THE ANTECEDENTS OF SUPPLY CHAIN MANUFACTURING JOINT VENTURES: A SOCIAL NETWORK PERSPECTIVE

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ABSTRACT OF THE DISSERTATION

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This thesis explores the role that various network constructs play in explaining partner selection in the formation of new supply chain manufacturing joint ventures. The overarching perspective of the thesis takes root in the idea that the structural properties of the network in which a firm is embedded are a significant explanatory mechanism in understanding supply chain manufacturing joint venture formations. This thesis draws from and extends the current understanding of social network and collaborative partnership theories by positing specific, theoretically driven hypotheses regarding various structural network characteristics such as ego network composition, measures of network centrality and network remoteness. This thesis further extends the current body of knowledge on supply chain joint ventures by comparing the joint venture formations of Original Equipment Manufacturers (OEMs) and Component Suppliers. Additional hypotheses regarding joint venture formations of domestic and international partners are also explored. In order to empirically test these hypotheses four econometric models are estimated: two discrete time event history analyses, with time-varying independent

variables are used to estimate the effects of the ego network and structural network constructs on the probability of a new manufacturing Joint Venture being formed. Additionally, to test the varying effects of OEMs as compared with Component Suppliers, and International vs. Domestic joint venture formations, two separate multinomial logistic event history models with time-varying independent variables are estimated. Results provide empirical support for the role of network structure, at multiple levels, in mitigating the uncertainties of new equity based partnership decisions in global supply chain networks.

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PREFACE

This Ph.D. thesis entitled, "The Antecedents of Supply Chain Manufacturing Joint Venture Formations: A Social Network Approach" was prepared by Steven Carnovale during the period from May 2012 until December 2013 at the Department of Supply Chain Management and Marketing Science, Rutgers University.

This thesis was written under the direction of my advisor, Dr. Sengun Yeniyurt and explores the role that various structural properties of the network in which a firm is embedded have on partner selection in new supply chain manufacturing joint venture formations.

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Although I have so many people to whom a sincere debt of gratitude is owed, I must begin by thanking my advisor Dr. Sengun Yeniyurt. I have had the pleasure of getting to know and work with him over the past four years and without his guidance, neither this thesis nor my acquisition of a Ph.D. would be possible. Secondly, I must also thank the members of my dissertation committee, Drs. Craig Carter, Lei Lei, Dale Rogers and Arash Azadegan. Their expertise and advise with research, teaching and all other matters has been fundamental to my development as an academic; for that I am sincerely grateful and indebted. Two final remarks of gratitude must be made. First to my mother, for providing me with an endless supply of inspiration and support throughout my entire academic journey. Without her I would not be where I am today. Finally, to my loving fiancé and soon-to-be wife. She has dealt with the struggles over the past four years with support and confidence, without her it would also not have been possible.

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CHAPTER 1: INTRODUCTION

As supply chains transcend traditional company boundaries the complexity associated with inter-organizational networks presents significant challenges to managers. The complexity arises not just from the great number of companies involved in a typical supply chain, but also from the myriad of inter-organizational connections among them. This large number of players and relationships results in increasingly complex supply networks (Choi, Dooley, & Rungtusanatham, 2001) where each company constantly aims to identify and engage in new partnerships while maintaining their existing partnership portfolio. In fact in recent years, much research has been conducted to articulate that, rather than viewing a businesses in isolation of its network participants, embraces the overall network structure as an important explanatory mechanism for firm behavior (Borgatti & Halgin, 2011; Borgatti & Li, 2009) particularly supply chain networks (Choi et al., 2001; Kim, Choi, Yan, & Dooley, 2011) and collaborative ventures (Ahuja, 2000; Ahuja, Polidoro Jr, & Mitchell, 2009). Further, in a recent review and reconceptualization of network theory it was articulated that, "networks are reshaping the global business architecture" (Parkhe, Wasserman, & Ralston, 2006) and given the proliferation of global sourcing and offshoring of late, this is clearly of significant interest to supply chain management; academically and professionally (Choi & Kim, 2008; Choi & Wu, 2009; Kim et al., 2011).

