in influencing a superior (e.g., university administrators). Recall that we define influence as behaviors that persuade another, such as a university dean, to do something that he or she would not ordinarily do. Please describe what led up to the situation (provide context). Exactly what did you or the other person do or not do that was especially ineffective? What was the outcome or result of this action? Why was this action ineffective?

APPENDIX C, Continued

8. Can you think of other examples in which you or another center director was ineffective in influencing a superior? (Follow up with above questions.)
9. Finally, I would like for you to consider the relationship between center directors and university administrators. What are some characteristics or indicators of the **quality** of relationship between center directors and the university administrators to whom they report?
10. Can you explain in general how the functions and reporting relationships of center director differ from those of center assistant directors (not site co-directors)? Would there be value in including center assistant directors in our survey?
11. Are there certain characteristics of the university or center environment that affect the relationship between center directors and the university administrators to whom they report? If so, what are they?
12. How do you think the relationship between center directors and university administrators, either positive or negative, affects the "business" of the center?

APPENDIX D

Leader-Member Exchange (LMX-7) Items

1. Do you know where you stand with your administrator? In other words, do you know how satisfied your administrator is with what you do?
   Rarely.....Occasionally.....Sometimes.....Fairly Often.....Very Often
   (1) (2) (3) (4) (5)

2. How well does your administrator understand your job problems and needs?
   Rarely.....Occasionally.....Sometimes.....Fairly Often.....Very Often
   (1) (2) (3) (4) (5)

3. How often does your administrator recognize your potential?
   Rarely.....Occasionally.....Sometimes.....Fairly Often.....Very Often
   (1) (2) (3) (4) (5)

4. Regardless of how much formal authority he/she has built into his/her position, what are the chances that your administrator would "bail you out" at his/her expense?
   None.....Small.....Moderate.....High.....Very High
   (1) (2) (3) (4) (5)

5. Regardless of how much formal authority he/she has built into his/her position, what are the chances that your administrator would use his/her power to help you solve problems in you work?
   None.....Small.....Moderate.....High.....Very High
   (1) (2) (3) (4) (5)

6. I have enough confidence in my administrator that I would defend and justify his/her decision if he/she were not present to do so.
   Strongly Disagree.....Disagree.....Neutral.....Agree.....Strongly Agree
   (1) (2) (3) (4) (5)

7. How would you characterize your working relationship with your administrator?
   Extremely Ineffective.....Worse than Average.....Average.....Better than Average.....
   (1) (2) (3) (4)
   Extremely Effective
   (5)

APPENDIX E

Perceived Supervisor Support (PSS) Items
Administered to Center Directors

0	1	2	3	4	5	6
Strongly Disagree	Moderately Disagree	Slightly disagree	Neither Disagree nor Agree	Slightly Agree	Moderately Agree	Strongly Agree

1. My administrator values my contributions to the center.
2. My administrator fails to appreciate any extra effort from me.
3. My administrator would ignore any complaint from me.
4. My administrator really cares about my well-being.
5. Even if I did the best job possible, my administrator would fail to notice.
6. My administrator cares about my general satisfaction at work.
7. My administrator shows very little concern for me.
8. My administrator takes pride in my accomplishments at work.

APPENDIX F

Upward Influence Effectiveness Items

1. How many of your influence attempts have resulted in complete commitment by your administrator?

0	1	2	3	4	5
None of them	Few of them	Some of them	Many of them	Most of them	All of them

2. How often have you successfully influenced your administrator?

0	1	2	3	4
Never	Once or twice	A few times	Several times	Many times

3. How effective are you in influencing your administrator to carry out requests and support proposals?

0	1	2	3	4
Not effective	Slightly effective	Moderately effective	Very effective	Extremely effective

APPENDIX G

Satisfaction with Center Measure

1	2	3	4	5
Very dissatisfied	Dissatisfied	Neither dissatisfied nor satisfied	Satisfied	Very satisfied

How satisfied are you with the following:

