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ABSTRACT

This research is undertaken to improve innovation prediction. Similarities and differences between physical goods innovation and service innovation are highlighted in order to discover more universal predictors of innovation than those currently available. To do so, this dissertation focuses on the overarching importance of knowledge to any form of innovation. As a result, predictors are employed that emphasize knowledge generation and acquisition. Specifically, internal drivers of innovation based on investments in human capital (i.e. employees) are investigated along with investments in external strategic partnerships vis-à-vis positions of firms in strategic networks. The effectiveness of these predictors is compared to traditional predictors such as research and development and marketing expenditures across three essays and 53 industries. In the first essay, investments in human capital are identified as superior predictors of innovation as compared to research and development and marketing expenditures. In the second essay, position in a network of strategic partners (i.e. centrality, constraint, and range) is assessed as an external predictor of innovation. The results of the second essay suggest that having many strategic partners (being central) and controlling the flow of knowledge among those partners (being unconstrained) are positively related to innovation. Finally, in the third essay, internal and external predictors are combined with the characteristics of strategic partners in a network analysis. The results support the findings of the first two essays and further suggest that firms should consider the resources of both their direct and indirect strategic partners when attempting to innovate. Taken together, the results of the three essays highlight the value of more universal predictors of innovation and suggest that managers and researchers focus on the basics of knowledge creation and acquisition when pursuing innovation.

CHAPTER ONE
INTRODUCTION

Innovation is widely identified as a key strategic imperative for firms seeking sustained competitive advantage (Atuahene-Gima 1996; Baden-Fuller and Stopford 1994; Chen, Lai, and Wen 2006; Dutta and Weiss 1997; Hult 2002; Madhavan and Grover 1998; Matthyssens, Vandenbempt, and Berghman 2006; Sher and Yang 2005; Storey and Easingwood 1999). Indeed, innovative firms experience greater profit margins and larger market shares as a result of increased customer loyalty and limited competitive entry into markets (Cainelli, Evangelista, and Savona 2004; Chaney and Devinney 1992; Ferguson and Hlavinka 2006; Geroski and Machin, 1992; King and Tucci 2002; Marvel and Lumpkin 2007; Matthyssens, Vandenbempt, and Berghman, 2006; Nayyar 1995; Mishra and Bhabra 2001; Sharma and Lacey 2004). Innovative products achieve such outcomes by satisfying existing customer needs, creating demand and preference for new products, and drawing customers away from competitors (Berry, Shankar, Parish, Cadwallader, and Dotzel 2006; King and Tucci 2002; Marvel and Lumpkin 2007). The success of such initiatives is causing many firms to espouse innovation in their mission statements and organizational values (e.g., accenture.com 2008; corporate-ir.net, 2008; nikebiz.com 2008; Parsons 1991; pg.com; solutions.3m.com, 2008).

Definitions of innovation such as "…a firm's tendency to engage in and support new ideas, experimentation, and creativity for the development of new processes" (Lumpkin and Dess 1996, p. 142) emphasize the importance of organizational support for innovation (Das and Joshi 2007). Unfortunately, in spite of the noted value of innovation, firms have limited resources from which to derive innovation (Wajcman 2008). Further, the allocation of such resources is under increasing scrutiny due to weakening economies and a rash of improper business practices (Cooper 2008). In order to successfully innovate, firms need to understand which resource investments are likely to return value for innovation (Lumpkin and Dess 1996, p. 142; Olson, Walker, and Ruekert 1995). The goal of this dissertation is to identify and assess the value of several potentially key factors suggested to impact innovation. The factors identified in this

research are intended to overcome a variety of limitations evident in existing predictors by focusing on basic keys to innovation such as knowledge. This dissertation looks to other potential explanations of successful innovation that are more strongly rooted in the knowledge used to create innovation. Specifically, this dissertation attempts to fill the gaps between concept and practice by empirically investigating relationships among human capital investments, a firm's position in a network of strategic partners, and the characteristics of strategic partners as alternatives to the traditional predictors of innovation.

Prior research highlights the importance of investments in research and development and marketing in innovation (e.g., Chin, Lee, Chi, and Anandarajan 2006; Hall 1993; Henard and Szymanski 2001; Lu and Yang 2004; Mairesse and Mohnen 2002; McAlister, Srinivasan, and Kim 2007; Sorescu, Chandy, and Prabhu 2003). However, studies of such investments are primarily limited to physical goods innovation, overlooking key differences with services (c.f., Damanpour 1991). Specifically, these studies do not typically account for issues such as intangibility, heterogeneity, and simultaneity when predicting innovation (Glazer 1999; Lusch and Vargo 2006; Nijssen, Hillebrand, Vermeulen, and Kemp 2006; Vargo and Lusch 2004). In addition, R&D and marketing are identified as weak predictors of innovation, as they do not always generate intended outcomes (Damanpour 1991; Evangelista, Sandven, Sirilli, and Smith 1998; Nijssen, Hillebrand, Vermeulen, and Kemp 2006; Sundbo 1997). As research and practice evolve toward a more service-centric focus, predictors need to be updated and aligned with more recent conceptual work (Tether 2003).

Research and development investments are identified in the physical goods literature as a key predictor of innovation for their role in prototyping and new materials procurement (Sher and Yang 2005; Veryzer 2005). Unfortunately, such activities are not typical of services, which are by nature intangible (de Jong and Vermeulen 2003; Ettlie and Reza 1992). Few service firms employ R&D departments or report such expenditures on financial statements (Nijssen, Hillebrand, Vermeulen, and Kemp 2006; Tether 2003). Further, outcomes of R&D spending such as patents are typically reserved for physical goods and are not available for intangible processes (Sher and Yang 2005;

Tellis, Prabhu, and Chandy 2007). As a result, research and development is unlikely to be an appropriate predictor of innovation in services contexts.

In addition to R&D, marketing is identified in the physical goods literature as a key innovation predictor for its role in disseminating new product information (Bruce and Cooper 1997, p. 20; Cornish 1997; Karniouchina, Victorino, and Verma 2006; Lilien, Kotler, and Moorthy 1992; Nijssen, Hillebrand, Vermeulen, and Kemp 2006; Peckham 1969, p. 30). However, many services rely more heavily on word-of-mouth strategies than formalized marketing campaigns (Moon and Quelch 2003, p. 499). Further, marketing is often a core or peripheral offering of many services such as advertising, consulting, telecommunications, and Internet firms (Anderson 2005; Christensen and Overdorf 2000; Evangelista, Sandven, Sirilli, and Smith 1998; Sundbo 1997; Sunbdo and Gallouj 2000; Zhao 2006). As a result, the sources of marketing profits and expenditures become complex and are not easily partitioned for the purposes of innovation prediction.

In light of the weaknesses of traditional innovation predictors, it is valuable to develop new, more universal predictors. This dissertation focuses on a common ground between goods and services innovation by considering knowledge as a root of innovation, irrespective of industry (Nix, Lusch, Zacharia, and Bridges, 2008; Olsen and Sallis 2006; Weerawardena 2003). Knowledge is critical to innovation efforts, as it includes awareness of customer needs, how to develop and deliver solutions to those needs, and how to limit competitive duplication of such efforts (Anthony, Johnson, and Sinfield 2008; Froehle, Roth, Chase, and Voss 2000; McDonough, Zack, Lin, and Berdrow 2008; Nix, Lusch, Zacharia, and Bridges 2008).

Whether knowledge is generated internally or acquired externally, its value is enhanced by its diversity (i.e., its ability to suggest new opportunities and solutions)(Chen and Huang 2008; Hitt, Bierman, Shimizu, and Kochhar 2001; Im and Workman 2004; Marvel and Lumpkin 2007). Internal knowledge is typically generated by human capital (e.g., engineers, designers, and researchers) (Chen and Huang 2008; Madsen and Ulhøi 2005; Scarborough 2003). Whether in goods or services industries, individuals identify innovation opportunities, think creatively about problem resolutions, and implement solutions (Becker 1962; Grant and Baden-Fuller 1995). Further, whether

or not funding is specifically allocated for research and development, it takes quality individuals to translate such funding into innovations (Becker 1962; Hurley and Hult 1998; Jaworski and Kohli 1993; Kohli and Jaworski 1990; Mowery, Oxley, and Sliverman, 1996; Sinkula 1994; Slater and Narver 1995). This contention is the basis for examining the role of human capital investments in predicting innovation.

Knowledge gathered outside of firms (i.e., externally) is also expected to enhance innovation (Kale and Singh 2007). External knowledge is often acquired through employee relationships with employees at other firms (i.e., boundary spanning) (Appleyard, Brown, and Sattler 2006; Cross, Yan, and Louis 2000). In fact, strategic partnerships are frequently created expressly for the purposes of innovation (Cross, Yan, and Louis 2000). Such partnerships provide access to a diverse range of knowledge that typically cannot be efficiently generated via internal means alone (Appleyard, Brown, and Sattler 2006; Tatikonda and Montoya-Weiss 2001). Investments in strategic partnerships, and the characteristics of those partnerships, are therefore identified as additional predictors of innovation in this dissertation. To fulfill the goal of this dissertation, and examine the value of internal and external knowledge on innovation, the components are analyzed in a sequence of three essays.

The objective of the first essay is to examine the value of internal investments in generating innovation. Specifically, human capital investments (i.e., those made in employees) are compared to traditional investments such as research and development and marketing expenditures on its ability to predict innovation. According to human capital theory, greater investments in employees are expected to result in improved performance to firms via superior skills and knowledge.

Information obtained from the COMPUSTAT database and innovation rankings from *Fortune's* Most Admired Companies database provide the data for this comparative study. COMPUSTAT contains 45 years worth of operational characteristics for over 28,500 US companies. The *Fortune* rankings are aggregated perceptions of 16,000+ executives, directors, and financial analysts in the industries of interest. These sources have been used extensively in a number of prior studies (e.g., Barber, Heath, and Odean 2003; Berry, Shankar, Parish, Cadwallader, and Dotzel 2006; Brammer, Brooks, and

Pavelin 2006; Hsu 2006; Markovitch, Steckel, and Yeung 2005; Prabhu, Chandy, and Ellis 2005).

The objective of the second essay is to examine potential external drivers of innovation. Specifically, Essay 2 assesses the importance of a firm's position in a network of strategic partners. For example, it is suggested that organizations with more strategic partners and more control over knowledge flows are able to maximize their knowledge intake and minimize unnecessary overlaps (Dyer and Nobeoka 2000; Madhavan, Koka, and Prescott 1998; Powell, Koput, and Smith-Doerr 1996). This improves an organization's response time and its speed to market, both of which are critical advantages for both goods and service organizations that compete using incremental process improvements (Das and Joshi 2007). Social network analysis is utilized to identify those relational characteristics that improve an organization's access to external knowledge and its impact on innovation (Sheremata 2000).

The data for the second study's dependent variable (innovation ranking) are the same as those utilized in Essay 1, while the network characteristics (e.g., centrality, constraint, and range) are computed from the SDC Platinum: Alliances Database (2000-2005). The SDC database provides alliance announcements from press wires such as *Dow Jones*, business periodicals such as *Wall Street Journal*, and other trade magazines. It has also been used in a number of prior studies (e.g., Barber, Heath, and Odean 2003; Berry, Shankar, Parish, Cadwallader, and Dotzel 2006; Brammer, Brooks, and Pavelin 2006; Hsu 2006; Markovitch, Steckel, and Yeung 2005; Prabhu, Chandy, and Ellis 2005).

The objective of the third essay is to examine internal and external innovation drivers, while also considering the characteristics of strategic partners. Such an analysis allows for a broader range of knowledge inputs to be considered when predicting innovation. Specifically, it is suggested how the characteristics of strategic partners may be just as important as simply having many strategic partners from which to draw knowledge.

Unfortunately, traditional analysis techniques such as those used in the first two essays (e.g., OLS regression) do not allow the effects of different types of resources to be considered simultaneously. That is, the impact of resources provided by multiple key

allies (partners) cannot be properly assessed without more advanced methods such as spatial econometric modeling. Thus, it is difficult for managers to determine the appropriate mix of relationships needed to drive innovation. To accomplish this task, a statistical technique similar to spatial econometrics is utilized to account for both internal and external firm characteristics. By utilizing spatial econometrics, the optimal mix of tangible and intangible resources can be identified. The SDC alliance data and the COMPUSTAT operational data are both used in Essay 3 to predict innovation, which is again based on *Fortune* magazine's yearly innovation rankings.

CHAPTER TWO
ESSAY 1: A HUMAN CAPITAL PERSPECTIVE ON INNOVATION

INTRODUCTION

Innovation is often regarded as a key component of sustainable competitive advantage (Baden-Fuller and Stopford 1994). Accordingly, organizations that successfully innovate typically experience larger profits and have more loyal customers than their less innovative counterparts (Storey and Easingwood 1999). As a result, many companies emphasize innovation as a key component of their competitive strategy. The emphasis on innovation is evident in the mission statements and business values of leading companies, such as "…our No. 1 goal - helping our clients innovate…" (accenture.com 2008) and "Our goal is to carry on his legacy of innovative thinking…" (nikebiz.com 2008).

As competition in many markets intensifies and world economies continue to falter, firms are becoming more reliant on innovation efforts for basic survival (BusinessWeek 2008). Specifically, profit margins are shrinking, resource investments are under increasing scrutiny, and organizational executives are being held responsible for sound decision-making (Cooper 2008). As a result, there is a growing need for firms to innovate in order to generate sales, while simultaneously using fewer resources. Firms have limited capital to invest in innovation and need to decide which investments yield the best results. Proper allocation of resources for innovation is thus a critical factor in determining a firm's longevity. Firms that ineffectively allocate and manage resources risk extinction.

Management of innovation is made more critical by accelerating technological advances and changing consumer preferences (Wajcman 2008). For example, the environmental focus evident in directives such as "going green" and "sustainability" are becoming important innovation issues (e.g., Gunther 2008; Mitchell 2003). As a result of changing conditions, organizations are forced to continually reinvent their offerings to remain competitive (Menor, Tatikonda, and Sampson 2002). To maintain or grow

profits, organizations need to continually develop and manage resources for innovation in order to appeal to existing and new customers. Specifically, such processes require attention to, integration of, and institutionalization of, new ideas and resources (Sorescu and Spanjol 2008; van de Ven 1986).

Prior research identifies research and development (R&D) and marketing as key innovation resources (e.g., Chin, Lee, Chi, and Anandarajan 2006; Hall 1993; Mairesse and Mohnen 2002). Research and development is so identified based on its support of new product development (e.g., new materials and new machinery) (Sher and Yang 2005; Veryzer 2005). Marketing is highlighted for its part in communicating new product rollouts (Nijssen, Hillebrand, Vermeulen, and Kemp 2006). However, substantial limitations exist related to how these investments encourage innovation (particularly service innovation) (c.f., Damanpour 1991). For example, services rarely employ R&D departments or report R&D on financial statements due to issues of intangibility (Nijssen, Hillebrand, Vermeulen, and Kemp 2006; Sundbo 1997). In addition, research and development and marketing are weak predictors of innovation even in physical goods industries (Evangelista, Sandven, Sirilli, and Smith 1998).

Another potential driver of innovation noted in the management and economics literatures is human capital (i.e., employees and their capabilities) (Hitt, Bierman, Shimizu, and Kochhar 2001; Jones and Schneider 2006; Lepak and Snell 1999; Snow and Warren 1990). Human capital is described as the cornerstone of creative thinking, knowledge generation, and innovation management (Chen and Huang 2009; Hitt, Bierman, Shimizu, and Kochhar 2001; Im and Workman 2004; Marvel and Lumpkin 2007). Accordingly, investments in human capital are posited to be a significant piece of the innovation puzzle and a quintessential component of innovation strategy.

Unfortunately, studies of human capital tend to limit their focus to either macro-economic issues such as the average skill base of entire nations (e.g., Jones and Schneider 2006; Snow and Warren 1990) or micro issues such as human resource development strategies (e.g., Chen and Huang 2009; Hitt, Bierman, Shimizu, and Kochhar 2001; Lepak and Snell 1999; Marvel and Lumpkin 2007). While such research is noteworthy, these areas do not specifically address the role of investments in human capital at the firm

level, or their potential impact on innovation. The research presented attempts to fill this gap by empirically investigating the relationship between human capital investments and innovation outcomes using firm-level data. Specifically, the objective of this research is to assess the potential impacts of different resource investments on innovation. In addition, the ability of human capital investments to explain innovation in service and goods firms is compared to R&D and marketing investments.

The rest of the article is organized as follows: First, a conceptual framework is developed, whereby innovation is cast as the outcome of various strategic investments. Next, the limitations of traditional predictors, such as R&D and marketing expenditures, are discussed in the context of recent shifts in theory and conceptualization. Human capital theory is introduced as a potentially valuable basis for predicting innovation. Next, the data sources are described and the results of the analysis detailed. The article concludes with a discussion of managerial and theoretical implications along with potential limitations and directions for future research.

CONCEPTUAL FRAMEWORK

This section describes the relationships investigated. The conceptual model that defines the relationships is identified in Figure 2.1. The innovation predictors identified on the left side of the figure are hypothesized to lead to innovation (see the right side of the figure). The first investments identified are the traditional predictors of innovation (R&D and marketing expenditures). Human capital is then identified in the middle of the figure as a potentially more universal predictor of innovation. The control variables that may also impact innovation are noted in the bottom part of the figure.

The benefits of innovation

Innovation is an established catalyst for firm performance and competitive advantage (Madhavan and Grover 1998; Sharma and Lacey 2004; Sher and Yang 2005; Storey and Easingwood 1999). Specifically, it is suggested that firms' efforts to innovate positively affects existing products, customer choice, and preferences for new products,

and competitive market dynamics (King and Tucci 2002; Marvel and Lumpkin 2007). Thus, innovation is expected to bolster long-term performance by increasing profit margins, generating customer loyalty, and limiting competitive entry into markets (Ferguson and Hlavinka 2006).

Existing products primarily benefit from innovation in complementary product categories that create resurgence in demand for established products. For example, advances in computer memory, processor speed, and software cause computers to obsolesce at rapid rates, creating a constantly renewing cycle of demand for new computers (Whelan 2002). Further, innovation aids existing products through updates that prolong product lifecycles and stave off product declines (Berenson and Mohr-Jackson 1994). Beer producers continue to update packaging (e.g., aluminum bottles, temperature indicating labels, and carbon dioxide distribution systems) despite the product's existence for thousands of years. Such innovations can sustain or even rejuvenate brand image, motivate current customers to increase their share-of-wallet to a firm, or increase positive word-of-mouth (King and Tucci 2002).

In addition to existing customers, innovation draws new customers to firms and simultaneously diminishes the customer bases of competitors (Storey and Easingwood 1999). New customers increase market share and aid in generating economies of scale, as relative costs often decrease substantially as a function of the number of product adopters (Jovanovic and MacDonald 1994). Further, such actions also pave the way for future products by reducing the effort required to position a product and induce trial (Jovanovic and MacDonald 1994).

In summary, innovation translates into substantial advantages in the marketplace. Specifically, innovation creates new markets, reenergizes existing markets, and provides competitive differentiation. These advantages justify such strategies as price skimming and image pricing, which generate increased profits (Garrido-Rubio and Polo-Redondo 2005). To achieve these advantages, managers need to understand what resource investments to make in order to optimize innovation efforts. In line with the research objectives, the next two sections discuss resource investments for innovation.