New partnerships further increase the complexity of the network by increasing the number of ties among the network's members. In this thesis, a tie constitutes an equity based collaborative venture (i.e. a joint venture). A joint venture is defined as two or

more firms pooling a portion of their resources within a common legal organization (Kogut, 1988). The focus of this study is supply chain manufacturing joint ventures, where two or more companies form an equity-based partnership to manufacture components for a focal firm. Historically, the research in "collaboration" spoke primarily to themes of vertical integration (Buchanan, 1992; Coase, 1937; Harrigan, 1985; Walker & Poppo, 1991) or in the international context 'internalization' strategies (Buckley & Casson, 1996). Essentially, collaboration meant acquisition as a means to control a firm's suppliers by essentially making them part of the larger organization (i.e. internalize them). As research evolved, it began to include a number of different alternatives to full vertical integration; joint ventures were among those alternatives.

Numerous articles have investigated the process of collaborative venture formations from a variety of perspectives (e.g. Kogut, 1988, 1991; Reuer & Koza, 2000; Yan, 1998). It is generally accepted that the main role of collaborative ventures is to provide additional value and enhancing market potential of each partner (Adler, 1966; Varadarajan & Rajaratnam, 1986). Yet, the supply chain considerations of collaborative venture formations have been largely overlooked. Particularly, there is a large gap in the literature regarding studies investigating supply chain management practices and manufacturing collaborations from a social network perspective (Borgatti & Li, 2009; Choi & Wu, 2009; Galaskiewicz, 2011)

There are significant challenges facing the firm undertaking the process of collaborative venture formation, particularly in the expansive global supply chains in which modern companies operate. These challenges propagate themselves principally around the lack of information and uncertainty that a firm faces (Mosakowski, 1997). I

postulate that companies can utilize network structure related cues to mitigate the uncertainty associated with partner selection in supply chain manufacturing joint ventures. Specifically, this thesis investigates the following research questions:

- What is the role of network structure when selecting a manufacturing JV partner?
- What is the effect of existing JV partnerships on new JV formations?
- How does this effect differ between component suppliers and Original Equipment Manufacturers (OEM)?
- How does this effect differ between domestic and international joint venture formations?

Expected Theoretical Contributions

This thesis finds itself at somewhat of an academic crossroads, an intersection of two interrelated and intellectually provocative disciplines: theory of supply network structure and the theory of equity based collaborative venture formations. With regard to network structure, much of the foundational research comes from the eclectic body of work in social network theory. In this research stream, there has been a substantial amount of work over the past seventy years (c.f. Bott, 1957; Burt, 1978; Burt, 1980a, b; Burt, 1982; Fombrun, 1982; Freeman, 1979, 1982; Granovetter, 1973; Mitchell, 1974; Moreno, 1934; Nadel, 1957; Tichy, Tushman, & Fombrun, 1979). Yet, only recently has this trend explicitly entered into the supply chain management domain (i.e. Bastl, Johnson, & Choi, 2013; Choi et al., 2001; Choi & Kim, 2008; Choi & Krause, 2006; Kim et al., 2011) and thus, this thesis extends current understanding of the importance of network structure in new joint venture formations.

With regard to collaborative venture formation, this paper contributes to the extant supply chain management literature by examining this dynamic process in the context of manufacturing joint-ventures (JV) in addition to developing and testing a theoretical framework regarding the effect of network structure on new JV formations. Inter-organizational partnerships can be non-equity based or equity based. I concentrate on equity based manufacturing collaborations, i.e., manufacturing joint ventures, where two companies make equity investments and develop a long term collaborative venture and a new entity is established with the purpose of manufacturing a specific component or sets of components. Furthermore, by focusing on the supplier selection process from the perspective of an Original Equipment Manufacturer (OEM) seeking to begin a new manufacturing based JV with a partner, insights into the importance of network structure as an antecedent to new JV formation are derived.