1. Quality of the research program
2. Relevance of the research program to industrial partners' needs
3. Center administration
4. Center operations
5. Amount of funding the center receives from industrial partners
6. Amount of autonomy researchers have in conducting research
7. Interactions with industry members
8. Interactions with faculty
9. Interactions with student researchers
10. The significance of the work we are doing
11. The facilities
12. The equipment
13. How supportive my administrator is in helping me achieve my goals
14. The quality of industrial research being performed by industrial partners
15. Amount of funding the center receives from the university
16. Amount of support I receive from the university administrator to whom I report
17. University policies regarding the center
18. Capabilities of the researchers
19. Breadth of the research topics covered
20. Focus of the research
21. Your job as director
22. Your university administrator

APPENDIX H

Organizational Commitment Questionnaire

1	2	3	4	5
Strongly Disagree	Disagree	Neither Disagree nor Agree	Agree	Strongly Agree

1. I am willing to put in a great deal of effort beyond that normally expected in order to help this I/UCRC be successful.
2. I talk up this I/UCRC to my friends as a great place to work
3. I feel very little loyalty to this I/UCRC.
4. I would accept almost any type of job assignment in order to keep working for this I/UCRC.
5. I find that my values and the I/UCRC's values are very similar.
6. I am proud to tell others that I am director of this I/UCRC.
7. I could just as well be working for a different I/UCRC as long as the type of work were similar.
8. This I/UCRC really inspires the very best in me in the way of job performance.
9. It would take very little change in my present circumstances to cause me to leave this I/UCRC.
10. I am extremely glad that I chose this I/UCRC to work for, over other job opportunities that I had at the time I joined.
11. There's not much to be gained by sticking with this I/UCRC indefinitely.
12. Often, I find it difficult to agree with this center's policies on important matters relating to employees.
13. I really care about the fate of this I/UCRC.
14. For me, this is the best of all possible organizations for which to work.
15. Deciding to direct this I/UCRC was a definite mistake on my part.

APPENDIX I

Intention to Quit Directing Center Items

1. How likely is it that you will actively look for a new job in the next year?

1	2	3	4	5	6	7
Not at all likely		Somewhat likely		Quite likely		Extremely likely

2. I often think about quitting the I/UCRC.

1	2	3	4	5	6	7
Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree

3. I will probably look for a new job in the next year.

1	2	3	4	5	6	7
Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree

APPENDIX J

Means, Standard Deviations, and Intercorrelations among Parcels

Parcels	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. LMXP1	3.72	1.01	--									
2. LMXP2	3.76	.87	.86**	--								
3. LMXP3	3.42	1.05	.84**	.82**	--							
4. PSSP1	5.62	1.41	.86**	.79**	.78**	--						
5. PSSP2	5.78	1.48	.78**	.72**	.67**	.88**	--					
6. PSSP3	5.61	1.37	.83**	.78**	.73**	.86**	.85**	--				
7. UIE1	3.65	1.35	.66**	.66**	.59**	.62**	.61**	.61**	--			
8. UIE2	3.43	1.03	.69**	.65**	.65**	.64**	.63**	.63**	.78**	--		
9. UIE3	3.34	.98	.66**	.63**	.62**	.58**	.62**	.63**	.76**	.80**	--	
10. SATRESP1	4.24	.77	.12	.04	.03	.09	.06	.10	.18*	.17*	.19*	--
11. SATRESP2	4.36	.66	.23*	.14	.15	.18*	.17*	.23*	.16	.21*	.21*	.82**

Note. $N = 96$. * $p \leq .05$. ** $p \leq .01$

APPENDIX J, Continued

Means, Standard Deviations, and Intercorrelations among Parcels

Parcels	Mean	SD	1	2	3	4	5	6	7	8	9	10
12. SATUAP1	3.79	.99	.67**	.66**	.59**	.70**	.70**	.71**	.61**	.59**	.60**	.31**
13. SATUAP2	3.64	.89	.52**	.53**	.55**	.60**	.63**	.64**	.61**	.57**	.60**	.30**
14. COMP1	4.25	.71	.19*	.17*	.15	.14	.19*	.22*	.28**	.28**	.27**	.57**
15. COMP2	3.98	.68	.16	.16	.11	.13	.14	.20*	.23*	.21*	.26*	.51**
16. COMP3	4.21	.66	.29**	.26**	.19*	.22*	.24**	.27**	.32**	.26**	.32**	.40**
17. DIRTOI1	2.24	1.58	-.15	-.15	-.11	-.16	-.17	-.18*	-.08	-.15	-.19*	-.27**
18. DIRTOI2	2.25	1.62	-.04	-.07	-.05	-.08	-.10	-.12	-.12	-.09	-.23*	-.20*