Traditional Resource Investments

Research and development and marketing expenditures are identified (see Figure 2.1) as traditional resource investments that lead to innovation (Bruce and Cooper 1997, p. 20; Sher and Yang 2005; Veryzer 2005). Definitions of innovation such as "…a firm's tendency to engage in and support new ideas, experimentation, and creativity for the development of new processes" (Lumpkin and Dess 1996, p. 142) emphasize the importance of organizational support for innovation vis-à-vis investments in such resources. As a result, the physical goods literature suggests that R&D and marketing expenditures positively relate to innovation (e.g., Veryzer 2005).

Innovative firms typically invest more in research and development than less innovative firms (Sher and Yang 2005; Veryzer 2005). Such investments often increase due to the need to procure new materials and equipment for product development (Wouters, Anderson, Narus, and Wynstra 2009). New items frequently incur greater costs as component procurement and production initially lack economies of scale (Wouters, Anderson, Narus, and Wynstra 2009). Innovative firms also invest a great deal in prototyping, which generates large amounts of waste until production processes are honed for the final product (Wheelwright and Clark 1992).

The impacts of innovation continue to be extolled in trade publications such as BusinessWeek (e.g., BusinessWeek April 28, 2008). For example, Google's CEO suggests that innovative firms invest heavily in R&D spending even in recessions (BusinessWeek April 28, 2008). This statement is backed up by a 72 percent increase in R&D spending at Google in 2007 despite a declining economy (BusinessWeek April 28, 2008). Such statements and actions are typical of firms that stress innovation as a key competitive activity.

In addition to R&D, marketing expenditures are typically high for innovative firms, as new products require more intense marketing efforts to support initial rollouts (Bruce and Cooper 1997, p. 20). Specifically, marketing expenses tend to rise as the number of new products increases. This is a result of continual efforts to build customer awareness and knowledge about new products. The cost of such efforts can be substantial for innovations due to customers' lack of familiarity with new product

features, advantages, and uses (Karniouchina, Victorino, and Verma 2006). In other words, marketing communications intensify as firms position new products and motivate customers to pursue desirable behaviors such as trial and repeat purchase. These efforts reduce the benefits that normally accrue from economies of scale as firms update their messages to stay consistent with new competitive offerings (Nijssen, Hillebrand, Vermeulen, and Kemp 2006).

Despite the noted advantages of R&D and marketing expense as innovation predictors, each has several disadvantages. First, most of the literature regarding R&D and marketing effects is based on physical goods innovation (e.g., Cornish 1997; Lilien, Kotler, and Moorthy 1992). As academics and practitioners begin to focus more heavily on services, the impact of service idiosyncrasies such as heterogeneity, intangibility, perishability, and simultaneity calls into question the transferability of knowledge related to physical goods innovation to services (Nijssen, Hillebrand, Vermeulen, and Kemp 2006). Second, R&D and marketing are often identified in the literature as weak predictors of innovation because such investments do not always lead to desired outcomes (Damanpour 1991; Evangelista, Sandven, Sirilli, and Smith 1998; Nijssen, Hillebrand, Vermeulen, and Kemp 2006; Sundbo 1997). This is particularly true in services where R&D investments are rarely reported on financial statements and marketing success may be more a result of word-of-mouth than of formal marketing efforts (Nijssen, Hillebrand, Vermeulen, and Kemp 2006; Sundbo 1997). Third, both goods and services firms rely on human capital to transform investments into innovative outcomes. Such reliance on human capital suggests that investments in employees are perhaps better predictors of innovation than R&D and marketing expenditures. To overcome potential limitations of existing innovation predictors, the research presented suggests that human capital investments represent a potentially powerful predictor of innovation.

The Role of Human Capital in Innovation

Human capital theory primarily describes the role of people in generating performance (Becker 1962). Employees are seen as a firm resource, much like financial

capital, that can be strategically deployed to achieve objectives (Barney 1991; Hitt, Bierman, Shimizu, and Kochhar 2001). As with financial capital, greater human capital is thought to be beneficial to firms (Lepak and Snell 1999). Unlike financial capital, however, human capital is an abstract concept referring primarily to intangible skills and knowledge rather than easily quantified investments (Jones and Schneider 2006). The value of employees in innovation efforts is reflected in the returns firms earn on innovation as a result of investments in human capital (Shrader and Siegel 2007). That is, employees with better skills and knowledge are shown to effectively contribute to the development and implement of innovations (e.g., Siegel, Waldman, and Youngdahl 1997). According to human capital theory, firms compensate employees for the value such skills return to the firm (Lepak and Snell 1999).

Human capital research focuses on identifying and assessing skills that benefit firms (e.g., Jones and Schneider 2006; Kessler and Lülfesmann 2006). Specifically, unique and valuable skills are suggested to foster performance and competitive advantage (Kessler and Lülfesmann 2006; Lepak and Snell 1999). Skills such as opportunity recognition, creative idea generation, problem solving, and risk coping are identified as the lifeblood of innovation (Chen and Huang 2009; Madsen and Ulhøi 2005). These skills allow employees to contend with the relatively high levels of uncertainty inherent in innovation processes (Atuahene-Gima 1996; Johne and Storey 1998; Nijssen, Hillebrand, Vermeulen, and Kemp 2006; Smith and Fischbacher 2005). Further, lack of skill and experience is designated as a key barrier to product development and financial success (Drew 1995). Such findings are identified from entry-level employees to top executives (Buchholtz, Ribbens, and Houle 2003) and highlight the potential value of human capital to innovation.

In addition to skills, employee knowledge drives innovation (Becker 1964; Lepak and Snell 1999; Marvel and Lumpkin 2007). According to the knowledge-based view of the firm, knowledge is a renewable resource that employees acquire through formal education and "on-the-job" learning (Grant 1996; Hitt, Bierman, Shimizu, and Kochhar 2001). Employees combine these forms of knowledge and adapt them in order to respond to ever changing business problems (Leonard and Sensiper 1998).

Knowledge, like skill, is shown to benefit innovation by increasing opportunity recognition and problem solving, while limiting the ability of competitors to duplicate it (Becker 1964; Chen and Huang 2009; Hansen 1999; Hitt, Bierman, Shimizu, and Kochhar 2001; Leonard and Sensiper 1998; O'Connor and Veryzer 2001). Such capabilities lead to lower costs, enhanced product offerings, and competitive differentiation (Prahalad 1983). Further, knowledge often lends itself to innovation by being firm specific and socially complex, reducing its potential for mobility to other firms (Chen and Huang 2009; Youndt, Snell, Dean, and Lepak 1996).

Benefits derived from human capital, whether in services or physical goods markets, typically are not without cost. That is, they are exchanged for other resources (Becker 1962). For example, firms exchange financial resources via employee compensation for the knowledge created and acquired by its employees (Becker 1962, 1964; Huther 2000). If either fails to uphold its end of the exchange, the relationships often become less effective or are terminated. Workers typically refuse to work for less compensation than their perceived relative worth (Lepak and Snell 1999; Ployhart, Weekley, and Baughman 2006). Specifically, firms do not typically provide superior compensation in exchange for substandard performance (Becker 1962; Ployhart, Weekley, and Baughman 2006). Exceptions to this rule undoubtedly exist, but human capital theory generally suggests that firms and employees seek equity in their exchanges (Becker 1962).

According to human capital theory, it is imperative to properly compensate individuals for skills and knowledge that contribute to innovation (Atuahene-Gima, 1996; Becker 1962; Marvel and Lumpkin 2007). For firms seeking innovation, compensation should be designed specifically to engender creativity, problem solving, and risk taking (Chen and Huang 2009; Delery and Doty 1996; Laursen and Foss 2003; MacDuffie 1995; Mumford 2000; Von Krogh 1998; Youndt, Snell, Dean, and Lepak 1996). A large amount of research suggests that pensions are among the most important forms of compensation for recruiting, retaining, and motivating quality employees (e.g., Coronado, Mitchell, Sharpe and Nesbitt 2008; Gough and Hick 2009; Loretto, White, and Duncan 2000; Terry and White 1997). Pensions represent compensation above and beyond basic

wages and are "subsidized" by firms rather than by employee (Loretto, White, and Duncan 2000). As a result, companies offering pension plans are seen as caring and as fulfilling their psychological contracts with their employees (Terry and White 1997).

Unfortunately, given the dire consequences associated with shrinking resource availability, many firms are emphasizing cost-cutting strategies instead of growth strategies, whereby resource investments are reduced (BusinessWeek 2008). A key area in which firms are seeking to trim excess cost is in human capital investments. Specifically, pension plans are being cut out of compensation packages in order to reduce financial burdens (Golding 2008).

Cutting pension plans reduces employee motivation and loyalty and increases turnover (Golding 2008). For example, some of the most under-funded pension plans belong to airlines, while better-funded plans exist in the financial services sector (Sahadi 2007). The discrepancy in pensions is coupled with noted praise in the marketplace for financial service innovations (Gentle 2007) and rebuke for a lack of innovation in airlines (Kochan 2008). Emphasizing cost cutting over growth often leads to efficiency, but not necessarily to effectiveness (Byrne, Lubowe, and Blitz 2007). Short-term benefits associated with cutting human capital costs therefore may reduce a firm's ability to innovate and cause it to mortgage its long-term survivability in favor of meeting immediate performance demands.

Advantages of human capital over traditional predictors

Investments in human capital have several advantages over traditional innovation drivers such as investments in research and development and marketing. First, people are critical, yet often overlooked, drivers of innovation in both goods and services (Lepak and Snell 1999; Pfeffer 1994). All organizations rely on some amount of human activity in order to deliver services and produce physical goods, thereby placing a substantial burden for success in the hands of employees (van de Ven 1986). This suggests a labor-intensive view of innovation and indicates that firms should account for organizational factors such as employee compensation when seeking innovation (Srinivasan, Lilien, and Rangaswamy 2002). Human capital is a primary means through which firms achieve

goals (Chen and Huang 2009). More specifically, innovation depends on the knowledge and expertise of employees to translate investments into outcomes (Youndt, Snell, Dean, and Lepak 1996). Capabilities that bolster innovation are necessarily complex and result from deliberate actions by educated and experienced workers with a desire to perform innovative actions (Becker 1964; Chen and Huang 2009; Marvel and Lumpkin 2007).

Second, human capital investments are potentially more universally applicable than other investments. Specifically, innovation drivers (resource investments) have not been adequately updated to account for the aforementioned service idiosyncrasies that may render established predictors ineffective. Further, research and development and marketing investments are much less pronounced and much less stable predictors of innovation, particularly in services (Damanpour 1991; Evangelista, Sandven, Sirilli, and Smith 1998; Nijssen, Hillebrand, Vermeulen, and Kemp 2006; Sundbo 1997). However, capable personnel are universally identified as key ingredients in innovation irrespective of industry (Hitt, Bierman, Shimizu, and Kochhar 2001; Jones and Schneider 2006; Lepak and Snell 1999; Snow and Warren 1990).

DATA AND METHODS

Data sources and sample

The data set is constructed from two sources (COMPUSTAT and *Fortune's* Most Admired Companies) for the years 2005-2008. COMPUSTAT is a Standard & Poor's database containing financial data for over 45 years and more than 28,000 companies. The *Fortune* rankings are generated each year by the Hay Group and are part of *Fortune's* Most Admired Companies list. To arrive at the list, the Hay Group surveys over 16,000 executives, directors, and financial analysts in over 65 industries about Fortune 1,000 companies. The final sample includes 251 goods firms and 367 service firms that can be matched between the databases in the available years.

Secondary data sources are utilized because they are consistent with the objectives of this study. Specifically, secondary data sources provide access to a wide array of information, which promotes generalizability. Further, *Fortune* rankings and

COMPUSTAT data are utilized in a variety of prior finance, management, and marketing research and are suggested to be valid measures of firm characteristics (e.g., Brammer, Brooks, and Pavelin 2006; Wiles 2007). For example, Brammer and colleagues (2006) assess the link between social responsibility via *Fortune* rankings and stock returns. Their findings indicate that social responsibility and financial performance are negatively related. In addition, Wiles (2007) utilizes *Fortune's* Most Admired Companies data and COMPUSTAT data to examine the relationship between customer service and retail shareholder wealth. His findings suggest that firms benefit from customer service initiatives.

In this study, data on human capital, R&D, and marketing expenditures are regressed upon innovation rankings, while controlling for firm size, prior performance, and goods versus services industry. Each component of the regression is discussed in greater detail below. The variables, their operationalizations, and data sources are summarized in Table 2.1.

Operationalization of variables

Variable transformations. Operational variables often exhibit heavy skewness (violating the assumption of normality) and therefore need to be normalized (Gruca and Rego 2005). For example, the number of small firms is typically much greater than the number of large firms, causing the statistical distribution to be skewed toward low values for size. Normalizing the variables reduces the extent to which outliers with high values impact the results. The total assets, pension, R&D and marketing expenditures, and Tobin's Q data for this study are no different. Thus, each is transformed via natural log function (e.g., Luo and Bhattacharya 2006). Further, as innovation is scored from 1 to 11 (highest to lowest), the scores of the predictor and control variables are reversed (i.e., multiplied by –1) so that higher scores have lower values (numbers).

In addition, innovation efforts themselves may differ by industry. For example, semiconductors are likely considered to be more innovative than job placement services. Therefore, it is also useful to account for potential industry differences (Zenkin and Dolya 2007). The *Fortune* data, however, do not account for these relative differences.

Predictor and control variables are therefore standardized within each industry. Specifically, the industry mean for the variable is subtracted from each observed value in the industry and is then divided by the standard error for the variable in each industry. This transformation makes each firm's values relative to others in its industry, which is similar to the measure of innovation. In other words, industry standardization allows industries with very different market dynamics to be directly compared.

Innovation. In accordance with prior research (e.g., Luo and Bhattacharya 2006), industry rankings from *Fortune* are used to operationalize innovation. The database provides rankings from 1 to 11 (highest to lowest) for firms within each industry based on survey results provided by industry experts. Innovation therefore begins as a latent construct created from expert opinions and is transformed into industry rankings.

R&D investments. In this research, firms' R&D investments are operationalized through R&D expenditures (e.g., Gruca and Rego 2005; Luo and Bhattacharya 2006). Such expenditures serve as proxies of firms' commitments to research, and accordingly, to innovation. Data on R&D expenditures are collected from COMPUSTAT.

Marketing investments. Firms' investments in marketing are operationalized via their advertising expenditures (e.g., Zenkin and Dolya 2007). While marketing encompasses much more than advertising, advertising expenditure, as measured by COMPUSTAT, exhibit advantages as a proxy measure for marketing investments. For example, COMPUSTAT data typically include marketing expenditures beyond what is specifically spent on advertising initiatives (Zenkin and Dolya 2007). In addition, promotional expenditures of any sort have been shown to indicate a firm's level of commitment to marketing efforts (Luo and Bhattacharya 2006).

Human capital investments. Following suggestions from prior research (e.g., Chou 2007), relative annual pension expense acts as the proxy for employee compensation in this research. Pensions are chosen over labor expense for two key reasons. First, labor expense is often aggregated on financial statements under Sales and General Administrative expenses, which occasionally include non-employee related expenses. As a result, it is difficult to effectively separate employee expenses and other expenses. Second, pensions represent compensation above and beyond regular

wages/salaries. Thus, pensions may be stronger indicators of firms' commitments to human capital than simply paying employees more money (Coronado, Mitchell, Sharpe and Nesbitt 2008; Gough and Hick 2009; Loretto, White, and Duncan 2000; Terry and White 1997).

Control variables. Control variables are included in the model to create better estimates of the research variables' contributions. Specifically, control variables remove explained variance in the research variables resulting from related factors. For example, larger firms are likely to have larger R&D budgets than small firms. Thus, including firm size as a control removes any explanatory power from R&D that is truly the result of firm size rather than the R&D spending itself. Control variables, therefore, allow for a more pure assessment of the explanatory power of the research variables.

Consistent with prior strategic research, firm size, performance, and industry are controlled (e.g., Luo and Bhattacharya 2006). Total assets are employed as a proxy for firm size, as they represent physical parts of firms that are not easily liquidated (Aboulnasr, Narasimhan, Blair, and Chandy 2008). Firm size is controlled because larger firms are likely to have greater resources and therefore economies of scale when seeking innovation (Cohen and Klepper 1996; Luo and Bhattacharya 2006). The total asset data are collected from COMPUSTAT. In addition to firm size, better performing firms are also expected to have more resources for innovation (Cohen and Klepper 1996). Prior performance vis-à-vis Tobin's Q is also controlled in the model. Finally, industries are categorized as either goods (0) or services (1) to highlight any potential industry differences in the data or other variables. A combination of *Fortune's* industry categories and Standard Industrial Classification codes from COMPUSTAT are used to classify firms as goods or services.

RESULTS

Descriptive Statistics

The descriptive statistics for the dependent, independent, and control variables are provided in Table 2.2. Low median values for employee compensation ($Median_{2005}$ =

$41,400; Median$_{2006}$ = $47,610) and negative minimums (Min$_{2005}$ = -$973,000; Min$_{2006}$ = -$714,000) support the notion that firms are reducing and eliminating pensions. Negative pension minimums are indicative of pension fund reductions (i.e., firms pulling money out of the funds). Despite having a data set composed strictly of *Fortune* 1000 firms, there is still a wide range of firm sizes, R&D and marketing investments, and performance levels represented. Having a wide range of firms represented in the data enhances the generalizability of the results.

Determinants of Innovation

The results of the hierarchical regression are provided in Table 2.3. There is a lack of significance in the goods versus services control ($\beta = .01$, $p > .46$), which suggests a lack of industry difference in the results. Research and development ($\beta = .08$, $p < .05$) and marketing ($\beta = .11$, $p < .01$) are significantly related to innovation when initially introduced into the model. These findings support prior research identifying the value of such metrics in predicting innovation. Despite each variable's significance, resulting gains in explanatory power beyond that of the control variables is relatively modest ($\Delta R^2_{step\ 2} = .006$, $p < .05$; $\Delta R^2_{step\ 2} = .011$, $p < .01$). Adding the human capital investments to the model nearly doubles the explanatory power ($\Delta R^2_{step\ 3} = .057$, $p < .001$). Further, human capital investments are shown to be positive predictors of innovation ($\beta = .25$, $p < .001$), which supports the notion that investing in employees is a valuable part of fostering innovation. The ultimate explanatory power of the model with all variables entered ($R^2 = .131$) is consistent with other research findings in corporate strategy and innovation (c.f., Brush and Bromiley 1997).

DISCUSSION

The objective of this research was to examine the value of human capital as a predictor of innovation. More specifically, this research assessed the relative importance of human capital investments versus traditional investments in R&D and marketing. The research results suggest that human capital investments are useful predictors of

innovation. In addition, the results suggest that human capital investments provide a better, more universal explanation for innovation than traditional predictors. The effects are consistently positive across both goods and services industries. Implications of the findings for theory and practice are discussed next.

Managerial Implications

The results have considerable relevance to practitioners in both goods and service sectors. Specifically, the findings suggest that firms desiring to compete on innovation need to be willing to invest heavily in human capital (e.g., training, pay, and supplemental employee support) to entice, retain, and benefit from high quality employees. As companies continue to shrink and eliminate pensions and other employment perks, the ability to maintain such benefits becomes rare, valuable, and not easily imitated (Barney 1991). Hence, investments in human capital represent a competitive advantage for firms. Further, the similarity of results across both goods and services industries implies that, irrespective of industry, practitioners need to recognize the importance of people in innovation efforts.

Practitioners are also cautioned to prevent overemphasizing research and development and marketing spending at the expense of employee support. A great deal of business and academic literature espouses the benefits of each in successful innovation, while ignoring other potential explanations such as human capital. This limited focus, unfortunately, fails to recognize the underlying reality that it takes high quality people to generate innovation. Losing quality personnel as a function of poor compensation is expected to render innovation efforts less effective. Practitioners are therefore advised to seek greater balance between investments in human capital, research and development, and marketing.