As noted above, the overarching research question addressed in this study deals with the role of network structure in the process of forming a new supply chain manufacturing JV. Specifically, this study takes a dyadic perspective (Zaheer, Gözübüyük, & Milanov, 2010) where the unit of analysis is the dyadic pair of two companies that, over the span of the dataset, have the potential to form a new manufacturing JV. Leveraging this dyadic perspective this thesis analyzes the effect of the existing network structure (i.e. the collection of all existing dyadic pair of firms that collectively comprise the overall network) on new manufacturing JV formations, something extant supply chain literature has overlooked. The goal of the inter-firm network level of analysis is to understand the nature of the relationship between two organizations, yet only recently has supply chain management research begun focusing

on this perspective. It has been indicated that network structure is an important factor when new inter-firm ties are formed (Zaheer et al., 2010) and thus, this thesis builds upon this notion from a supply chain management perspective.

Expected Managerial Contributions

Network connections are an important element of supply chains and they should be treated and managed as such. Indeed, as supply chain management becomes increasingly a preeminent issue for managers in today's dynamic environment understanding the implications of network structure and its affect on business is critical. Hence, this thesis provides a concrete framework, and empirical support for various network specific implications firms should pay attention to when beginning the process of a new joint venture formation; particularly, how to gauge the credibility and potential opportunism of a potential partner in a supply chain joint venture.

Thus, the remainder of this thesis is organized as follows. Chapter 2 will provide an in-depth review of the theoretical underpinnings of this thesis (i.e. Network theory, joint ventures, international joint ventures and supply chain based joint ventures). In addition, specific theoretically driven hypotheses that are grouped based on the level of the network the hypotheses analyzes will be advanced for empirical testing. Chapter 3 will then provide the methodological approach, complete with the source of the data and the econometric methodology for the empirical context of this thesis. Then, Chapter 4 will detail the results of the empirical study and Chapter 5 will cover a thorough discussion of these results. Finally, Chapter 6 will detail the limitations as well as future research directions of the thesis.

CHAPTER 2: THEORETICAL FOUNDATIONS

Theoretical Perspectives on Network Theory

Network Theory as a field of study has largely been embedded in much research over the past two centuries, either implicitly or explicitly. Applications can be seen in disciplines ranging from the early developments in Auguste Comte's conceptualization of "social physics" (Borgatti, Mehra, Brass, & Labianca, 2009) to more recent work studying supply chain management (Choi et al., 2001; Choi & Hartley, 1996; Choi & Kim, 2008; Choi & Krause, 2006; Choi & Yunsook, 2002) knowledge networks and knowledge transfer (Borgatti & Cross, 2003), alliance behavior (Ahuja, 2000), and firm level social capital (Walker, Kogut, & Shan, 1997). In the process, network theory has been influenced by a various, and eclectic, number of disciplines including cultural anthropology (Nadel, 1957), social anthropology (Bott, 1957; Kapferer, 1972; Mitchell, 1974), graph theory (Freeman, 1982; Harary, 1959) and management (Ahuja, 2000; Brass, Galaskiewicz, Greve, & Wenpin, 2004; Coviello, 2006; Harryson, Dudkowski, & Stern, 2008; Parkhe et al., 2006; Suarez, 2005). Yet, even with these broad applications, network theory has long struggled to ground itself with a conclusive identity, perhaps this is a result of its interdisciplinary underpinnings. In fact, some scholars even question its existence by asking, "is there a network theory?"(Mitchell, 1974:281). Taking it a step further some even "reject it as mere methodology lacking due regard for substantive issues" (Wellman, 1983).

Essentially, "network theory refers to the mechanisms and processes that interact with network structures to yield certain outcomes for individuals and groups" (Borgatti &

Halgin, 2011:1168). The network perspective, as a theoretical lens, views these structures as sets of interrelated and purposively connected, rather than disjoint or loosely assimilated units (Borgatti & Li, 2009). These interconnected entities are typically comprised of an individual actor (i.e. a firm), a dyad (i.e. two firms engaging in a joint venture) or a triad (i.e. when an manufacturer has two supply chain partners) (Wasserman & Faust, 1994). Early in the development of network theory the most common application was on an individual level (i.e.Moreno, 1934; Nadel, 1957) but recent research in has examined a dyadic perspective (Ahuja, 2000; Ahuja, Polidoro Jr, & Mitchell, 2009; Gulati, 1995, 1999) as well as a triadic one (Bastl et al., 2013; Choi & Wu, 2009).