Note. $N = 96$. * $p \leq .05$. ** $p \leq .01$

APPENDIX J, Continued

Means, Standard Deviations, and Intercorrelations among Parcels

Parcels	11	12	13	14	15	16	17	18
12. SATUAP1	.39**	--						
13. SATUAP2	.41**	.78**	--					
14. COMP1	.63**	.39**	.46**	--				
15. COMP2	.50**	.32**	.36**	.78**	--			
16. COMP3	.48**	.26**	.34**	.62**	.65**	--		
17. DIRTOI1	-.29**	-.18*	-.16	-.44**	-.49**	-.57**	--	
18. DIRTOI2	-.27**	-.14	-.15	-.36**	-.43**	-.53**	.62**	--

Note. $N = 96$. * $p \leq .05$. ** $p \leq .01$.

APPENDIX K

Covariance Matrix Imputed into LISREL

Parcels	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. LMXP1	3.72	1.01	1.03										
2. LMXP2	3.76	.87	.76	.76									
3. LMXP3	3.42	1.05	.89	.75	1.10								
4. PSSP1	5.62	1.41	1.22	.97	1.15	1.99							
5. PSSP2	5.78	1.48	1.67	.93	1.04	1.84	2.19						
6. PSSP3	5.61	1.37	1.15	.93	1.04	1.66	1.73	1.88					
7. UIE1	3.65	1.35	.90	.77	.83	1.17	1.21	1.12	1.81				
8. UIE2	3.43	1.03	.73	.58	.71	.94	.96	.89	1.08	1.07			
9. UIE3	3.34	.98	.65	.54	.63	.80	.90	.84	1.01	.81	.97		
10. SATRESP1	4.24	.77	.09	.03	.03	.10	.07	.10	.19	.14	.14	.60	
11. SATRESP2	4.36	.66	.15	.08	.10	.17	.17	.21	.14	.14	.14	.42	.44

Note. $N = 96$.

APPENDIX K, Continued

Covariance Matrix Imputed into LISREL

Parcels	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
12. SATUAP1	3.79	.99	.67	.56	.61	.98	1.02	.95	.81	.60	.58	.24	.25
13. SATUAP2	3.64	.89	.47	.41	.52	.76	.83	.78	.73	.52	.52	.20	.24
14. COMP1	4.25	.71	.14	.11	.11	.14	.19	.21	.27	.20	.19	.31	.29
15. COMP2	3.98	.68	.11	.10	.08	.12	.15	.18	.21	.15	.17	.27	.23
16. COMP3	4.21	.66	.19	.15	.13	.21	.24	.24	.29	.18	.21	.20	.21
17. DIRTOI1	2.24	1.58	-.24	-.21	-.18	-.35	-.39	-.38	-.17	-.25	-.29	-.33	-.30
18. DIRTOI2	2.25	1.62	-.07	-.10	-.09	-.18	-.25	-.27	-.27	-.15	-.36	-.25	-.29

Note. $N = 96$.

APPENDIX K, Continued

Covariance Matrix Imputed into LISREL

Parcels	12	13	14	15	16	17	18
12. SATUAP1	.97						
13. SATUAP2	.68	.79					
14. COMP1	.27	.29	.50				
15. COMP2	.22	.22	.37	.46			
16. COMP3	.17	.20	.29	.29	.44		
17. DIRTOI1	-.29	-.22	-.49	-.53	-.59	2.50	
18. DIRTOI2	-.23	-.22	-.41	-.47	-.57	1.59	2.61

Note. $N = 96$.

APPENDIX L

Confirmatory Factor Analyses of the Scales

LMX Scale: Maximum Likelihood Factor Loadings for Lambda X, Theta Deltas, and Squared Multiple Correlations (R^2)

	Factor Loadings	Theta Delta	R^2
ITEM1	.79	.37	.63
ITEM2	.87	.25	.75
ITEM3	.82	.33	.67
ITEM4	.91	.18	.82
ITEM5	.76	.42	.58
ITEM6	.83	.32	.68
ITEM7	.91	.17	.83

Note. $N = 96$. Estimates of goodness-of-fit are: χ^2 ($df = 14$, $p < .01$) = 35.08, GFI = .90, CFI = .98, NNFI = .97, RMSEA = .13. All *t*-values are greater than 2.00.