Theoretical Implications

Human capital theory has a rich tradition in a variety of fields such as strategic management, organizational behavior, sociology, and economics dating back to the 1700s (Becker 1964; Marvel and Lumpkin 2007). However, many other research streams (e.g.,

innovation, services, and personal selling) rely heavily on human elements, yet are devoid of human capital theory consideration. Researchers in these areas need to make greater strides toward adopting and adapting human capital theory to address innovation.

This research makes initial inroads into the theoretical bases of human capital as they pertain to innovation. Specifically, human capital investments are shown to generate superior innovation irrespective of industry. This finding is important to researchers, as it identifies a new, powerful, and more universal innovation driver than previously available. In addition, establishing the effectiveness of human capital as an innovation driver provides evidence for the importance of human capital theory to research and practice.

Limitations and Future Research

The research has several potential limitations. First, this research measures human capital, organizational innovation, and organizational performance at an industry level. Such a perspective lends itself well to generalizability, as a multitude of different firms are included in the sample from both goods and services industries. Unfortunately, it also limits the extent to which more specific nuances of knowledge creation and usage can be assessed, as such analyses require information from inside firms (e.g., surveys of employees and managers). The current study provides a broad theoretic perspective, which aids in the generalizability of future research conducted in micro scale. Specifically, the research findings represent industry-wide (i.e., macro scale) support for the importance of human capital investments in innovation.

A firm can utilize differences in human capital expenditures to gauge its innovation efforts versus key competitors. In addition, it might be useful to know what combination of human capital, R&D, and marketing investments are optimal for firms within given industries and what other firm-specific characteristics impact such calculations. For example, the extent of product customization, industry maturity, the extent of internationalization, and the average skill level of the labor pool may impact the ability of resources to be deployed. As a result, certain resources may become more important than others.

The variables selected for this study represent a second potential limitation. Despite the aggregate of the *Fortune* innovation rankings, they represent only one measure of innovation. Further, the measure is from an industry expert perspective rather than from an end user's perspective. Differences may exist when alternative sources are used for gauging innovation. Currently, *Fortune* represents one of the only widely available and known multi-industry set of innovation rankings. Similar research should use new measures of innovation as they become accepted. Despite this limitation, *Fortune's* Most Admired Companies list is recognized, respected, and utilized in both industry and academic research.

Classifying firms as goods or services via SIC code represents a final potential limitation in this research. While SIC codes are a valuable means of classification, firms may have multiple business units that include both goods and services. As a result, the primary SIC code identified for each company may not effectively distinguish goods from service firms. Future research should investigate alternative classification schema and revisit the potential similarities between goods and service firms posed in this research.

TABLE 2.1: VARIABLES AND DATA SOURCES

Conceptual Variable	Measured Variable	Data Source
Dependent Variable		
Innovation	Average industry ranking from industry experts	*Fortune's* M.A.C.
Human Capital Variable		
Employee Compensation	Average pension standardized by industry	*Fortune's* M.A.C.
Other Predictor Variables		
R&D	Research and development expenditures standardized by industry	COMPUSTAT
Advertising	Advertising expenditures standardized by industry	COMPUSTAT
Control Variables		
Firm Size	Natural Logarithm of total assets	COMPUSTAT
Performance	Natural Logarithm of Tobin's Q	COMPUSTAT
Goods or Services Industry	Goods = 0; Service = 1	*Fortune's* M.A.C.

Note: M.A.C. = Most Admired Companies.

TABLE 2.2: DESCRIPTIVE STATISTICS

Variable	Mean	SD	Min	Median	Max	Skewness
Dependent Variable						
Innovation 2006	5.09	2.77	1	5	10	.173
Innovation 2007	5.17	2.77	1	5	10	.126
Tradition Investment Variables						
Advertising 2005[a]	533.44	1,015.45	.50	158.12	5,919.82	3.47
Advertising 2006[a]	549.79	1,052.28	.70	156.46	6,866.40	3.77
R&D 2005[a]	676.96	1,527.79	0	103.00	9,094.00	3.23
R&D 2006[a]	732.64	1,459.37	0	112.99	8,258.00	2.98
Human Capital Variable						
Average Pension 2005 [a]	138.43	298.92	-973.00	41.40	2,496.00	3.96
Average Pension 2006 [a]	166.68	451.90	-714.00	47.61	4,939.70	6.72
Control Variables						
Total Assets 2005[a]	54,320	146,808	363	7,747	1,494,037	6.18
Total Assets 2006[a]	48,721	122,460	208	10,154	1,632,104	4.74
Tobin's Q 2005	1.49	4.63	.003	.86	101.25	18.19
Tobin's Q 2006	1.98	6.44	.001	.91	210.62	16.87

[a]: thousands

TABLE 2.3: HIERARCHICAL REGRESSION ANALYSIS

Variable	Step 1 (Controls)	Step 2 (R&D)	Step 3 (Advertising)	Step 4 (Average Pension)
Total Assets	.06	.04	.04	.00
Tobin's Q	.23***	.23***	.23***	.26***
GS	.01	.03	.03	.01
R&D		.08*	.06	.02
Advertising			.11**	.09*
Average Pension				.25***
R^2	.053	.059	.070	.127
Change in R^2	.053***	.006*	.011**	.057***

* $p < .05$, ** $p < .01$, *** $p < .001$

Note: Standardized betas are shown, GS = Good or Service

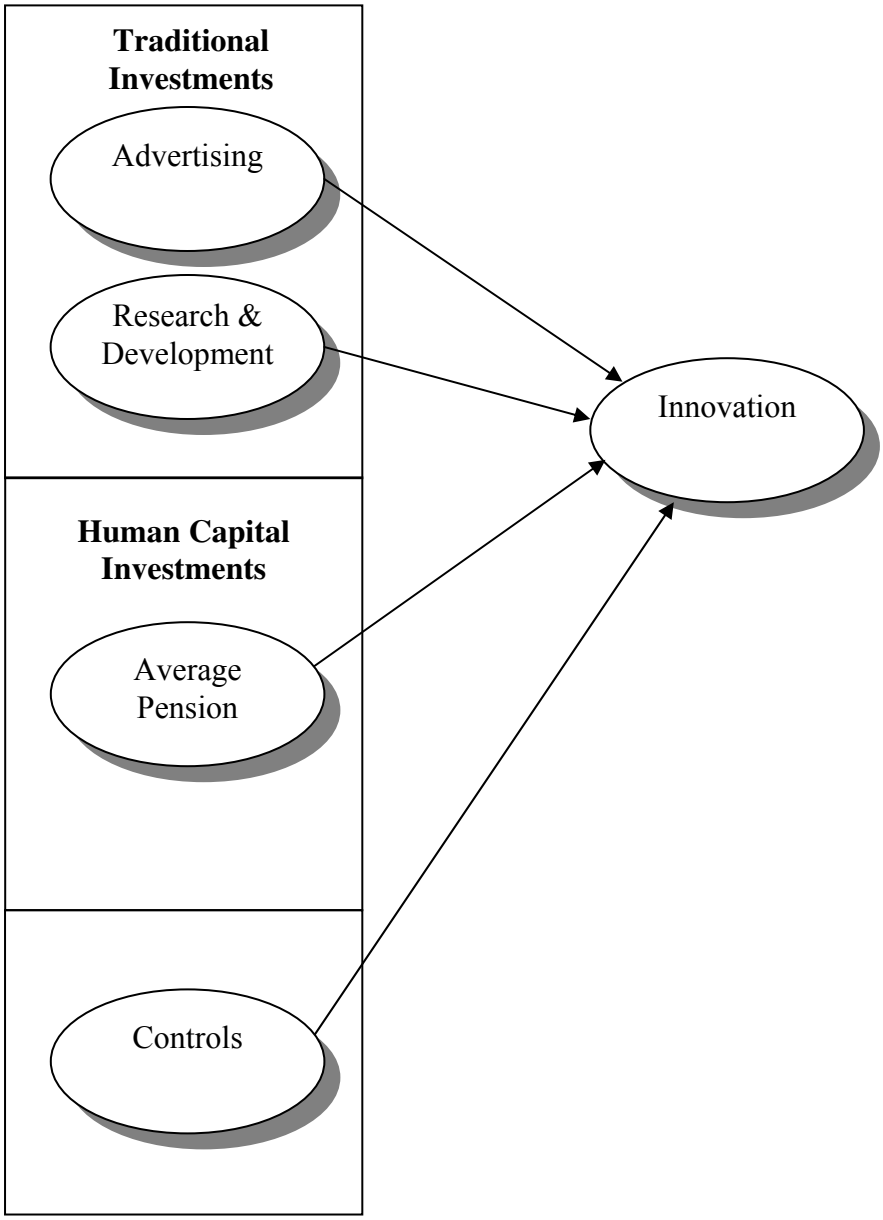

FIGURE 2.1: CONCEPTUAL MODEL

CHAPTER 3
ESSAY 2: WEAVING WEBS OF INNOVATION

INTRODUCTION

Innovation is identified by industry leaders and researchers as a key strategic imperative (Atuahene-Gima 1996; de Brentani 1989) for its role in generating competitive advantage and bolstering organizational performance (Matthyssens, Vandenbempt, and Berghman 2006). Specifically, innovative firms are recognizing enhanced profit margins as a result of increased market shares and repeat purchases from loyal customers (Storey and Easingwood 1999). Further, it is suggested that innovation strategies may be an integral component of organizational survival in today's rapidly changing markets (de Jong and Vermeulen 2003). As a result, innovation is included in the mission statements of world-renown companies such as Apple (phx.corporate-ir.net 2008), Procter & Gamble (www.pg.com 2008), and 3M (solutions.3m.com 2008).

A critical input to innovation is knowledge, which pertains to a firm's awareness of key marketplace issues and the potential for more creative problem resolutions (McDonough, Zack, Lin, and Berdrow 2008). More directly, knowledge indicates the extent to which firms are aware of strategic imperatives, such as customer desires and competitors' actions (Nix, Lusch, Zacharia, and Bridges 2008). Once acquired, knowledge is translated into actions, such as innovation, that benefit firms. In fact, firms that have greater access to knowledge resources are suggested to be more innovative and more successful (McDonough, Zack, Lin, and Berdrow 2008; Nix, Lusch, Zacharia, and Bridges 2008).

Knowledge that is capable of enhancing innovation and creating competitive differentiation is rare and thus difficult to efficiently develop by internal means alone (Appleyard, Brown, and Sattler 2006). Further, innovation requires a rejuvenation of ideas and thrives in dynamic environments where knowledge is sought in order to identify the means to satisfy customer demands (McDonough, Zack, Lin, and Berdrow 2008). As a result, many firms are beginning to look externally for key innovation

resources. External knowledge acquisition, however, is relatively unexplored in terms of its contribution to innovation efforts. This represents a substantial gap in the marketing literature. The objective of this research is to determine how firms should position themselves in a network of strategic partners to achieve greater access to knowledge from external sources.

Despite a lack of empirical study on external knowledge acquisition and innovation, it is clear that an increasingly common and effective way for organizations to gain external knowledge for innovation is by developing strategic partnerships (Cross, Yan, and Louis 2000). The stated growth in strategic partnerships for innovation is supported by industry examples such as those identified below.

"P&G has out-hustled rivals by turning to outsiders more often for consumer-products ideas" (BusinessWeek, 2008, Page 63).

"As it [Nokia] pushes into Web services, it's tapping outsiders to create games and offer feedback" (BusinessWeek, 2008, Page 63).

Implied in these statements is the use of multiple external partners (i.e., networks of strategic partnerships). Such networks consist of a series of direct and indirect strategic relationships. These relationships determine the position of the firm among those with whom they interact (i.e., a firm's location within the network). A firm's position determines its access to valuable external knowledge resources and its control over those resources (Liu, Madhavan, and Sudharshan 2005). As such relationships are often visually depicted as webs, the process of establishing an optimal location in a network for enacting partnerships and enhancing innovation can be viewed strategically as weaving a web of innovation. By effectively positioning themselves in such webs, organizations are able to combine internal and external knowledge resources for the purpose of innovation (Glaskiewicz 1979; Pfeffer and Salancik 1978). It is unclear, however, as to what positional characteristics impact knowledge acquisition for innovation.

A firm's position in a web of innovation is defined in this research by the number of partnerships it maintains, the control it has over those partners, and the distance the organization is from all other organizations in the web. Position is thus assumed to determine the extent to which a firm gains access to and control over undistorted knowledge resources (Rogers 2003). Further, organizations acting as bridges between other organizations are likely more innovative because of the knowledge that flows through them and their ability to restrict the knowledge that flows to other organizations (Granovetter 1973). The value of control over such knowledge resources is thus vested in a firm's ability to bolster its own innovation efforts, while limiting the innovation efforts of competing firms (Anthony, Johnson, and Sinfield 2008).

In addition, the costs (in terms of time, money, and opportunity) to develop and maintain strategic partnerships and to exert control over them are often substantial (Lei and Slocum 1992). Managers thereby need to understand which partnerships to seek, which ones to avoid, which ones to maintain, and which ones to eliminate in order to create a position in its web that maximizes returns on innovation efforts. The purpose of this research is therefore to examine which aspects of network position impact innovation in order to answer the question of how firms gain access to critical knowledge resources.

The rest of this article begins by considering how knowledge is related to a firm's ability to innovate. Next, the impacts of three key aspects of network position on knowledge acquisition for innovation are proposed. A description of how to compute aspects of position through social network analysis and the methodology are then described. Next, the results of the analysis are detailed. Finally, the managerial and research implications are identified along with limitations and suggestions for future research.

CONCEPTUAL FRAMEWORK

Knowledge is recognized as an essential building block of innovation (Nix, Lusch, Zacharia, and Bridges 2008). Specifically, firms utilize knowledge to predict trends, enhance creative efforts, and solve existing and potential problems (Anthony,

Johnson, and Sinfield 2008). Such capabilities improve innovation efforts by focusing firms on the needs of buyers and by increasing their ability to effectively respond to those needs (McDonough, Zack, Lin, and Berdrow 2008).

Consistent with the knowledge-based view (KBV) of the firm (e.g., Grant and Baden-Fuller 1995), organizations translate knowledge resources into innovative efforts through a process known as organizational learning (Hurley and Hult 1998; Jaworski and Kohli 1993; Kohli and Jaworski 1990; Mowery, Oxley, and Sliverman 1996; Sinkula 1994; Slater and Narver 1995). It is suggested that the most critical piece of this learning process is the acquisition of valuable knowledge inputs (Froehle, Roth, Chase, and Voss 2000). Without such inputs, the process of creating innovation outputs is likely to be slow, or result in poor decision-making (Nix, Lusch, Zacharia, and Bridges 2008). In essence, organizational learning processes that lead to innovation are only as good as the knowledge put into them.

Valuable knowledge resources are increasingly being sought and acquired externally via networks of strategic partnerships (Appleyard, Brown, and Sattler 2006; Cross, Yan, and Louis 2000; Kale and Singh 2007). Such partnerships provide access to a range of knowledge resources (e.g., engineering plans, operations know-how, and customer needs identification) that cannot be generated efficiently via internal means alone (Anand and Khanna 2000; Dutta and Weiss 1997; Mowery, Oxley, and Silverman 1996). As a result, external relationships represent opportunities for competitive advantage.

Looking externally has the potential to provide access to diverse knowledge resources that are essential building blocks for innovation (Tatikonda and Montoya-Weiss 2001). Specifically, it is suggested that proactive external knowledge searches complement internal knowledge development by reducing barriers such as complacency and groupthink (Appleyard, Brown, and Sattler 2006). Organizations thus position themselves in strategic partnership webs designed to enhance access to innovation knowledge, while reducing wasteful overlaps in knowledge. In other words, firms seek to establish webs of strategic partnerships that provide knowledge efficiently and effectively.

The rationale for how such webs impact innovation is identified by Liu, Madhavan, and Sudharshan (2005). Specifically, centrality (having a large number of direct partners) is posited to enhance innovation efforts. Constraint (the extent to which partners communicate with each other outside of a focal firm) and range (through how many firms knowledge must pass to get to a focal firm) are posited to weaken innovation efforts. These constructs indicate how well an organization is positioned in a network of strategic partnerships to efficiently and effectively acquire valuable knowledge resources. More specifically, the ability of firms to gain access to large amounts (centrality) of non-redundant (constraint) knowledge that is undistorted (range) is expected to strengthen their ability to innovate. Further, knowledge that is distorted or lost through numerous transfers has less potential to contribute to innovation. The proposed relationship between a firm's position in a web of strategic partnerships and innovation are highlighted in Figure 3.1. Specifics of each network position characteristic are discussed next.

Centrality

Centrality is the first component of a firm's network position identified in Figure 3.1. A central organization is one that directly connects with multiple other organizations (Scott 1991). Being central in a web means that a firm has many direct strategic partners from which to gather knowledge (Dyer and Nobeoka 2000; Glaskiewicz 1979; Madhavan, Koka, and Prescott 1998; Pfeffer and Salancik 1978). In terms of knowledge diffusion (i.e., how knowledge spreads between numerous organizations), being central in a web of strategic partnerships determines how much access organizations have to the external knowledge resources that drive innovation (Kunst and Kratzer 2007). In addition, such connections often act as bridges between unrelated firms, giving central firms the power to control the transfer of knowledge between disconnected firms (Rogers 2003).

Organizations that act as a bridge between other organizations (i.e., central organizations) are therefore likely to achieve greater access to knowledge and restrict other firms' access to knowledge (Granovetter 1973). In essence, central organizations

have greater amounts of knowledge resources, more diverse knowledge resources, and are able to limit gains made by other organizations. As a result, central organizations tend to be more powerful and more innovative (Dutta and Weiss 1997; Rogers and Kincaid 1981). The knowledge gained from such partnerships not only allows firms to respond rapidly to environmental changes, but also to anticipate future changes (Nix, Lusch, Zacharia, and Bridges 2008). The impact on innovation imparted by partnerships is therefore vested in the knowledge gained from partners and the control of knowledge transfers amongst them (Reich and Mankin 1986).

Due to increased access to external knowledge, central organizations are more likely to be innovators and early adopters of technology and practices (Madhavan, Koka, and Prescott 1998; Rogers 2003). Less central (disconnected) organizations are likely to adopt at later times and are less likely to receive new knowledge (Rogers and Kincaid 1981). Further, such disconnection is indicative of managerial philosophies that are less concerned with innovation (Nix, Lusch, Zacharia, and Bridges 2008). As a result, organizations that seek external knowledge through strategic partnerships are poised to take advantage of innovation opportunities (Olsen and Sallis 2006). Thus, organizations that are connected to many strategic partners are expected to be more innovative than those connected to fewer.

To highlight the potential value of centrality to innovation, a visual depiction is provided in Figure 3.2. In this example, the position of *A* in the network is more central than that of *B*. This is because *A* is directly related to (and acts as a bridge between) four other organizations, whereas *B* is only directly related to one other organization (and does not act as a bridge). Therefore, *A* has greater potential access to external knowledge resources than *B*. As a result, *A* is expected to be more innovative than *B*. Thus, the following hypothesis is proposed:

> **H1:** Organizations with higher degrees of centrality are more likely to be effective innovators.