The advantage that the network perspective provides for scholars is inherent at the core of the theory: those connections between individuals, dyads or triads, and by extension the general network structure are of significant interest (Granovetter, 1973; Mitchell, 1974). More succinctly stated, "fundamental axiom of social network analysis is the concept that structure matters" (Borgatti et al., 2009). Structure in this case refers to all of the actors within a network as well as the connections that exist between and among them. The modern inception and proliferation of network analysis started with sociologists attempting to understand the interactions among individual actors in groups (Choi & Kim, 2008). The study of these interactions is known as sociometry (Granovetter, 1973) where the end result of a sociometric study is the formal construction of the network of the interactions between actors. Typically, the researcher will observe the interactions between various actors within the network over a period of time, thus allowing for numerous empirical observations and a longitudinal data set. This technique

dates back as early as 1934, when psychiatrist Jacob Moreno studied the runaway patterns of groups of school girls and found that the social structure of these girls was a significant explanatory mechanism in their runaway patterns (Moreno, 1934).

Later as the academic literature that uses network theory matured, these repeated interactions between actors became formally known as ties, each of which exhibited varying degrees of strength. The strength of a tie has been defined as a combination of the amount of time, the emotional intensity, the intimacy and the amount of reciprocity between actors (Granovetter, 1973). Ties are typically dichotomized into continuous and discrete ties. Continuous ties are "those that are always "on" for the duration of the relationship", whereas discrete ties are "are based on a series of discrete events" (Borgatti et al., 2009). In a supply chain setting, a continuous tie may characterize a situation where a manufacturer's supplier physically co-locates on the manufacturer's plant location, thus establishing an on-going continuous relationship. Alternatively, an original equipment manufacturer's (OEM) relationship with a parts supplier in an arms length market based transaction would be a discrete tie, that is one characterized by intermittent frequencies.

To understand ties in a network however it's critical to understand the types of networks that exist. Typically, there are two types of networks: attribute networks and transactional networks. "Attribute networks link individuals who share a commonality (such as similarity of attributes, goals, sex, status). Transactional networks, on the other hand, focus on the exchanges that occur among a set of individuals" (Fombrun, 1982). Early applications of network theory (i.e. Bott, 1957; Kapferer, 1972; Moreno, 1934; Nadel, 1957) were clearly rooted in studying attribute networks ranging from

anthropological studies of villages, to the composition of friendship networks. In the business literature, the research is now contributing to the body of knowledge in network theory by looking at transactional networks in numerous supply chain concepts (i.e.Choi et al., 2001; Choi & Wu, 2009; Choi & Yunsook, 2002; Dyer, 1996; Galaskiewicz, 2011; Gulati, 1995, 1999).

As the above demonstrates, the literature in social networks is quite multi-disciplinary. Some empirical research streams take a graph theoretic approach to analyzing networks (e.g. Watts, 1999, 2004). Other research streams that are particular to the business literature include inter group conflict and social capital (Hongseok, Myung-Ho, & Labianca, 2004; Labianca, Brass, & Gray, 1998) learning (Borgatti & Cross, 2003), complexity and trust in strategic alliances (Robson, Katsikeas, & Bello, 2008) and social commerce networks (Stephen & Toubia, 2010).

Social network analysis in the management literature typically analyzes two broad levels of exploration: inter-personal and inter-firm. The inter-personal dimension attempts to understand the benefit that actors receive by increasing the strength of their ties with other network actors. Reduction of conflict is one of the most important benefits of stronger ties (Labianca, Brass, & Gray, 1998). On the other hand, the inter-firm perspective examines "ties between organizations or firms … such as strategic alliances, buyer-supplier relationships, director interlocks, investment bank ties, personnel movement links, and cross-patent citation ties" (Zaheer et al., 2010). Essentially, by leveraging this view of the organization (and implicitly the firms on which it is dependent via the network) a more holistic perspective of competitiveness emerges.