APPENDIX L, Continued

Perceived Supervisor Support Scale: Maximum Likelihood Factor Loadings for Lambda X, Theta Deltas, and Squared Multiple Correlations (R^2)

	Factor Loadings	Theta Delta	R^2
ITEM1	.84	.29	.71
ITEM2	.77	.40	.60
ITEM3	.70	.51	.49
ITEM4	.89	.20	.80
ITEM5	.83	.31	.69
ITEM6	.92	.16	.84
ITEM7	.93	.17	.83
ITEM8	.79	.38	.62

Note. $N = 96$. Estimates of goodness-of-fit are: χ^2 ($df = 20$, $p < .05$) = 36.00, GFI = .91, CFI = .99, NNFI = .98, RMSEA = .10. All *t*-values are greater than 2.00.

APPENDIX L, Continued

Upward Influence Effectiveness Scale: Maximum Likelihood Factor Loadings for Lambda X, Theta Deltas, and Squared Multiple Correlations (R^2)

	Factor Loadings	Theta Delta	R^2
ITEM1	.86	.26	.74
ITEM2	.90	.19	.81
ITEM3	.89	.21	.79

Note. $N = 96$. Estimates of goodness-of-fit are: χ^2 ($df = 4$, p = .09) = 8.13, GFI = .97, CFI = .98, NNFI = .95, RMSEA = .10. All *t*-values are greater than 2.00.

APPENDIX L, Continued

Satisfaction with Center Research Scale: Maximum Likelihood Factor Loadings for Lambda X, Theta Deltas, and Squared Multiple Correlations (R^2)

	Factor Loadings	Theta Delta	R^2
ITEM 1	.81	.35	.65
ITEM 2	.75	.44	.56
ITEM10	.81	.34	.66
ITEM19	.78	.39	.61
ITEM20	.89	.21	.79

Note. $N = 96$. Estimates of goodness-of-fit are: χ^2 ($df = 5$, p = .06) = 10.51, GFI = .96, CFI = .99, NNFI = .97, RMSEA = .10. All *t*-values are greater than 2.00.

APPENDIX L, Continued

Satisfaction with University Administrator Scale: Maximum Likelihood Factor Loadings for Lambda X, Theta Deltas, and Squared Multiple Correlations (R^2)

	Factor Loadings	Theta Delta	R^2
ITEM13	.84	.29	.71
ITEM15	.54	.71	.29
ITEM16	.92	.16	.84
ITEM17	.65	.58	.42
ITEM22	.87	.24	.76

Note. $N = 96$. Estimates of goodness-of-fit are: χ^2 ($df = 5$, $p = .10$) = 9.20, GFI = .96, CFI = .99, NNFI = .97, RMSEA = .09. All *t*-values are greater than 2.00.

APPENDIX L, Continued

Commitment to the Center Scale: Maximum Likelihood Factor Loadings for Lambda X, Theta Deltas, and Squared Multiple Correlations (R^2)

	Factor Loadings	Theta Delta	R^2
ITEM1	.77	.40	.60
ITEM2	.80	.35	.65
ITEM5	.67	.55	.45
ITEM6	.76	.42	.58
ITEM8	.67	.55	.45
ITEM10	.73	.46	.54
ITEM11	.52	.73	.27
ITEM13	.51	.74	.26
ITEM14	.77	.40	.60
ITEM15	.56	.69	.31

Note. $N = 96$. Estimates of goodness-of-fit are: χ^2 ($df = 35$, $p < .01$) = 101.75, GFI = .81, CFI = .93, NNFI = .91, RMSEA = .15. All *t*-values are greater than 2.00.

APPENDIX L, Continued

Intention to Quit Directing the Center Scale: Maximum Likelihood Factor Loadings for Lambda X, Theta Deltas, and Squared Multiple Correlations (R^2)

	Factor Loadings	Theta Delta	R^2
ITEM2	.79	.38	.62
ITEM3	.79	.37	.63

Note. $N = 96$. Estimates of goodness-of-fit are: χ^2 ($df = 4$, p = .09) = 8.13, GFI = .97, CFI = .98, NNFI = .95, RMSEA = .10. All *t*-values are greater than 2.00.

VITA

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