Constraint

Constraint is the second component of a firm's network position identified in Figure 3.1. Most strategic networks typically do not exhibit links between every organization, which gives some organizations more powerful positions. Part of the power of this position derives from the ability of one firm to gain access to critical knowledge resources, while reducing other firms' access (Burt 1983). Organizations whose strategic partners are able to bypass them when transferring knowledge are *constrained*. In other words, knowledge does not have to flow through the constrained firm. Thus, access to and control over knowledge is therefore limited and innovation potential is restricted.

Organizations that are positioned to limit the interactions of their partners receive greater access to knowledge resources with fewer redundancies (i.e., receiving the same knowledge multiple times) (Liu, Madhavan, and Sudharshan 2005). Therefore, such organizations are less likely to waste time filtering through knowledge that does not enhance innovation (Granovetter 1973). As a result, it is expected that organizations constrained by the interactions of their partners are less innovative.

To highlight the potential impact of constraint on innovation, a visual example of constraint is shown in Figure 3.3. In this example, *A* is less constrained than *B*. This is because fewer of *A*'s directly linked firms are directly linked with each other than are *B*'s. Specifically, *A* is completely unconstrained as none of its partners have direct relationships. On the other hand, four out of six possible direct relationships exist among *B*'s direct partners, meaning that *B* is heavily constrained. As a result, *B* is less likely to receive unique (non-redundant) and useful knowledge than *A*. As a result, *B* is expected to be less innovative than *A*. Therefore the following hypothesis is proposed:

> **H2:** Organizations that are more highly constrained by their strategic partners are less likely to be effective innovators.

Range

Range is the third component of a firm's network position identified in Figure 3.1. Range is synonymous with an organization's reach across its web of strategic partnerships. In other words, range describes the average number of strategic relationships it takes to reach every other firm. Greater range is associated with more direct relationships and fewer firms through which knowledge must travel to reach a focal firm. This is important to innovation because knowledge has the potential to be distorted or eliminated as it passes among organizations (Nix, Lusch, Zacharia, and Bridges 2008). This potential increases as the number of organizations increases between a sender and a receiver (Lee, Padmanabhan, and Whang 1997). This is likely to reduce the value of knowledge and its ability to aid innovation efforts.

Another advantage that accrues to organizations with good range (i.e., those in which knowledge passes through relatively few firms) rests in the timeliness of knowledge acquisition. The shelf life of new knowledge is diminishing at an increasing rate as a function of high technology information distribution, as well as changing customer tastes (Glazer 1999). Further, knowledge ages (i.e., becomes less novel) as more and more organizations gain access. The competitive value of knowledge is thereby reduced when it transfers across many organizations. Firms with more direct access to new knowledge (i.e., those with greater range) are therefore expected to be more innovative than firms that must wait for new knowledge to transition through many other firms (i.e., those with lower range).

To highlight the role of range in determining innovation, a visual example is depicted in Figure 3.4. In the example, *A* has superior range to *B*. This is because knowledge does not pass between other organizations prior to reaching *A*, whereas knowledge passes through several other organizations prior to reaching *B*. Therefore, there is less potential for knowledge elimination or distortion between *A* and any member of its network as, on average, knowledge must pass through only one ((1+1+1+1)/4 = 1) organization. However, knowledge must, on average, pass through two ((1+2+3)/3 = 2) other organizations to reach *B*, which increases the chance of knowledge being altered,

distorted, delayed, or eliminated on its way to *B*. As a result, *B* is expected to be less innovative than *A*. Therefore, the following hypothesis is proposed:

H3: Organizations with greater range are more likely to be effective innovators.

DATA AND METHODS

Data sources and sample

The data for this study are drawn from the *SDC Platinum: Alliances and Joint Ventures* database, a set of aggregate innovation rankings from *Fortune's* Most Admired Companies List, and the COMPUSTAT database. An advantage of using these data sources is that they provide data across a wide range of organizations and industries. Specifically, the SDC database provides alliance announcements from press wires such as *Dow Jones*, business periodicals such as the *Wall Street Journal*, and other trade magazines. *Fortune* is a trade magazine that periodically offers industry rankings determined by surveying thousands of executives, directors, and financial analysts, while COMPUSTAT is a Standard & Poor's database that provides more than 45 years of financial data for more than 28,000 firms. The data in this study consist of 563 firms that could be matched across each of these databases for the years 2006 and 2007.

These data sources are utilized in a variety of prior financial, management, and marketing research, including leading academic journals. For example, Barber and colleagues (2003) utilize *Fortune*'s Most Admired Companies and COMPUSTAT to compare the investment decisions of stock clubs and individual investors. The results indicate that the most admired companies list is a powerful predictor of individual and stock club investment decisions. In addition, Markovitch and colleagues (2005) utilize the SDC database and COMPUSTAT to tie market intelligence to capital markets. Their results suggest that a firm's location in a network of alliances impacts its access to market information and subsequent performance. At the core of the research, better performing firms are shown to have more central locations in the network.

Model formulation

The first part of the analysis requires the creation of a matrix of relationships from the SDC data, whereby alliances between firms are recorded as a (1) in the matrix and a lack of an alliance is recorded as a (0). Social network analysis (SNA) is then used to compute the relevant network position variables (centrality, constraint, range). Social network analysis is a tool that assists in understanding knowledge acquisition by identifying underlying patterns of strategic relationships expected to enhance or limit access to knowledge. Rogers and Kincaid (1981) developed SNA to assess communication structure in socio-behavioral frameworks. Since then, a variety of studies in information systems (e.g., Vivacqa and de Souza 2008), management (e.g., Rowley 1997), and sociology (e.g., Molm, Quist, and Wiseley 1994) have employed SNA.

The network patterns of social network analysis are described by three key variables: centrality, constraint, and range. According to Liu, Madhavan, and Sudharshan (2005), these are the most likely network characteristics to impact knowledge acquisition and performance. The analysis generates values for each organization based on its location in the network relative to other organizations in the network. The resulting variables are then entered into a hierarchical regression as the predictors of innovation. The construction of each variable is discussed in the next section.

Operationalization of variables

This section discusses how the study's variables are collected, operationalized, and transformed. A summary of the variables, their operationalizations, and data sources is provided in Table 3.1.

Innovation. *Fortune's* Most Admired Companies database is used to operationalize innovation. The database provides rankings from 1 to 11 (highest to lowest) for firms within each industry according to survey results provided by industry experts. Innovation therefore begins as a latent construct created from expert opinions and is transformed into an industry ranking.

Centrality. In this research, centrality is measured as the number of direct strategic partnerships held by each firm (Wasserman and Faust 1994). Centrality is

therefore a count of the number of direct strategic partnerships that a firm maintains. Higher levels of centrality for a firm equate to having more direct strategic partnerships. These direct links are indicated in the SDC database by the mention of an alliance between two or more firms. Whenever a link between two or more firms is mentioned, a (1) is placed in an n x n contiguity matrix that records which firms are related to each other. From this matrix, computing centrality is simply a matter of summing the rows of the matrix (each row or column header represents a specific firm).

Constraint. In this research, constraint is measured as a ratio. This is similar to Granovetter's (1973) operationalization of network density, which describes the number of unique paths along which knowledge can pass between two firms. In essence, the constraint ratio measures how constrained a firm is in comparison to how constrained the firm could be. In the ratio, values close to one imply that a firm is highly constrained, while values close to zero imply that a firm is very unconstrained. Higher levels of constraint, therefore, indicate that a greater number of a firm's strategic partners are also directly linked and can therefore bypass the focal firm.

In the computation, the numerator is a count of the number of direct links among a firm's strategic partners (i.e., how many strategic partners are themselves directly linked). The numerator captures the extent to which a firm's partners are able to communicate with each other without going through the focal firm. The denominator in the ratio is the total number of possible associations among a firm's strategic partners (i.e., the number of direct partnerships that could exist among a firm's direct partners). The computation for the denominator is $n(n\text{-}1)/2$, where n is the number of strategic partnerships held by a firm. The data for the constraint computation originate from the contiguity matrix developed from the SDC database.

Range. Range is measured in this research as the average number of relational links from each firm to all other firms in its network (Wasserman and Faust 1994). The computation is the sum of the shortest number of links from a focal firm to each of the other firms in a network divided by the number of other firms in the network. Higher values indicate a greater number of firms through which knowledge must travel and

therefore equate to lower range (poor reach). The data for the range computation originate from the contiguity matrix developed from the SDC database.

Control Variables. Consistent with prior research, firm size, prior performance, and industry differences are controlled. Firm size is operationalized using the total assets of each firm (e.g., Aboulnasr, Narasimhan, Blair, and Chandy 2008). Firm size is included because larger firms tend to have greater resource bases and access to economies of scale (Luo and Bhattacharya 2006). In addition, previously established predictors of innovation such as advertising and research and development are included as controls to determine the additional value of the positional predictors. Further, prior firm performance vis-à-vis Tobin's Q is included in the control variables as firms with better prior performance are expected to have better opportunities for future innovation (Salomo, Talke, and Strecker 2008). Total assets, advertising expenditures, research and development expenditures, equity market value, equity book value, and liabilities book value are collected from COMPUSTAT. To account for potential differences between goods and services, companies are identified and coded as goods [0] and services [1] according to their primary two-digit SIC codes. A breakdown of industries and related SIC codes is provided in Table 3.2.

As with much secondary data, skewness is a potential issue. To limit any possible impacts from skewness in the variables, data for total assets, advertising, research and development, Tobin's Q, centrality, constraint, and range are normalized by taking the natural log of each value (c.f., Luo and Bhattacharya 2006). In addition, smaller values for innovation represent higher levels of innovation, while smaller values for the predictors represent lower levels of the predictors. In order to create a consistent directionality among the measurement of innovation and its predictors, the predictor values are reversed (i.e., multiplied by –1) so that higher scores represent lower values.

Innovation may differ by industry as a function of technological differences or end user demands. For example, consumer electronics industries may be considered much more innovative than transportation industries. As a function of these differences, it is useful to control for potential industry differences (Zenkin and Dolya 2007). The *Fortune* data, however, does not directly account for these relative differences, but does

categorize each firm into one of 64 industries. Predictor and control variables are therefore standardized within each industry to control for potential industry differences (McAlister, Srinivasan, and Kim 2007). The mean of each variable is first computed for each industry. These means are then subtracted from each of the observed values for each industry. Finally, these difference scores are divided by the standard error for each industry. This transformation makes each firm's values relative to others in its industry, which more closely approximates the format of the innovation measure.

Descriptive statistics

Descriptive statistics for the dependent, independent, and control variables are provided in Table 3.3. The data are broken down by year for descriptive purposes, but are combined into one data set in subsequent analyses. Centrality, constraint, and total assets exhibit a wide range of values and heavy skewness. Computing measures relative to each industry, however, reduces the skew (i.e., normalizes the data). Means of 9.00 (2005) and 7.77 (2006) suggest that for firms in this sample, on average, approximately eight direct strategic partnerships are maintained. This highlights the extent to which firms are seeking knowledge resources externally through strategic partnerships and their willingness to maintain such partnerships. On average, firms in this sample are heavily constrained. Specifically, average constraint is .93 and .91 in 2005 and 2006 respectively. These high ratios suggest that most firms' strategic partners are also linked outside the focal firm. Therefore, knowledge is likely difficult to control for most firms in this sample. The data also suggests that it takes few relationships ($Range_{2005} = 3.59$; $Range_{2006} = 4.06$) on average to reach other firms in the network. This suggests that knowledge must pass through relatively few firms (approximately four) to reach other firms in the network. This limits the potential for distortion, elimination, and aging that is possible when knowledge is transferred across multiple organizations.

RESULTS

The hierarchical regression analysis results are presented in Table 3.4. The results of the analysis suggest that centrality is a positive driver of innovation ($\beta = .29$, $p < .01$), which supports Hypothesis 1. This suggests that organizational innovation benefits from having a large number of strategic partners. Constraint is a significant detractor from innovation ($\beta = -.19$, $p < .05$), which supports Hypothesis 2. This suggests that it is beneficial for a firm to limit the partnerships and communication that occurs among its strategic partners. Range is not a significant predictor of innovation ($\beta = .03$, $p > .56$), which fails to support Hypothesis 3. This suggests that, relative to other variables, firms do not benefit from having more closely tied networks that limit the number of organizations through which information must flow prior to being received by a focal organization. This is perhaps due to the age of electronic commerce whereby firms transfer information digitally, giving it less opportunity for distortion, elimination, or aging. The results also appear to be consistent across goods and service industries as the goods versus services variable is not significant and none of the interaction terms are significant. The total variance explained in the model is consistent with numerous other studies in corporate strategy (c.f., Brush and Bromiley 1997) where there is little bias (e.g., common method bias, acquiescence bias, and extremity bias) to artificially inflate relationships and significance levels. The R^2 value for innovation is .115 with all variables in the model.

DISCUSSION

The purpose of this research was to examine the impacts of knowledge generating relationships, such as strategic partnerships, on innovation. More specifically, the goal was to assess how positional characteristics in a network, such as centrality, constraint, and range, act to enhance or subdue knowledge acquisitions that drive innovation. The research findings highlight the value of considering a firm's position within a web of strategic partnerships when predicting innovation. Specifically, the results highlight the

primacy of centrality (i.e., having many strategic partners) in determining innovation for both goods and service companies. The results further suggest that constraint (i.e., having partners that can communicate without going through the focal firm) is also an important innovation detractor and that range (i.e., through how many firms knowledge passes before reaching the focal firm) is not a significant antecedent to innovation. Implications of the research for managers and researchers are discussed next.

Managerial Implications

As firms continue to look externally for knowledge that enhances innovation and competitive advantage, the number of strategic partnerships sought is likely to increase. Due to the capital intensity required to maintain such strategic partnerships (Lei and Slocum 1992), and given a limited set of internal resources, practitioners need to understand how to develop webs of innovation that efficiently and effectively provide knowledge for innovation. The results primarily suggest that practitioners should seek numerous partnerships and, to a lesser extent, attempt to limit interactions between strategic partners, whether in goods or service industries. In other words, firms are advised to partner with many other firms and restrict interactions among their strategic partners.

The results further imply that firms should form individual alliances with other firms rather than creating groups of alliances that involve more than two firms. Group alliances are more likely to involve communication across multiple partners and shared control, constraining the firms involved. Such constraint is shown to detract from innovation. Practitioners are thereby advised to attempt to be the initiators and directors of alliances rather than simply agreeing to participate in alliances proposed by other firms. In situations where firms lack the resources or capabilities to effectively initiate or direct alliances, practitioners are advised to accept alliances that limit the number of strategic partners involved.

The results also have implications for supply managers, as supply chains constitute important forms of strategic partnerships that often extend beyond mere knowledge transfers to movement of physical products. For supply chain practitioners,

the results highlight the value of having channel power (i.e., being a channel captain) so that one firm controls critical supply chain knowledge and directs other firms in ways that benefit the firm, as well as the supply chain as a whole. Such findings further highlight the potential value of exclusive contracts, single supplier networks, and franchise systems in bolstering innovation. These practices allow firms to create valuable information asymmetries and competitive advantage. Supply chain practitioners are therefore advised to emphasize contracts and relationship structures that the balance of power to their firms.

Research Implications

This research extends prior research by identifying a new way of predicting innovation via network analysis. Specifically, the network predictors overcome some limitations of traditionally accepted predictors stemming from physical goods literature. Specifically, prior research primarily emphasizes research and development and marketing expenditures in predicting innovation (e.g., Chin, Lee, Chi, and Anandarajan 2006; Hall 1993; Mairesse and Mohnen 2002). Unfortunately, such predictors do not necessarily translate well into services contexts (Damanpour 1991; Nijssen, Hillebrand, Vermuelen, and Kemp 2006; Sundbo 1997). I suggest that innovation predictors pertaining to external knowledge acquisition are more universally applicable (i.e., apply to both goods and services) than those identified for physical goods. This is because knowledge is a critical component of generating both innovative physical goods and innovative services.

A limited amount of research attempts to identify investments that foster service innovation. This research suggests that examining sources of knowledge (e.g., webs of strategic partners) and investments in such sources are valuable avenues of inquiry in marketing research. As a result, innovation research should begin focusing more on intangibles, such as knowledge, when considering how innovation is derived.

Prior research identifies the potential value of networks in marketing research (e.g., Iacobucci and Hopkins 1992). Further, the importance of network analysis techniques is growing in research as competition shifts from the firm level to the supply chain or network level. However, relatively few empirical articles employ network

analyses when investigating marketing problems despite prevalence in a variety of other fields such as operations (e.g., Dutta and Weiss 1997), strategic management (e.g., McNamara, Deephouse, and Luce 2003; Westphal, Boivie, and Chng 2006), human resources management (e.g., Brass 1995), and logistics (e.g., Carter, Elram, and Tate 2007). The results of this research highlight the value of social network analysis in marketing research. Specifically, this research moves beyond traditional dyadic assessments and examines larger network structures. In addition, this research shows how variables derived from social network analysis can be used to predict key operational outcomes such as innovation.

Social network analysis is a primary tool used in analyzing network data. As networks receive greater emphasis in marketing (Iacobucci and Hopkins 1992), so must the use of social network analysis. Additional research is needed to extend the use and complexity of social network analysis into other contexts such as consumer behavior. For example, areas such as word-of-mouth and diffusion of innovation are predicated on relationships, yet studies focus almost entirely on internal consumer characteristics (e.g., attitude toward complaining), while avoiding the strength and importance of external influences.

Limitations and future research

This research has several potential limiting factors that should be noted. The first potential limitation of this study is the range of variables selected for analysis. Social network analysis can be used to create other firm level and network level predictors such as embeddedness, network centralization, and network density. These variables were excluded from this analysis because there is no literature to suggest how these characteristics might impact innovation. Further, the set of firms chosen for analysis in this research were linked into a small set of networks, thus eliminating the potential for comparisons between different networks (centralization and density variables). In other words, given the data available, there are too few networks to make valid statistical comparisons between different networks. Future research should consider comparing the ability of different networks to impact innovation, as there is a strong movement to

compare competition at the network level rather than at the individual firm level (c.f., Whipple and Frankel 2000). In addition, network position is likely to affect other resources and capabilities than innovation, such as human capital, tangible assets, and marketing promotions. Future research should therefore examine how such network variables impact other key outcomes for firms.

The data sources used represent a second possible limitation in this study. The dependent variable (innovation) was collected from multiple years of *Fortune's* Most Admired Companies list. The predictor variables (centrality, constraint, and range) were created from the SDC platinum: alliances and joint ventures database. The control variables (total assets, advertising intensity, and industry) were taken from the COMPUSTAT database. The generalizability achieved by such aggregate industry measures necessarily limits investigations of more specific internal organizational drivers of innovation such as technology acceptance (Wang, Lo, and Fang 2008) and entrepreneurial spirit (Weerawardena and O'Cass 2004). However, the databases are frequently used in finance, operations, and marketing studies (e.g., Barber, Heath, and Odean 2003; Markovitch, Steckel, and Yeung 2005) as well as in business practice (e.g., Schmerken 1985). As other databases and measures for these variables are identified and developed, future research should revisit the findings of this research to continue to test the relevance of network characteristics in enhancing innovation.

A third potential limitation of this research is the level of analysis. Specifically, it is assumed that resources such as knowledge are transferred among partners as a result of strategic alliances. However, at a network level of analysis it is impossible to know what specific resources are exchanged, in what ways, and how this is accomplished. Future research should therefore build from this analysis by conducting deeper, more specific, assessments (e.g., through surveys of managers) of what resource exchanges take place and how to form alliances in ways that benefit innovation efforts.

Using SIC codes to classify firms as goods or services represents a final potential limitation in this research. While SIC codes are often used for such classifications, firms may have multiple business units that include both goods and services. As a result, the primary SIC code identified for each company may not effectively distinguish between

goods and services firms. Future research should examine alternative methods for classification and revisit potential similarities between goods and service firms.

TABLE 3.1: VARIABLES AND DATA SOURCES

Conceptual Variable	Measured Variable	Data Source
Dependent Variable		
Innovation	Average industry ranking from industry experts	*Fortune's* M.A.C.
Network Position Variables		
Centrality	Number of direct strategic partner links	SDC Platinum: Alliances and Joint Ventures
Constraint	Number of direct partner links who are also directly linked / Number of possible direct links among partners	SDC Platinum: Alliances and Joint Ventures
Range	Average number of links it takes to get to every other member of the network	SDC Platinum: Alliances and Joint Ventures
Control Variables		
Firm Size	Natural logarithm of total assets	COMPUSTAT
Performance	Natural logarithm of Tobin's Q	COMPUSTAT
Advertising	Natural logarithm of advertising expenditures	COMPUSTAT
R&D	Natural logarithm of R&D expenditures	COMPUSTAT

Note: M.A.C. = Most Admired Companies.

TABLE 3.2: CATEGORIZATION OF INDUSTRIES AS GOODS OR SERVICES

Industry	SIC Codes
PHYSICAL GOODS	
Aerospace and Defense	37
Apparel	22
Chemicals	28
Computers	35
Consumer Food Products	20
Food Production	20
Household and Personal Products	39
Metals	10,33,34
Mining, Crude-Oil Production	13
Motor Vehicles	37
Motor Vehicles and Parts	37
Petroleum Refining	13
Publishing	27
Semiconductors	36
SERVICES	
Delivery	47
Electric and Gas Utilities	49
Energy	49
Engineering, Construction	17
Entertainment	78
Financial Data Services	62
Food Services	54
General Merchandisers	53
Hotels, Casinos, Resorts	70
Information Technology Services	73
Internet Services and Retailing	59
Megabanks and Credit Card Companies	61
Mortgage Services	61
Network Communications	48
Real Estate	65
Securities	61
Specialty Retailers	53
Superregional Banks	60
Telecommunications	48
Trucking	42
Wholesalers: Electronics	50

TABLE 3.3: DESCRIPTIVE STATISTICS

Variable	Mean	SD	Min	Median	Max	Skewness
Dependent Variable						
Innovation 2006	5.09	2.77	1	5	10	.173
Innovation 2007	5.17	2.77	1	5	10	.126
Network Position Variables						
Centrality 2005	9.00	18.27	1	3	200	6.07
Centrality 2006	7.77	15.10	1	3	188	7.19
Constraint 2005	.93	.12	.29	.99	1	-2.45
Constraint 2006	.91	.21	0	.99	1	-3.22
Range 2005	3.59	2.16	.5	4.22	8.58	-.284
Range 2006	4.06	2.48	.5	4.67	10.02	-.259
Control Variables						
Total Assets 2005[a]	54,320	146,808	363	7,747	1,494,037	6.18
Total Assets 2006[a]	48,721	122,460	208	10,154	1,632,104	4.74
Advertising 2005[a]	533.44	1,015.45	.50	158.12	5,919.82	3.47
Advertising 2006[a]	549.79	1,052.28	.70	156.46	6,866.40	3.77
R&D 2005[a]	676.96	1,527.79	0	103.00	9,094.00	3.23
R&D 2006[a]	732.64	1,459.37	0	112.99	8,258.00	2.98
Tobin's Q 2005	1.49	4.63	.003	.86	101.25	18.19
Tobin's Q 2006	1.98	6.44	.001	.91	210.62	16.87

[a]: thousands

TABLE 3.4: HIERARCHICAL REGRESSION ANALYSIS

Variable	Step 1 (Controls)	Step 2 (Centrality)	Step 3 (Constraint)	Step 4 (Range)	Step 5 (Interactions)
Total Assets	.06	.05	.05	.05	.05
Advertising	.10*	.10*	.09*	.09*	.09*
R&D	.06	.03	.02	.02	.02
Tobin's Q	.26***	.27***	.27***	.27***	.27***
GS	.08^{+}	.06	.05	.05	.05
Centrality		.11**	.30***	.29**	.24^{+}
Constraint			-.21*	-.19*	-.16
Range				.03	.08
GS x Centrality					.01
GS x Constraint					.07
GS x Range					.06
R^2	.090	.101	.110	.111	.115
Change in R^2	.090	.011**	.008*	.001	.005

$^{+}$ $p < .10$,* $p < .05$, ** $p < .01$, *** $p < .001$

Note: Standardized betas are shown, GS = Good or Service

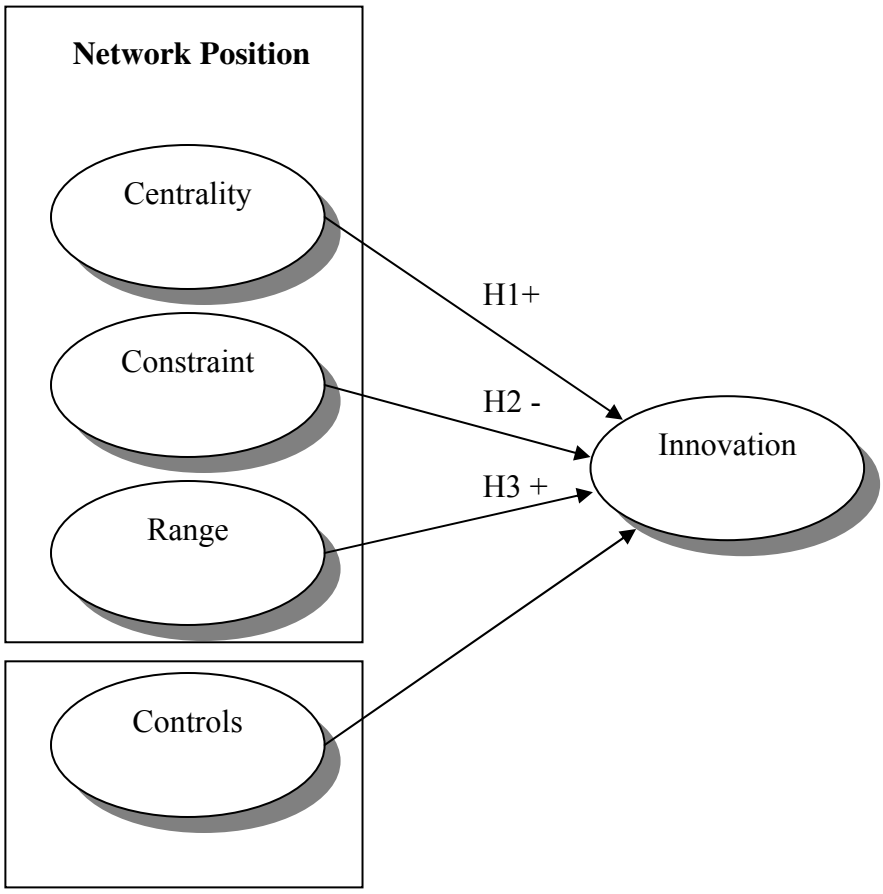

FIGURE 3.1: CONCEPTUAL FRAMEWORK

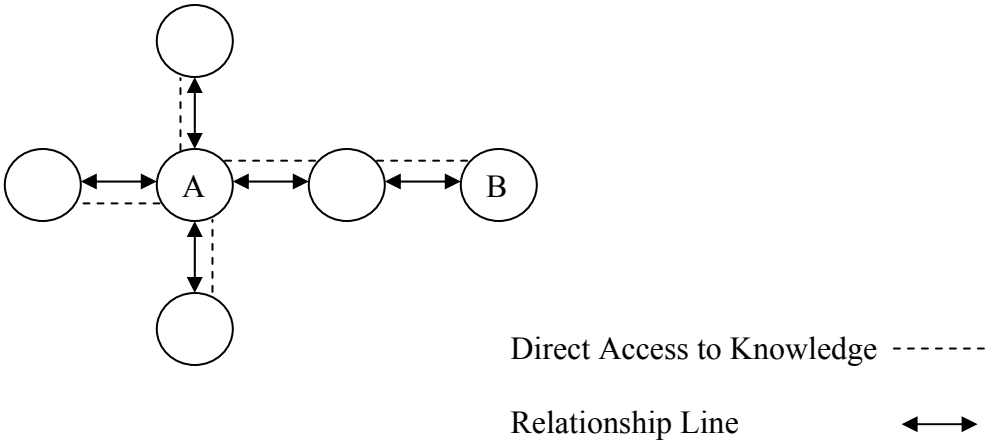

FIGURE 3.2: CENTRALITY

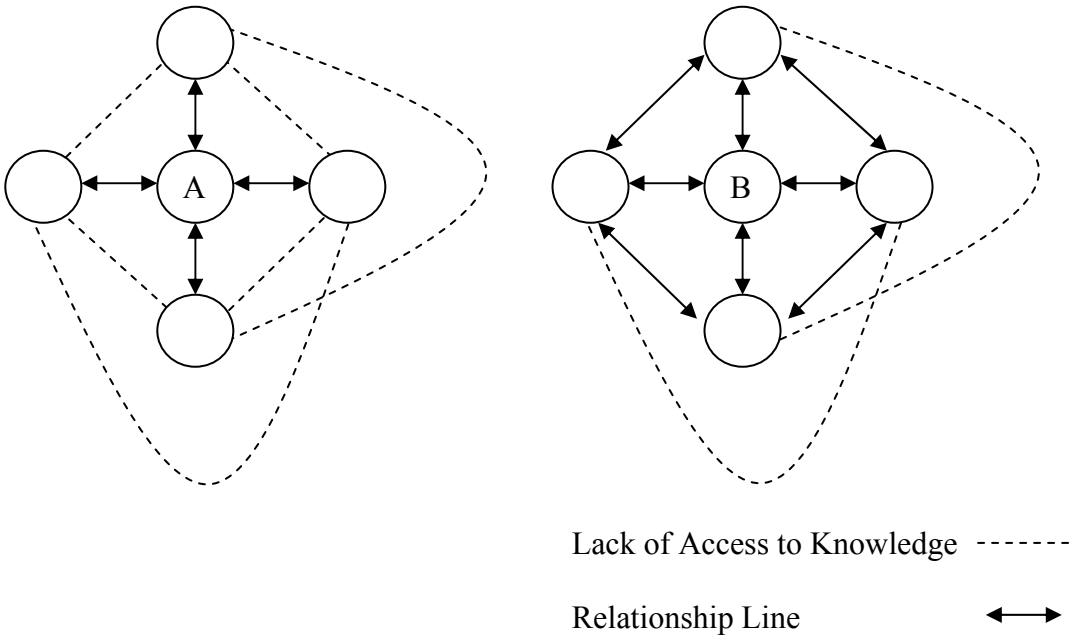

FIGURE 3.3: CONSTRAINT

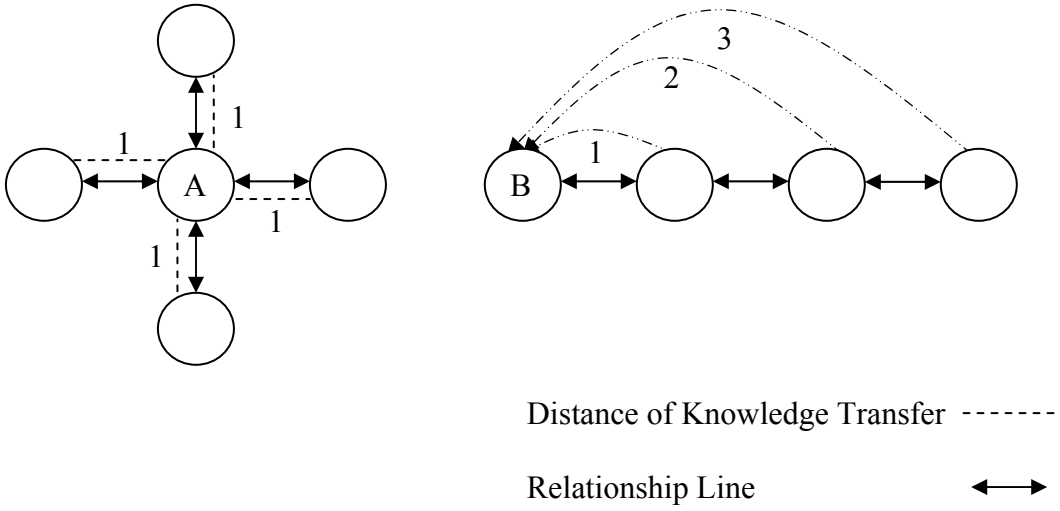

FIGURE 3.4: RANGE

CHAPTER 4
ESSAY 3: INTERNAL AND EXTERNAL DRIVERS OF INNOVATION: A NETWORK ANALYSIS APPROACH

INTRODUCTION

Innovation is rapidly becoming a critical issue to marketers as firms seek to establish sustainable competitive advantages (Marketing Science Institute Research Priorities 2006; Matthyssens, Vandenbempt, and Berghman 2006). Marketing's primary role in this process is identifying what defines, or drives, successful innovations (i.e., those that fulfill the needs of profitable customer segments). The importance of innovation continues to grow as innovative products are suggested to garner greater profit margins, to result in competitive advantage as such products are better able to satisfy customers, and to become the basis or platform for additional marketing efforts (Berry et al. 2006).

The importance of innovation in achieving performance and competitive advantage is identified both in trade publications and in the work of academic researchers. For example, firms such as Google (BusinessWeek April 28, 2008) and Hewlett Packard (BusinessWeek April 17, 2008) are recognized not only as innovation leaders, but also are among the most profitable firms in their respective industries. Academic research provides further support for the notion that innovative firms outperform non-innovative firms financially (c.f., Geroski and Machin 1992). As innovation efforts intensify, successful firms must efficiently acquire and rapidly deploy a diverse range of resources.

Thus, possessing and utilizing the right mixture of strategic resources (e.g., capital, personnel, goods, and knowledge) is critical in efforts to use innovation to create and sustain a competitive advantage (Olson, Walker, and Ruekert 1995). Specifically, investments in research and development (R&D) and marketing are identified in the operations and marketing literatures as key innovation drivers (Henard and Szymanski 2001; Lu and Yang 2004; McAlister, Srinivasan, and Kim 2007). However, other factors

deemed critical to innovation, such as knowledge generation and partner firm resources receive much less attention. Incorporating a service dominant perspective (Lusch and Vargo 2006; Vargo and Lusch 2004) and the knowledge-based view of the firm (Grant and Baden-Fuller 1995), the goal of this research is to assess the impact of internal and external knowledge generating resources on innovation.

Today, despite growing interest in identifying the antecedents of successful innovation (e.g., Droge, Calantone, and Harmancioglu 2008), and more specifically the antecedents of successful service innovation (e.g., Berry et al. 2006; Matthyssens, Vandenbempt, and Berghman 2006), there are few attempts to empirically identify the strategic resource differences that impact innovation. Specifically, there are few studies to date that assess the impact of external resources on innovation that move beyond a consideration of simple dyadic links (i.e., direct external partners), even though there is a growing body of literature that identifies the importance of alliance networks in fostering innovation (e.g., Kale and Singh 2007; Powell, Koput, and Smith-Doerr 1996; Tiwana 2008).

In order to better comprehend differences in the success of innovation efforts, managers and researchers need to understand and account for critical internal and external resources. Such information is essential if firms are to be able to assess probable impacts of specific innovation options on their competitive position. Therefore, the objective of this study is to assess the impact of the resources inherent in the networks within which firms compete on an organization's ability to innovate. Specifically, the research uses network analysis to identify how a firm's set of marketplace partners affects its innovation efforts. The objective in using a network analysis is primarily to assist managers in determining which firms to partner with in order to attain the best mix of resources needed to maximize innovation.

In pursuit of this objective, an exploratory analysis is conducted using a network approach to parameter estimation. More specifically, the impacts of firms' internal resources, and the resources of multiple external partners, on innovation are assessed in a single model. The inclusion of multiple external partners is consistent with moves toward network analyses (e.g., Cross, Borgatti, and Parker 2002; Iacobucci and Hopkins

1992; Kale and Singh 2007; McNamara, Deephouse, and Luce 2003; Powell, Koput, and Smith-Doerr 1996; Syson and Perks 2004; Tiwana 2008). The advantage of a network approach is that it limits the loss of predictive power by including more information (e.g., more strategic partnerships and more predictors) and reducing estimation bias (i.e., the extent to which impacts are quantitatively misestimated). Thereby, the network approach provides insights as to the relative importance of generating internal resources versus acquiring resources externally from strategic partners.

The rest of the article starts with a review of the relevant literature on knowledge and innovation. Specifically, the knowledge-based view of the firm, organizational learning, human capital, and resource-dependence theory are synthesized as a means of understanding how firms accumulate innovation knowledge. Collectively, these theories describe the interplay among internal and external knowledge resources and innovation. Next, the network analysis utilized to assess the impacts of internal and external resources on the innovation of organizations is detailed, along with a description of the data used in the analysis. The results of the analysis are then provided, followed by the managerial and research implications, the identification of potential limitations, and a discussion of the opportunities for future research that are identified as a result of the study.

CONCEPTUAL BACKGROUND

Knowledge Creation and Innovation

As alluded to above, knowledge resources are deemed to be a critical driver of innovation. Although knowledge covers a broad spectrum of informational components (e.g., technical, market, and managerial) (Lyles and Salk 1996), it is commonly argued that innovation derives from the ability of firms to access a diverse range of knowledge resources and then exploit them to develop new goods and services (e.g., Burt 1992; Hargadon and Sutton 1997; Rodan and Galunic 2004; Zaheer and Bell 2005). The premise that underlies this argument is that knowledge diversity is strongly linked to organizational creativity, which in turn is linked to innovation (Amabile, Conti, Coon,

Lazenby, and Herron 1996; Rodan and Galunic 2004). Within the knowledge-based view (KBV) of the firm, creativity and performance are posited to be enhanced when existing knowledge is integrated with best practices, thereby sparking new solutions to problems (Ahuja 2000; Grant 1996). The success of organizations is thus defined in this view by their ability to acquire and use knowledge for competitive purposes (Mowery, Oxley, and Sliverman 1996).

Knowledge resources are collected, stored, and acted upon in a process known as organizational learning (Huber 1991; Hult 2002; Hurley and Hult 1998; Jay 2003; Weerawardena 2003). Firms that align organizational learning with a marketing orientation accrue competitive benefits such as lower costs, enhanced product offerings, competitive differentiation, and enhanced innovation (Collis and Montgomery 1995; Hult 2002; Hurley and Hult 1998; Kohli and Jaworski 1990; Menon and Varadarajan 1992; Narver and Slater 1990; Nelson and Phelps 1966; Prahalad 1983; Slater and Narver 1995; van Reil, Lemmink, and Ouwersloot 2004). Learning environments are shown to promote knowledge sharing and contribute to performance in a variety of areas such as supply chains (Li et al. 2005), financial services (Lievens, Moenaert, and S'Jegers 1999), and high technology services (van Reil, Lemmink, and Ouwersloot 2004). The extent of value provided by the organizational learning process, however, hinges on a firm's ability to accumulate valuable knowledge resources (Froehle et al. 2000; Selnes and Sallis 2003). In other words, the innovation process is only as good as its knowledge inputs.

Internal Knowledge Generation

Organizations rely heavily on the creativity and prowess of their own labor force to build knowledge resources for innovation. Specifically, internal knowledge generation often emphasizes the importance of human capital (i.e., skilled workers) and management support for a marketing orientation (Selnes and Sallis 2003; Slater and Narver 1995). In fact, human capital theory originates from the notion that labor quality and compensation are positively correlated (Becker 1962, 1964; Huther 2000). In addition, it is suggested that knowledge and skills are often retained by human capital, making such resources available and renewable by hiring, motivating, and communicating with employees

(Barney 1991; Dierickx and Cool 1989; Ulrich 1991). In essence, employees are vessels that store and utilize knowledge to enhance innovation. The knowledge and skills of employees may benefit organizations through work in formal innovation roles such as engineers (responsible for design) or managers (responsible for implementation and external relationship building), or in less formal innovation roles such as front line service workers (responsible for implementation). In either formal or informal roles, employees with greater knowledge capacity and ability become valuable agents of change and innovation (Link and Siegel 2007; Siegel, Waldman, and Youngdahl 1997). According to human capital theory, it is necessary to compensate these employees for these superior knowledge capabilities. The effectiveness of superior compensation on innovation is visible in a number of industry examples including Google and Starbucks. Both firms provide higher than average compensation to employees and are continually listed among the most innovative firms in their industries (BusinessWeek April 28, 2008). These examples highlight the potential value of effectively gaining, retaining, and motivating internal sources of knowledge creation and creativity when seeking innovation.

External Knowledge Acquisition

In addition to internal sources of knowledge, a growing body of literature emphasizes the importance of external knowledge acquisition in fostering innovation (Dyer and Singh 1998; Hitt et al. 2000; Inkpen and Tsang 2005). In the KBV, alliances are often formed to exploit relational knowledge resources (Adams 1976; Howard and Herker, 1977; Mowery et al. 1996). That is, firms rely on strategic partnerships to access diverse knowledge resources that specifically bolster innovation (Doz and Hamel 1998; Gulati 1998; Gulati and Gargiulo 1999; Hagedoorn 1993). Through these external relationships, firms gain access to specialized capabilities that may be difficult to imitate or acquire and thus result in competitive advantage (Gulati and Gargiulo 1999; McEvily and Marcus 2005).

Innovation efforts are typically optimized when organizations collect and integrate external knowledge more efficiently and effectively than competitors

(Damanpour 1991; Dewar and Dutton 1986). It is suggested that strategic partnerships tend to provide more directed and sustained access to external information than other market sensing activities (Cross, Yan, and Louis 2000). As a result of the potentially superior value generated through such external links, organizations often become codependent once resource sharing begins and their respective competitive advantage depends on the continuation of the partnership (Anand and Khanna 2000; Dutta and Weiss 1997; Morgan and Hunt 1994; Mowery, Oxley and Silverman 1996; Tatikonda and Montoya-Weiss 2001).

Once a firm establishes links to external knowledge resources, it often cannot effectively return to an isolated state lest its knowledge inputs be weakened. In essence, a firm's innovation becomes dependent on specific external knowledge resources. Research indicates that strategic partnerships can lead to knowledge resources that cannot be created or replicated by internal means alone (Mowery, Oxley, and Silverman 1996; Prabhu, Chandy, and Ellis 2005). As a firm's use of external knowledge resources increases, its reliance on external knowledge resources also increases (Pfeffer and Salancik 1978).

Resource-Dependence

Environmental uncertainty is an inescapable component of innovation (Tatikonda and Montoya-Weiss 2001). Resource-dependence theory suggests that organizations are not capable of responding internally to the majority of environmental changes and therefore must seek critical resources externally (Pfeffer and Salancik 1978). Heavier reliance on external resources begets dependence and effective governance structures must be established to control critical resources (Pfeffer 1982; Stock 2006). These formal or informal bridging mechanisms grant access to innovation critical resources such as knowledge, labor, and technology.

Formal bridging strategies include mergers, acquisitions, joint ventures, and alliances. Despite support for the value of acquisitions and mergers in innovation, the financial and organizational burdens associated with mergers, acquisitions, and joint ventures make them poor candidates for rapid and effective knowledge access

(Christensen and Overdorf 2000; Finkelstein 1997; Prabhu, Chandy, and Ellis 2005). The focus of this research is therefore on less tangible asset intensive mechanisms such as alliances.

Strategic alliances represent a fast and effective means of expanding critical inputs and are thereby becoming increasingly important in the struggle for competitive advantage (Wisnieski and Soni 2004). The value accrued to alliances over more ownership-based strategies in terms of cost, flexibility, and risk is well established in the literature (c.f., Westphal, Boivie, and Chng 2006). In addition, unique combinations of the resources shared between partners have the potential to create a competitive advantage (Harrison et al. 1991). As a result, the number of strategic alliances, and the financial value attached to those strategic alliances, has increased in recent years (Ireland, Hitt, and Vaidyanath 2002).

Strategic alliances are being sought on an ever-increasing basis by organizations in an effort to enhance innovation and subsequent profitability (Allen and Phillips 2000; Xie and Johnston 2004). Through these strategic partnerships, firms share and leverage each other's resources to generate competitive advantage by compensating for internal knowledge shortcomings and by gaining access to diverse external knowledge (Achrol 1991; Anderson and Narus 1991; Dev and Klein 1993). Millennium Pharmaceuticals, Pfizer, Merck, Microsoft, Cisco, Intel, and Nektar are all examples of firms that have benefited from well-developed alliances that integrate the capabilities of multiple external innovators (Chesbrough and Schwartz 2007). The noted benefits highlight the need for research such as that pursued in the current study.

Theoretical Integration

Irrespective of the form of governance mechanism in place, there is a general consensus regarding the importance of diverse knowledge to the innovation process (Prabhu, Chandy, and Ellis 2005). Some of the resources that are critical to innovation, such as skilled employees (Lepak and Snell 1999), however, are often overlooked (Ireland, Hitt, and Vaidyanath 2002). The knowledge-based view of the firm (Bierly and Chakrabarti 1996; Nonaka 1994; Spender 1996) and human capital theory (Becker 1964;

Lepak and Snell 1999; Tsang, Rumberger, and Levine 1991) suggest that employees provide critical resources to the firm in terms of knowledge generation, acquisition, implementation, and retention (Ireland, Hitt, and Vaidyanath 2002; Wright, Smart, and McMahan 1995).

Resource-dependence theory further indicates that these value-adding resources can be generated either internally or externally through partnerships and boundary-spanning employees (Olson, Walker, and Ruekert 1995; Prabhu, Chandy, and Ellis 2005). For example, Stuart (2000) suggests that organizational innovation and sales growth is enhanced by greater technological capabilities of partners. Effective alliance management starts with internal assessment and proceeds with partner selections that complement internal strengths or compensate for internal weaknesses (Ireland, Hitt, and Vaidyanath 2002). Therefore, the current study integrates theories that apply to both internal and external knowledge acquisition and analyzes the patterns of internal and external resources that lead to innovation.

A Network Approach

Assessing the internal knowledge capabilities of firms is generally straightforward as data are collected directly from an organization, often in the form of employee surveys or "hard" operations numbers. Linking external knowledge to a firm, however, is often more cumbersome. For example, links between firms must be established, and then information from the linked firms must be captured. To deal with the difficulty inherent in capturing external data, the impacts of external resources on organizational performance are often assessed by surveying two firms in a dyad. This method unfortunately exhibits several weaknesses. For example, a "key" partner firm is often the focus of dyadic surveys (Iacobucci and Hopkins 1992). This key partner firm may be one of hundreds and account for less than one percent of a firm's business. In analyzing innovation, this suggests that the resources of a single partner are capable of explaining the totality of innovativeness in a focal firm. According to many scholars (Dyer and Nobeoka 2000; Madhavan, Koka, and Prescott 1998; Powell, Koput, and Smith-Doerr

1996), this is highly unlikely given the need for a large quantity of diverse information when initiating innovation.

To address the problem of excluding relevant partners, analyses of network structures are proposed (Cross, Borgatti, and Parker 2002; Iacobucci and Hopkins 1992; McNamara, Deephouse, and Luce 2003; Syson and Perks 2004). The purpose of this type of analysis is to come as close to the "truth" as possible and to decode the structure of the innovation network. The inclusion of additional data that supports, qualifies, or rejects findings is useful in that it provides managers and researchers with a better idea of what truly impacts innovation. To this end, it is suggested that both internal and external resources be considered.

Borrowing from supply chain terminology, the relational distance between partners can be contextualized as tiers (e.g., Kim and Park 2008). In essence, the organization itself is tier zero, direct partners are at tier one, and all indirect partners are at tier two or greater. Network partners can be either directly or indirectly linked and each impacts organizational performance and innovation (Ahuja 2000). For example, large networks provide diverse information opportunities and an organization may benefit by partnering with another firm that is already linked into a larger network, rather than by expending the effort to develop their own large network. In such cases, an organization banks on their ability to benefit from the knowledge generated by partners of their partners. To this end, McNamara, Deephouse, and Luce (2003) suggest that strategic position in a group of partners determines performance. The importance of network composition is further evidenced by its impact on the performance of startups (Baum, Calabrese, and Silverman 2000). Specifically, Baum, Calabrese, and Silverman (2000) find that startups benefit from being part of large networks with efficient knowledge transfers upon inception.

Given the current lack of understanding of innovation from a network perspective (particularly in services), it is virtually impossible to hypothesize what variables have a significant impact at the various relational tiers. Understanding the characteristics of the direct and indirect tiers of partners, however, can impart useful information. For instance, knowing how much indirectly related firms impact organizational innovation

lends insight into the types of partnerships to develop, with whom, and how many. Such an understanding enables organizations to acquire more diverse sets of resources with less effort and hastens their pursuit of a sustainable competitive advantage.

DATA AND MODEL FORMULATIONS

Data for this study are collected from three sources; COMPUSTAT, *Fortune's* Most Admired Companies, and the SDC Platinum: Joint Ventures & Alliances database**.** Relevant operational data, such as total assets and labor expenses are gathered from COMPUSTAT with data accuracy being confirmed by comparing the COMPUSTAT output to their reported values on form 10K of the SEC filings for each firm. Human capital expenditures (measured as average pension expense per company), R&D expenditures, and marketing expenditures are also extracted from COMPUSTAT. The SDC Platinum: Joint Ventures & Alliances database enables the network structure for the allied firms to be identified. Specifically, the database lists what firms are allied together. The existence of a relationship between two firms is denoted as a "1," while a lack of relationship between two firms is denoted as a "0". The level of innovation is calculated from an aggregate set of industry rankings provided by *Fortune* magazine's annual survey of executives, directors, and financial analysts.

The data sources noted above have been discussed, utilized, and validated in prior research relating to alliances, innovation, and financial performance. For example, Barber, Heath, and Odean (2003) assess the link between appearing on *Fortune's* Most Admired Companies list and subsequent investment decisions by stock groups and individual investors. Brammer, Brooks, and Pavelin (2006) tie corporate social responsibility (from the Most Admired List) to stock returns. Further, Prabhu, Chandy and Ellis (2005) use the SDC database to assess the impacts of acquisitions on innovation, while controlling for firm size and R&D expenditures via COMPUSTAT data.

Social network analysis (SNA) is then used to translate the alliance network structure into firm-level characteristics (centrality, constraint, and range). Social

Network Analysis is an analytical technique that takes relational data sets (where a 1 typically represents a relationship and a 0 represents no relationship) and computes variables for each firm that indicate how the firm is positioned in the network of relationships. Centrality represents the extent which a firm has access to external resources. In the present analysis, centrality derives from the number of direct relationships a firm maintains with other organizations. Constraint refers to the extent to which a focal firm's partners can communicate with each other without going through the focal firm. In this analysis, the measure of constraint is equal to the actual (A) number of links among a firm's direct partners divided by the number of possible (P) links among its direct partners (A/P = C). A firm whose partners are all directly linked to each other is thus totally constrained (C = 1.0), whereas a firm whose partners are not at all linked is totally unconstrained (C = 0.0). Range refers to the number of firms across which information must travel to reach a focal firm. In the current analysis, range derives from the average of the number of links it takes to get from a focal firm to each of the other firms in that firm's network.

Social networks have been investigated in a variety of research settings such as geographic differences in service satisfaction (Mittal, Kamakura, and Govind 2004), geographic differences in customer choice (Jank and Kannan 2005), vertical industry relationships (Economides 1996), and the impacts of market proximity to market intelligence (Cornish 1997). Operational and network characteristics internal to the firm, along with external innovation, operational, and network characteristics are then regressed upon the innovativeness rankings for each firm using a generalized least squares (GLS) approach. The analysis is accomplished with MATLAB.

The result of this approach is the identification of a set of predictors whose impacts are contingent upon their distance from a focal firm. In other words, innovativeness for a given firm depends not only on internal characteristics (tier 0) and the characteristics of direct partners (tier 1), but also on the characteristics of their partner's partners (tier 2) and so on (see Figure 4.1). An advantage of this method over more traditional methods is that each observation need not have the same number of relationships. Hence, the number of predictors for each observation is allowed to differ

in this formulation. Dyadic approaches, on the other hand, require that each observation have the same number of predictors for each observation. The network procedure eliminates this restriction.

Goods and services are both of interest in this research. Standard industrial classification (SIC) codes, along with the industry titles provided by *Fortune*, are used to categorize firms as either goods or service providers. The breakdown of the industry titles belonging to each category, along with each industry's descriptive statistics, is provided in Tables 4.1 and 4.2. In accordance with Capron, Dussauge, and Mitchell (1998), missing values for industries in the tables are mean imputed (i.e., replaced with the overall mean of the rest of the industries) during further analysis. Doing so preserves important relationships in the data without biasing the results (i.e., suggesting that relationships are more positive or negative than they actually are). In other words, the probability that an imputed mean is higher or lower than its actual value is equivalent. The sum of these differences is expected to equal zero (i.e., create no bias).

It is also necessary to partition the data in a way that allows the impacts of goods firms on service firms and vice versus, the impacts of goods firms on other goods firms, and the impacts of service firms on other service firms to be assessed. With only one level of analysis (e.g., only internal independent variables), the data could simply be divided into goods and services to assess internal impacts with separate analyses or interaction terms. In the current analysis, however, further partitioning is necessary in order to capture cross-industry impacts (i.e., how goods partners affect services and vice versus) from both direct and indirect partners. As a result, goods firm innovation is predicted in one analysis, while service firm innovation is predicted in another.

The regression model for goods firms is as follows:

$$\mathbf{y} = \mathbf{X}_G^0 \mathbf{b}_G^0 + \sum_{t=1}^{T} \mathbf{P}_{GG}^t \mathbf{X}_G^t \mathbf{b}_{GG}^t + \sum_{t=1}^{T} \mathbf{P}_{GS}^t \mathbf{X}_S^t \mathbf{b}_{GS}^t + \mathbf{e}_G$$

The regression model for service firms is as follows:

$$\mathbf{y} = \mathbf{X}_S^0 \mathbf{b}_S^0 + \sum_{t=1}^{T} \mathbf{P}_{SS}^t \mathbf{X}_S^t \mathbf{b}_{SS}^t + \sum_{t=1}^{T} \mathbf{P}_{SG}^t \mathbf{X}_G^t \mathbf{b}_{SG}^t + \mathbf{e}_S$$

where,

v : the number of predictor variables;

T : the number of network tiers considered in the model

n_G : the number of goods firms in the sample;

n_S : the number of services firms in the sample;

$\mathbf{y}_G$: an $n_G \times 1$ vector of response variable measurements (innovation measurements) for goods firms;

$\mathbf{y}_S$: an $n_S \times 1$ vector of response variable measurements (innovation measurements) for services firms;

$\mathbf{X}_G$: an $n_G \times v$ matrix of predictor variable measurements (innovation measurements) for goods firms;

$\mathbf{X}_S$: an $n_S \times v$ matrix of predictor variable measurements (innovation measurements) for services firms;

$\mathbf{X}_G^0$: an $n_G \times (v+1)$ matrix of predictor variable measurements for goods firms at tier 0 (direct relationships), which is formed by $[\mathbf{1} : \mathbf{X}_G]$, where $\mathbf{1}$ is an $n_G \times (v+1)$ vector of 1's;

$\mathbf{X}_S^0$: an $n_S \times (v+1)$ matrix of predictor variable measurements for services firms at tier 0 (direct relationships), which is formed by $[\mathbf{1} : \mathbf{X}_S]$, where $\mathbf{1}$ is an $n_S \times (v+1)$ vector of 1's;

$\mathbf{X}_G^t$: an $n_G \times (v+1)$ matrix of predictor variable measurements for good firms at tier t (indirect relationships), which is formed by $[\mathbf{y} : \mathbf{X}_G]$, for $1 \le t \le T$;

$\mathbf{X}_S^t$: an $n_S \times (v+1)$ matrix of predictor variable measurements for services firms at tier t (indirect relationships), which is formed by $[\mathbf{y} : \mathbf{X}_S]$, for $1 \le t \le T$;

$\mathbf{P}_{GG}^t$: an $n_G \times n_G$ binary matrix of structural ties at tier t between goods firms and other goods firms, for $1 \le t \le T$;

$\mathbf{P}_{SS}^t$: an $n_S \times n_S$ binary matrix of structural ties at tier t between services firms and other services firms, for $1 \le t \le T$;

$\mathbf{P}_{SG}^t$: an $n_S \times n_G$ binary matrix of structural ties at tier t between services firms and goods firms, for $1 \le t \le T$;

$\mathbf{P}_{GS}^t$: an $n_G \times n_S$ binary matrix of structural ties at tier t between goods firms and services firms, for $1 \le t \le T$;

$\mathbf{b}_G^0$: a $(v+1) \times 1$ vector of regression coefficients for goods firms at tier 0 (direct relationships);

$\mathbf{b}_S^0$: a $(v+1) \times 1$ vector of regression coefficients for services firms at tier 0 (direct relationships);

$\mathbf{b}_{GG}^t$: a $(v+1) \times 1$ vector of regression coefficients for structural relations between goods firms and other goods firms at tier t, for $1 \le t \le T$;

$\mathbf{b}_{SS}^t$: a $(v+1) \times 1$ vector of regression coefficients for structural relations between services firms and other services firms at tier t, for $1 \le t \le T$;

$\mathbf{b}_{SG}^t$: a $(v+1) \times 1$ vector of regression coefficients for structural relations between services firms and goods firms at tier t, for $1 \le t \le T$;

$\mathbf{b}_{GS}^t$: a $v \times 1$ vector of regression coefficients for structural relations between goods firms and services firms at tier t, for $1 \le t \le T$;

$\mathbf{e}_G$: an $n_G \times 1$ vector of error terms for goods firms;

$\mathbf{e}_S$: an $n_S \times 1$ vector of error terms for services firms;

RESULTS

The results of the GLS regression are presented in Table 4.3 (Goods) and Table 4.4 (Services). The analysis is limited to two tiers (the first level of indirect strategic partners) because analyses of subsequent tiers did not yield any additional explanation. The total variance explained by the models is comparable to other studies in corporate strategy (c.f., Brush and Bromiley 1997). The overall R^2 for the analysis is .098, while the R^2 for the physical goods group is .095 and the R^2 for the services group is .099. The F-statistic for the overall analysis ($F(30, 632) = 2.45$, $p < .001$), as well as for the physical goods ($F(30,258) = 2.05$, $p < .001$) and services ($F(30,375) = 2.91$, $p < .001$) group is significant. Not surprisingly, both types of firms benefit from acquiring and compensating topnotch knowledge workers, while only goods are shown to benefit from being central in their alliance networks. These are indicated by positive coefficients for average pension ($ß_{Goods} = .12$, $p < .05$; $ß_{Services} = .21$, $p < .001$) and centrality ($ß_{Goods} = .05$, $p < .05$) in Tables 4.3 and 4.4.

Analysis of the impacts of direct strategic partners (Tier 1) is where the goods and services findings begin to diverge. First, other goods firms do not appear to impact the innovativeness of focal goods firms. This is evidenced by a lack of significant coefficients for the goods-to-goods variables at Tier 1. Service firms that are direct (first tier) allies of goods firms, however, have a substantial impact on the innovation of goods firms. Specifically, human capital investments of service firms are negatively related to goods firm innovation ($ß = -.27$, $p < .01$). Though on the surface this finding may seem counterintuitive, this likely indicates the type of service capabilities that benefit goods firms rather than suggesting that higher quality service labor is actually detrimental to goods firms. Specifically, lower human capital investments often indicate greater standardization and less complexity due to lower skill levels required (Becker 1964). Standardized practices are easier to transfer and implement than more complex practices (Becker 1964), which limits the amount of attention goods firms must pay to peripheral product features such as value added services. Further support for this point is found in the negative relationship between goods firm innovation and the innovation level of

indirect service partners (ß = -.06, $p < .01$). Lower levels of innovation again identify standardized service firms as better innovation partners for goods firms.

Additionally, greater constraint of first tier service partners of goods firms leads to lower innovation levels (ß = -.74, $p < .001$). This suggests that it is advantageous for first tier service partners to be able to directly communicate with each other and share knowledge. Goods firms are unlikely to compete directly with service firms. Hence, more communication among service partners does not compromise competitive information. It is interesting to note that there is not a significant relationship between goods firm innovation and the characteristics of partnered goods firms. This potentially indicates that little value is derived from partnering with other goods firms.

For service firms, the impact of strategic partnerships is quite different from goods firms. From Table 4.4, it is clear that internal human capital is a key driver of innovation for services, while partner characteristics appear to be of little consequence. As a result, service firms may not benefit from strategic partnerships or from a different set of partner characteristics than those posed in this research.

DISCUSSION

The objective of this research is to examine how the resources that goods and service firms garner from their partners impact the ability to innovate. To do this, the research investigates how network characteristics (centrality, constraint, and range) and human capital investments work to facilitate or hinder organizational innovation. This is one of the first studies to examine the characteristics of goods and service firms in this manner. Further, this research is one of the first to assess innovation through the application of networked data. This is an important contribution to the literature because it is a means of accounting for multiple tiers of networked relationships.

The findings suggest that being central in a network of alliances, and investing in human capital, are important drivers of innovation for goods firms, while internal human capital investments are the primary driver of innovation for service firms. In addition, goods firms appear to benefit from service firms with low human capital investments,

which are also constrained (i.e., their partners are able to communicate without going through the focal service firm). These findings have substantial implications for both practitioners and academics, which are detailed in the next section.

In addition to the practical findings, this research introduces to the marketing literature a new network technique for use in investigating how drivers of internal and external knowledge impact organizational innovation. The importance of this technique in innovation research resides in its ability to identify the impacts of external knowledge resources generated from networks rather than simple dyads. Dyadic research paved the way for this study by highlighting important innovation antecedents and establishing their ability to predict innovation in isolation from other potentially key partners. The contexts in which these dyads are investigated, however, are necessarily limited by the exclusion of other key players. This is not to say that the analysis presented here is devoid of the potential for exclusion of relevant firms. Rather, the network approach is the next logical step in the evolution of multi-firm, multi-level, analyses.

Managerial Implications

Managers in both goods and service firms can benefit from the findings identified by this research. Goods firms appear to prosper from relationships with specific types of service allies (i.e., those with low innovation and low human capital expenditures), while service firms do not appear to prosper from partners at all. This could be a sign that services tend to utilize a commodity approach whereby they focus more heavily on their own firms' core service activities. Differences in the way each type of firm is likely to benefit from knowledge sharing provide some explanation for these effects.

Irrespective of the distance of the relationship, the results suggest that goods firms benefit from allying with less innovative service firms that are relatively unconstrained. In other words, goods firms should ally with standardized service providers that do not focus their competitive efforts on innovation. A potential reason for this lies in the need for goods firms to develop procedural efficiencies so that they can focus on their core competencies (Aguayo 1990). Service innovation often requires constant adaptation, which is not conducive to efficiency (Lyons, Chatman, and Joyce 2007). Goods firms are

therefore advised to seek service firms that have well-established processes that can be used in innovative ways (Bröring, Cloutier, and Leker 2006).

In addition to partner characteristics, the results suggest that goods firms should ensure that seek to limit communication amongst their service partners. This is because unconstrained service partners are shown to enhance the innovation efforts of goods firms. Once service firms hone and standardize innovative processes, goods firms may then be poised to better adapt the innovative processes and knowledge to the needs of their own organizations. Lack of communication amongst service partners helps prevent competitive information from being spread across too many organizations, resulting in a loss of competitive advantage. These findings may seem counterintuitive, as innovation is typically tied to concepts such as customization and being on the cutting edge. The speed of change and heterogeneity inherent in service processes, however, make innovative processes unlikely candidates for adoption by goods firms. Rather, goods-based innovation relies on the ability to adapt existing, tested, practices to new manufacturing needs as opposed to integrating new untested processes (Bröring, Cloutier, and Leker 2006).

Research Implications

This research points to the potential contribution of a network approach to parameter estimation in marketing research. While this research focuses primarily on key innovation drivers in goods and services, consideration of networked/relationship data has far reaching implications. For example, supply chain and channels research largely investigates dyadic samples despite the potential importance of considering larger network effects. Specifically, networks allow for greater levels of information to be included in analyses and thus generate more accurate results. Further, ignoring these partner networks imparts biased results through exclusion of relevant regressors, such as the impact of partner characteristics on innovation.

The use of network analyses in marketing is in its infancy, as only a handful of articles employ such methods (e.g., Allaway, Berkowitz, and D'Souza 2003; Bronnenberg and Mahajan 2001). A potential impact of traditional methods, such as

dyadic collections, is in limiting theories to those that can be tested with traditional methods. For example, supply chain contagion is defined in terms of the dyadic impacts of one firm's actions on another (McFarland, Bloodgood, and Payan 2008). This does not include far reaching impacts such as how a manufacturer's actions toward a wholesaler impact subsequent actions by retailers. For example, a manufacturer's inventory level impacts the rest of the supply chain and not just those in direct relationships with the manufacturer. Network analysis provides a methodological tool for reaching beyond these direct impacts and assessing the wave of indirect impacts that result when one member of a chain takes some action. As a result, theory development expands in scope beyond the consideration of simple internal characteristics and immediate relationships and considers a broader range of effects. More directly, network analysis points to the need for more expansive theories and hypotheses that account for more distant levels of relationships. Just like the inclusion of control variables in empirical estimations, accounting for these additional impacts increases the accuracy of results.

In addition to the methodological contributions, the relationship between firm characteristics and innovation is important to researchers. The results suggest that employee benefits, the centrality of organizations in alliance networks, and the constraint of organizations in alliance networks may be important drivers of innovation (indicated by the significant coefficients in Table 4.3 and Table 4.4). As a result, researchers should continue to investigate the importance of these variables in bolstering or suppressing key organizational capabilities such as innovation.

Limitations and Future Research

While this study provides valuable insights into how network structures impact innovation, it has several limitations. This study's limitations primarily pertain to the data sources available for analysis. The SDC alliances and joint ventures database is widely used for investigating networked relationships. It is limited, however, to publicly announced alliances. It has the potential to ignore key alliances that are generated out of view of the public. This has the potential to lead to the problems of exclusion discussed

above. In addition, this research limits its focus to alliances in general. The SDC database provides specific information on the type of alliance formed (e.g., marketing, information technology, or manufacturing). Future research should consider more specific breakdowns of alliances when less encumbered by sample size concerns, as different alliance types likely create different types of knowledge resources that may have differing effects on innovation.

Innovation, and innovation predictors also have the potential to be measured in different ways. The innovation measure used in this study is drawn from *Fortune* and the employee compensation data are drawn from COMPUSTAT. These data sources contain publicly traded *Fortune* 1000 firms, excluding smaller, private firms. Additionally, centrality, constraint, and range are established via social network analysis of the SDC database. Future research should consider alternative data sources that build on the findings presented herein by including small private firms and assessing other sources of network relationships. Such an analysis can aid in understanding how firm size, financial resources, and organizational structure impacts the ability to innovate. For example, it is suggested that smaller companies are more flexible and adapt faster than larger companies. Economies of scale, however, support the notion that larger firms have greater access to knowledge resources and are hence more innovative. As a result, smaller firms may not be endowed with resources that allow them to make as many network connections as larger firms. A further difficulty lies in the fact that data on smaller companies needs to be accessed by contacting each firm individually, perhaps through chambers of commerce. This, however, represents a rather daunting task and could result in a great deal of missing data.

Using SIC codes to classify firms as goods or services represents a final potential limitation in this research. While SIC codes are often used for such classifications, firms may have multiple business units that include both goods and services. As a result, the primary SIC code identified for each company may not effectively distinguish between goods and services firms. Future research should examine alternative methods for classification and revisit potential similarities between goods and service firms.

TABLE 4.1: INDUSTRIES AND DESCRIPTIVE STATISTICS (GOODS FIRMS, N = 119)

	Total Assets*	R&D Expense*	Marketing Expense*	Average Pension**	Centrality	Constraint	Range
Aerospace and Defense (n=10)	27,572	968		103	8.66	.19	3.23
	(14,001)	(934)		(.38)	(10.33)	(.29)	(2.07)
Apparel (n=8)	2,958		150		2.29	.28	1.60
	(1,484)		(109)		(.95)	(.34)	(1.70)
Chemicals (n=11)	23,638	650	716	86	9.30	.02	5.08
	(24,198)	(949)	(1,076)	(2.85)	(8.37)	(.02)	(2.47)
Computers (n=9)	32,508	1,987	617		20.1	.09	4.83
	(36,069)	(1,938)	(536)		(23.33)	(.20)	(.88)
Consumer Food Products (n=7)	28,887	650	1,998	39.48	4.8	.00	3.29
	(28,433)	(613)	(2,787)		(5.22)	(.01)	(2.56)
Food Production (n=7)	7,853	33.50	493		3.6	.12	2.78
	(7,847)	(16.26)			(4.72)	(.16)	(2.83)
Household and Personal Products (n=9)	20,465	329	1,430		3.33	.06	5.74
	(43,453)	(662)	(2,238)		(2.94)	(.14)	(2.61)
Metals (n=9)	12,896	119		64.61	3.57	.11	2.48
	(12,215)	(114)			(2.70)	(.24)	(2.25)
Mining, Crude-Oil Production (n=10)	21,329	2.84	1.80	8.09	3.17	.04	3.65
	(17,563)				(2.14)	(.10)	(2.27)
Motor Vehicles (n=5)	182,380	5,408	4,627	79.94	13.63	.03	5.27
	(101,971)	(2,972)	(1,089)	(9.40)	(9.46)	(.03)	(.99)
Motor Vehicles and Parts (n=6)	11,731	424	163		11.29	.46	4.36
	(6,465)	(253)	(225)		(12.88)	(1.07)	(2.36)
Petroleum Refining (n=8)	100,518	345	87	107	9.57	.05	4.64
	(93,226)	(288)			(8.06)	(.09)	(1.78)
Publishing (n=9)	6,123		234	57.40	2.00	.06	1.95
	(5,197)		(313)		(1.67)	(.14)	(2.63)
Semiconductors (n=11)	11,259	1,166	751		15.8	.07	4.19
	(12,999)	(1,732)	(1,054)		(21.86)	(.16)	(1.50)

Note: Means are shown with standard deviations below in parentheses; *000,000; **000.

TABLE 4.2: INDUSTRIES AND DESCRIPTIVE STATISTICS (SERVICES, N = 181)

	Total Assets*	R&D Expense*	Marketing Expense*	Average Pension**	Centrality	Constraint	Range
Delivery (n=4)	12,026			61.26	1.5	.08	3.83
	(18,361)			(5.95)	(.58)	(.17)	(3.93)
Electric and Gas Utilities (n=12)	33,969				1.0	0	.5
	(8,636)				(0)	(0)	(0)
Energy (n=8)	23,571				1.71	.00	4.95
	(21,298)				(.76)	(.00)	(3.27)
Engineering, Construction (n=8)	2,615			19.80	2.5	.39	2.63
	(1,027)				(1.05)	(.38)	(2.71)
Entertainment (n=10)	27,571	77.99	1,434		5.2	.00	4.58
	(43,331)	(50.93)	(1,799)		(5.05)	(.01)	(2.88)
Financial Data Services (n=8)	10,806	309	35.55		6	.12	3.82
	(12,741)	(397)	(5.59)		(4.87)	(.24)	(2.40)
Food Services (n=10)	5,319	19.75	225	10.28	9.33	.01	3.80
	(8,483)	(18.74)	(249)	(2.30)	(7.37)	(.01)	(2.91)
General Merchandisers (n=9)	28,259		862		3.6	.00	6.63
	(50,957)		(832)		(2.41)	(.00)	(.60)
Hotels, Casinos, Resorts (n=8)	9,312		134		7.71	.15	3.58
	(6,827)		(116)		(5.35)	(.26)	(2.68)
Information Technology Services (n=9)	7,656	178	38.66	44.27	13.67	.02	4.97
	(6,328)	(155)	(42.65)		(8.53)	(.02)	(1.34)
Internet Services and Retailing (n=7)	9,470	651	404		14.17	.04	5.08
	(6,332)	(441)	(317)		(13.14)	(.07)	(1.11)
Megabanks and Credit Card Companies	670,390			84.32	6.56	.00	4.84
(n=10)	(657,088)			(18.14)	(4.77)	(.01)	(2.49)
	183,759		260	95.46	1.67	.19	.72
Mortgage Services (n=8)	(282,598)			(45.13)	(.52)	(.16)	(.23)
	14,479	1,283	5.80		17.08	.19	3.79
Network Communications (n=12)	(14,943)	(1,580)	(1.41)		(15.61)	(.47)	(1.47)
	17,657		88.48		3	.33	2.90
Real Estate (n=6)	(5,485)				(1.79)	(.82)	(2.51)
	365,413		156	316	4.11	.04	6.50
Securities (n=9)	(376,884)			(172)	(2.62)	(.11)	(2.71)
	14,364		593		3.71	.00	4.94
Specialty Retailers (n=11)	(14,324)		(278)		(2.98)	(.00)	(2.16)
	89,775			92.01	2.75	.08	5.14
Superregional Banks (n=11)	(31,449)			(25.46)	(1.58)	(.21)	(2.75)
	88,727	140	1,074		9.42	.01	4.60
Telecommunications (n=7)	(103,549)	(118)	(839)		(7.22)	(.02)	(.33)
	2,818			54.07	1.5	.17	.58
Trucking (n=7)	(2,502)			(18.95)	(.71)	(.24)	(.12)
	3,264		43.95		5.43	.07	3.83
Wholesalers: Electronics (n=7)	(2,443)		(64.58)		(6.16)	(.12)	(2.86)

Note: Means are shown with standard deviations below in parentheses. * Values are in millions of dollars.

TABLE 4.3: REGRESSION RESULTS FOR PHYSICAL GOODS FIRMS

R2 = .095, F (30, 258) = 2.05, $p < .001$			
	B	Standard Error	T
INTERNAL EFFECTS			
Constant	5.20	.20	26.29***
Total Assets	-.00	.00	-.20
Average Pension	.12	.07	1.73+
Centrality	.05	.03	1.98*
Constraint	-.19	.18	-1.08
Range	.11	.07	1.72+
FIRST TIER PHYSICAL GOODS EFFECTS			
Innovation	.07	.05	.88
Total Assets	.00	.00	.00
Average Pension	-.04	.10	-.32
Centrality	.00	.02	.07
Constraint	.14	.18	.34
Range	.09	.11	.62
FIRST TIER SERVICES EFFECTS			
Innovation	-.00	.05	-.04
Total Assets	-.00	.00	-.00
Average Pension	-.27	.10	-2.81**
Centrality	-.01	.02	-.58
Constraint	-.74	.18	-4.01***
Range	.04	.11	.39
SECOND TIER PHYSICAL GOODS EFFECTS			
Innovation	-.00	.02	-.04
Total Assets	.00	.00	.00
Average Pension	-.01	.04	-.07
Centrality	-.01	.01	-.25
Constraint	-.17	.09	-.53
Range	.10	.05	.77
SECOND TIER SERVICES EFFECTS			
Innovation	-.06	.02	-3.01**
Total Assets	.00	.00	.00
Average Pension	-.04	.04	-1.04
Centrality	-.01	.01	-.52
Constraint	.03	.09	.30
Range	-.01	.05	-.14

+$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$

TABLE 4.4: REGRESSION RESULTS FOR SERVICE FIRMS

R2 = .099, F(30, 375) = 2.91, $p < .001$			
	B	Standard Error	T
INTERNAL EFFECTS			
Constant	5.27	.16	33.90***
Total Assets	-.00	.00	-.26
Average Pension	.21	.06	3.53***
Centrality	.05	.03	1.72+
Constraint	-.01	.11	-.10
Range	.01	.06	.10
FIRST TIER SERVICES EFFECTS			
Innovation	-.06	.05	-.84
Total Assets	.00	.00	.00
Average Pension	.02	.10	.17
Centrality	-.04	.02	-.81
Constraint	-.67	.18	-1.35
Range	.03	.11	.19
FIRST TIER PHYSICAL GOODS EFFECTS			
Innovation	-.08	.05	-1.64+
Total Assets	.00	.00	.00
Average Pension	-.13	.10	1.35
Centrality	.01	.02	.54
Constraint	-.07	.18	.39
Range	.22	.11	2.07*
SECOND TIER SERVICES EFFECTS			
Innovation	-.01	.02	-.17
Total Assets	-.00	.00	-.00
Average Pension	.12	.04	.99
Centrality	-.01	.01	-.32
Constraint	-.16	.09	-.41
Range	.05	.05	.38
SECOND TIER PHYSICAL GOODS EFFECTS			
Innovation	-.00	.02	-.06
Total Assets	-.00	.00	-.00
Average Pension	-.00	.04	-.04
Centrality	.00	.01	.01
Constraint	.02	.09	.20
Range	-.05	.05	-.85

+$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$

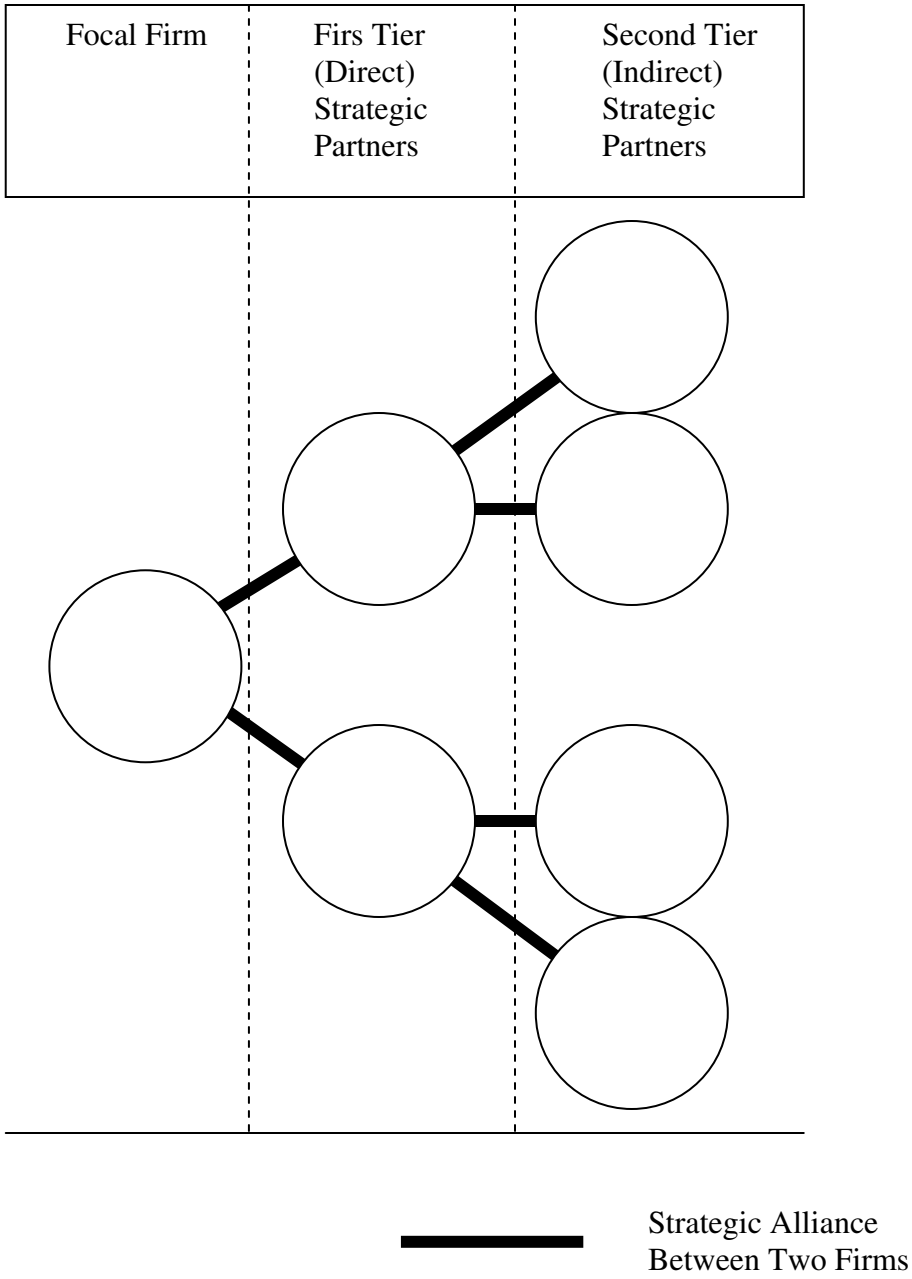

FIGURE 4.1: TIERS OF STRATEGIC PARTNERS

CHAPTER FIVE
SUMMARY AND CONCLUSIONS

This section presents an overarching integration of the results and implications of each of the three essays. In so doing, the larger scale contribution of this research is identified. The overall purpose of this research was to examine potential drivers of successful innovation. Essay 1 investigated the relative impacts of internal investments in innovation such as human capital, research and development, and marketing expenditures. The findings from Essay 1 support the notion that high quality employees are key ingredients of successful innovation across multiple industries. Essay 2 then focused on external drivers of innovation, such as position in a network of strategic partners. The results of Essay 2 suggest that firms can enhance innovation efforts by centrally positioning themselves in networks of strategic partners and controlling knowledge that flows to those partners. Finally, Essay 3 examined both internal and external drivers collectively, while also assessing the characteristics of strategic partners. The findings from Essay 3 extend the first two essays by showing the value to goods firms in having constrained service firms as partners (i.e., service partners that are not able to restrict knowledge access by other firms). The results of these three essays have important implications for both theory and practice.

Overall Managerial Implications

On the practitioner side, the results help identify investments that are likely to enhance innovation across a wide range of industries. Specifically, the findings imply that better employee compensation is associated with greater innovation. This is assumed to be a function of greater skill sets such as critical thinking, creativity, and boundary spanning. From a human resources perspective, firms competing on innovation in any industry are thus advised to hire capable, high quality employees and then pay them well in order to motivate performance, while limiting defections to competing firms. Even companies that prosper from innovative cost cutting strategies, such as Wal-Mart, require skilled managers to make those assessments and implement innovative actions.

The number of external organizations with which a firm chooses to ally (centrality) is also an important driver of innovation. This is assumed to result from the acquisition of a diverse range of external knowledge (e.g., cutting edge techniques and marketplace awareness). From a strategic management perspective, firms competing on innovation are thus advised to develop partnerships with firms that provide knowledge diversity. Within-industry competition may result in myopic benchmarking and mirror image competitive reactions. For example, Southwest Airlines benchmarks Indy racing to innovate plane turnaround rather than focusing on the efforts of other airlines. Extending beyond the scope of one's own industry provides strategic planners with access to a cache of competitive weapons that are more likely to be rare, valuable, and not easily imitated, thus offering the potential for competitive advantage.

Finally, limiting relationships among direct strategic partners and the knowledge that flows to them is positively associated with innovation. From a managerial standpoint, this result suggests that firms should attempt to partner with others that can be persuaded to act in the interest of the focal firms (i.e., are heavily reliant on the resources of their partner firm and limited in their ability to seek many strategic partnerships). Such control is often achieved through exclusivity contracts, sole sourcing practices, or simply by occupying another firm's resources so that they cannot be deployed elsewhere (Barney 1991).

Overall Research Implications

In addition to practical implications, this dissertation makes several important contributions to innovation research. First, this research revises traditional perspectives that base innovation on physical goods production by taking a more universal, knowledge-based perspective. This is not the first research to suggest such a stance in general. Rather, it combines knowledge- (e.g., Conner and Prahalad 1996; Grant 1996) and service-based (e.g., Vargo and Lusch 2004) perspectives for the specific purpose of uncovering innovation drivers. Specifically, this dissertation views and empirically supports the notion that innovation is enhanced by investments in human capital and strategic partnerships. The findings suggest that researchers can benefit from taking a

broader view of innovation in the future and focusing on knowledge as a critical input to the innovation process.

The second research contribution is the introduction and empirical testing of new antecedents to innovation. Specifically, employee compensation, centrality, constraint, and range have not previously been examined in the prediction of innovation. The results suggest that both compensation (internal drivers) and position in a network of strategic partners (external drivers) are useful predictors of innovation. The investigation and application of new variables adds breadth and depth of understanding to the drivers of innovation. With increased understanding comes increased explanation and enhanced prediction of innovation.

The third research contribution is the identification and application of spatial econometrics techniques to the investigation of networked organizations. Only a handful of researchers have utilized spatial models in marketing research. However, the overwhelming majority of these studies views space in literal terms, such as geographic distance (e.g., Allaway, Berkowitz, and D'Souza 2003; Bronnenberg and Mahajan 2001). Unlike other research, this research views distance in terms of direct versus indirect contiguous relationships. Adopting this binary approach is more appropriate when identifying whether or not a connection exists between organizations. Further, as calls to examine network structures gain speed, researchers need to be able to move beyond simple descriptive tools, such as social network analysis, and adopt more predictive tools, such as spatial econometrics.

Overall Limitations and Research Extensions

Despite the value of this dissertation to theory and practice, there are two potentially limiting factors of the research and several valuable avenues for future research to consider. A potential limitation recognized in each essay is the level of data analysis. In each essay, secondary data is utilized to investigate the proposed relationships among the constructs. Such data are valuable for generalizing findings, but limit the extent to which more specific and actionable relationships can be established. For instance, this dissertation suggests that investing in employees and strategic

partnerships fosters innovation. However, the specifics of such investments (e.g., What level of employee? What forms of compensation are most effective? Are certain types of alliances more effective than others?) are not addressed in this research. A valuable extension of this dissertation would be to bring the analysis to an employee or alliance dyad level. More detailed research utilizing primary data (e.g., surveys or internal data) could then be generated.

Another potential limitation that spans the three essays is the variables investigated. While compensation, centrality, and constraint are shown to be valuable predictors of innovation, other internal and external variables may add value to innovation prediction. Future research should continue to evaluate each of these constructs using different data and different methodologies, while extending investigations into other potential drivers of innovation. For example, other network descriptors such as density and centralization might be valuable predictors of innovation. Analyzing these variables, however, requires a series of different networks across which to make comparisons that were not available in this research data. Future research should therefore employ additional types of data that encompass alternative network structures.

Using SIC codes to classify firms as goods or services represents a final potential limitation across this research. While SIC codes are often used for such classifications, firms may have multiple business units that include both goods and services. As a result, the primary SIC code identified for each company may not effectively distinguish between goods and services firms. Future research should examine alternative methods for classification and revisit potential similarities between goods and service firms.

APPENDIX A

MATLAB CODE FOR SOCIAL NETWORK CALCULATIONS

```
%************************************************
%
% This program takes a dataset of the form:
%
%a= [1,10,1;
%    2,80,0;
%    2,70,0;
%    3,40,1;
%    3,50,1;
%    4,30,0;
%    5,20,0;
%    6,80,1;
%    7,71,0;
%    8,50,1;
%    8,60,1;
%    9,80,0;
%    10,999,1;
%    11,999,1;
%    12,999,0];
%
% and turns it into a network contiguity matrix.
% That matrix is then saved to the file netdata.dat
%
%************************************************

tic;
 load Alliances2007.dat;
a=[Alliances2007(:,:)];
toc
b=[];
h=2;
m=0;
[n,d]=size(a);

%*********************************************************************
%Reduce the data size by eliminating observations that are not connected to
%networks of interest (i.e., those that contain focal observations.
for i=1:n
   if a(i,3)==1
      b(i-m,1)=a(i,1);
      b(i-m,2)=a(i,2);
```

```
      b(i-m,3)=0;
      for j=h:n
         if a(i,2)==a(j,2)
            a(j,3)=1;
            for k=1:n
               if a(k,1)==a(j,1)
                  a(k,3)=1;
               end
            end
         end
      end
   else
      m=m+1;
   end
h=h+1;
end
[u,p]=size(b);
a=[];
toc
%*************************************************************************

%*************************************************************************
%Sort the B matrix by company
c=[];
c=sortrows(b,1);
b=[];
%*************************************************************************

%*************************************************************************
%Create a matrix of coordinates in the c matrix to signify where each
%company falls in the contiguity matrix
coord=1;
c(1,3)=coord;
%Create coordinates in the C Matrix
for i=1:(u-1)
      if c(i,1)==c(i+1,1)
         c(i+1,3)=coord;
      else
         coord=coord+1;
         c(i+1,3)=coord;
      end
end
toc
%*************************************************************************
```

```
%*************************************************************************
%Create a matrix of unique company values
t=1;
d(1,1)=c(1,1);
d(1,2)=c(1,3);
for i=1:(u-1)
   if c(i,1)~=c(i+1,1)
      d(t+1,1)=c(i+1,1);
      d(t+1,2)=c(i+1,3);
      t=t+1;
   end
end
toc
%*************************************************************************

%*************************************************************************
[u,p]=size(c);
topnum=(max(c(:,3)));
cont=[zeros(topnum)];
gcnt=0;
%CREATE THE CONTIGUITY MATRIX
for i=1:(u-1)
       for j=2:u
          if c(i,2)==c(j,2)
             cont((c(i,3)),(c(j,3)))=1;
             cont((c(j,3)),(c(i,3)))=1;
             cont((c(i,3)),(c(i,3)))=0;
             cont((c(j,3)),(c(j,3)))=0;
          end
       end
       gcnt=gcnt+1;
       gcnt
       toc
end
toc
%*************************************************************************

%*************************************************************************
%Calculate the centrality for each observation
constraint=[];
po=0;
cont2=cont;
for i=1:topnum
   centrality=sum(cont)';
end
```

```
%*************************************************************************

%*************************************************************************
%Calculate the constraint for each observation
for i=1:topnum
   gg=(cont(i,:));
   ctc=find(gg);
   ddd=(cont(ctc,ctc)-1)*-1;
   eee=tril(ddd,-1);
   fff(i,1)=sum(sum(eee));
end
constraint=0-fff;
%*************************************************************************

%*************************************************************************
%Calculate the total pathlength for each observation
for i=1:topnum
   for j=1:topnum
      links=(cont2(:,j));
      locatelinks=find(links==i);
      [rowa columna]=size(locatelinks);
      if locatelinks~=0
      for k=1:rowa
         for m=1:topnum
            if cont2(m,j)==0
               if (cont2(m,locatelinks(k,1)))~=0
                  cont2(m,j)=cont2(m,locatelinks(k,1))+i;
               end
            else
               if (cont2(m,locatelinks(k,1)))~=0
                  if (cont2(m,locatelinks(k,1))+i)<(cont2(m,j))
                     cont2(m,j)=cont2(m,locatelinks(k,1))+i;
                  end
               end
            end
         end
         cont2(j,j)=0;
      end
      end
   end
   toc
   po=po+1;
   po
end
pathlength=(sum(cont2))';
```

```
%*************************************************************************

%*************************************************************************
%Determine to which network each firm belongs and add it to the d matrix
d(1,3)=0;
cnt=1;
d(1,3)=cnt;
for i=1:topnum
      v=(cont2(i,:));
      w=find(v);
      [p,m]=size(w);
      if d(i,3)==0
         cnt=cnt+1;
         d(i,3)=cnt;
      end
         for j=1:m
            if d((d((w(1,j)),2)),3)==0
              d((d((w(1,j)),2)),3)=d(i,3);
            end
         end
end
%*************************************************************************
dlmwrite('cont07.txt',cont2,',');
cont2=[];
%*************************************************************************
%Determine how many firms are in each network and provide it for each
%observation in the d matrix
septs=max(d(:,3));
for i=1:septs
   qq=find(d(:,3)==i);
   [networksize(i),tt]=size(qq);
end
for i=1:topnum
   d(i,4)=networksize(1,(d(i,3)));
end
%*************************************************************************

results=[d centrality constraint pathlength]
d=[];
centrality=[];
constraint=[];
pathlength=[];
dlmwrite('results07_2.csv',results,',');
toc
```

APPENDIX B

MATLAB CODE FOR SPATIAL ECONOMETRICS ANALYSIS

```
%*************************************************************************
%
%The purpose of this program is to calculate coefficients and tests for
%spatial econometrics models.
%
%*************************************************************************

%*********************************************
%This line sets the number of tiers of interest
%
tiers = 1;
%*********************************************

%*************************************************************************
%This section loads the contiguity matrix, response variable, and predictor
%variables
%ivs=   [6,2;
%       6,2;
%      6,2;
%       6,1;
%       6,1;
%       4,1;
%       4,2];

%dv = [4;5;2;5;5;7;7];

ivs2=[dv ivs];
ivs = [ones(size(dv)) ivs];

[n,e]=size(dv);
[n,d]=size(ivs);

ivnet= [1,1,0,0,0,2,3;
       1,1,0,0,0,2,3;
       0,0,1,1,0,2,3;
       0,0,1,1,0,2,3;
       3,3,3,3,2,0,1;
       3,3,3,3,2,0,0;
       3,3,3,3,2,0,1];

mid=eye([n]);
```

```
ivnet2(:,:,1)=mid;
for i=1:(tiers)
   for j=1:n
      for k=1:n
         if ivnet(j,k)==i
            ivnet2(j,k,(i+1))=1;
         else
            ivnet2(j,k,(i+1))=0;
         end
      end
   end
end
ivnet2(:,:,2) = ivnet2(:,:,2)-mid;
%*********************************************

%*********************************************
%This part initializes the parameter estimates
%
G_init=[zeros(d,1)];
B_init=[zeros(d,tiers)];
G_best=G_init;
B_best=B_init;
B_new=[];
G_new=[];

%*********************************************

%*************************************************
%This section sets the initial error sum of squares
%
e1=dv-ivnet2(:,:,1)*ivs*G_init;
for i=1:tiers
   e1=e1-ivnet2(:,:,(i+1))*ivs2*B_init(:,i);
end
sse_init=e1'*e1;

%*************************************************

%*************************************************************************
%This part recomputes the error sum of squares to find more optimal
%parameter estimates
%
sse_best=sse_init;

for i=1:1000000
```

```
%This section creates new parameter estimates to test
%Right now it simply enters random numbers looking for the best
%result
   for j=1:d
   mmm=rand();
   nnn=rand();
   if mmm <.5
      ttt = -1;
   else
      ttt = 1;
   end
   if nnn <.5
      sss = -1;
   else
      sss = 1;
   end
      G_new(j,1)=G_init(j,1)+(ttt*rand());
   end

   for j=1:tiers
      for k=1:d
      mmm=rand();
      nnn=rand();
      if mmm <.5
         ttt = -1;
      else
         ttt = 1;
      end
      if nnn <.5
         sss = -1;
      else
         sss = 1;
      end
         B_new(k,j)=B_init(k,j)+(sss*rand());
      end
   end
%*****************************************************
%Recompute the error sum of squares
e2=dv-ivnet2(:,:,1)*ivs*G_new;
for i=1:tiers
   e2=e2-ivnet2(:,:,(i+1))*ivs2*B_new(:,i);
end
sse_new=e2'*e2;
%**********************************
%If the new error sum of squares is lower, then make it the
```

```
        %incumbent
        if sse_new < sse_init
           sse_best=sse_new;
           sse_init=sse_new;
           G_best=G_new;
           B_best=B_new;
           G_init=G_new;
           B_init=B_new;
        end
end

xset=[];
vars=[ivs];
for i=1:(tiers)
    vars=[vars (ivnet2(:,:,(i+1))*ivs2)];
end

xset=diag(inv(vars'*vars));
mse=(sse_best./(n-(d*(tiers+1))));  %The degrees of freedom are probably not right here
dvbar=(sum(dv))/n;
sst=sum((dv-dvbar).^2);
xset=xset.*mse;
ssr=sst-sse_best;
msr=ssr./(d*(tiers+1));
F=msr/mse;
stderr=xset.^0.5;
T=[];
coef=[G_best;B_best];
T = coef./xset.^0.5;
r2=ssr/sst;
disp('#######New Results Start Here######');
disp('R2--------------------------------');
[r2]
disp('SSE-----MSE-------F----------------');
[ssr msr F]
[sse_best mse]
[sst]
disp('-----------------------------------');
disp('Param     StdErr     T-Value');
[coef xset T]
```

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BIOGRAPHICAL SKETCH

Gavin L. Fox was born in Norfolk, Virginia in 1976. Gavin received his Bachelor's degree in Management Science and Information Technology in May of 1999 and his MBA in May of 2001 from Virginia Tech. Gavin served in the Virginia National Guard and Army Reserve a combined ten years as an infantry private and a quartermaster officer. He was called to active service on his first day in the Ph.D. program at Florida State in August of 2004. He was deployed as a warehouse platoon leader to Balad, Iraq in 2004 and 2005. Upon his return, Gavin resumed Ph.D. work in the summer of 2005.

Gavin has consulted on marketing and logistics for Fortune 100 companies and small startup firms. His love of variety and academic excellence has placed him in a number of diverse environments. He has taught business and statistics courses at several colleges and universities in the United States and Canada since 2001. Gavin was awarded the degree of Doctor of Philosophy in Marketing from Florida State University in May of 2009. He accepted a position as an Assistant Professor of Marketing at Texas Tech University.

Gavin's research interests center on innovation, firm profitability, and marketing metrics, with a particular interest in developing new analytical techniques for use in academic and business applications. Gavin's research has been published or accepted for publication in *Journal of Retailing*, *Multivariate Behavioral Research, Journal of Advertising, Psychology & Marketing*, *Industrial Marketing Management*, *The Journal of Services Marketing*, *International Journal of Operations and Production Management*, and *Journal of Consumer Satisfaction, Dissatisfaction and Complaining Behavior*, *Supply Chain Management*, as well as in the proceedings of a number of national conferences.