Recently, the network perspective has gained some rather powerful traction in supply chain management. It has been suggested that more research that leverages a network perspective is needed (Galaskiewicz, 2011) citing it as a method with much applicability to the discipline (Borgatti & Li, 2009). For example, Terpend and Ashenbaum (2012) examine the moderating impact that supplier network size has on performance. Kim et al. (2011) utilize social network analysis to unveil the structure of supply networks in the automotive industry. Additionally, extant research has examined the supplier selection process in the automotive industry while considering a partner's position in the network (Choi & Hartley, 1996). Other studies explore network operating structure (Choi & Yunsook, 2002), the role of network embededness (Choi & Kim, 2008) and triadic network relationships within the supply chain (Choi & Wu, 2009). This thesis complements and extends the existing literature by empirically examining multiple dimensions that make up the structure of supply chain networks and their impact on new supply chain joint venture formations.

Joint Ventures: A Theoretical Overview

It is generally accepted that the main role of collaborative ventures is providing additional value and enhancing the market potential of each partner (Adler, 1966; Varadarajan & Rajaratnam, 1986). Collaboration, and by extension collaborative ventures, is an important aspect of supply chain management and several studies have researched their role with regard to buyer-supplier relationship management. For example, Gulati and Sytch (2007) examine the interdependence between buyers and suppliers in US automotive manufacturers' procurement relationships. They empirically test a dual faceted view of economic interdependence and show a positive relationship between

mutual dependence and performance. Houston and Johnson (2000) examine a firm's choice of governance mechanism in an inter-firm relationship and find empirical support that JVs reduce governance problems between buyers and suppliers. In the bio-tech industry, it has been shown that having a highly central position in the network improves firm performance, facilitates organizational growth, and engenders increased research and development investment and further participation in research and development alliances (Powell, Koput, Smith-Doerr, & Owen-Smith, 1999).

Yet, there are multiple forms of inter-organizational collaborative arrangements, which can be classified according to their levels of involvement or equity in the arrangement. An increasingly common form of inter-organizational collaboration is an alliance between two or more firms. An alliance is a collaborative inter-organizational arrangement that uses more than one organization's resources in order to complete a transaction (Inkpen, 2008). These firms remain independent (i.e. not common ownership of one another) and there is often a significantly smaller, if any, amount of equity between partners.

On the other hand, and with a significantly higher degree of equity involved, a joint venture is defined as two or more firms pooling a portion of their resources within a common legal organization (Kogut, 1988). In a joint venture, there is a new entity set up in order to perform a specified task. In supply chain management, a joint venture has been defined as a new entity formed by two or more firms for distributing a product and/or controlling informational flows related to the product or service activity (Tokman, Elmadag, Uray, & Richey Jr, 2007). In this thesis, the focus is manufacturing joint

ventures, i.e., equity-based collaborative partnerships created with the primary purpose of manufacturing components.

A great number of studies have been undertaken in the joint venture domain (e.g.Aimin & Ming, 1999; Brouthers & Hennart, 2007; Buckley & Casson, 1996; Hennart, Dong-Jae, & Ming, 1998; Kogut, 1988, 1991; Kogut & Singh, 1988; Lee, 2010; Pan, 2000; Roy & Oliver, 2009; Tokman, Elmadag, Uray, & Richey Jr, 2007; Yaping, Shenkar, Yadong, & Mee-Kau, 2005). Accordingly, a number of theories have been advanced to explain the underpinning mechanisms behind these equity-based partnerships; Transaction Cost Economics (TCE) is one such pioneering theory. This field of study was pioneered by Ronald Coase (1937) in *Economica* entitled "The Nature of The Firm". Essentially, TCE posits that a firm can become more efficient by gaining control of those portions of the business whose transaction costs outnumber the cost of direct production. These costs refer to conducting an arms length (i.e. non-equity based, short term partnership) exchange in the intermediate product markets in which a firm operates. As an example, for a firm engaged in automotive manufacturing, the cost of purchasing tires from these intermediate product markets may out weigh the cost of a more equity driven collaborative venture arise. Under TCE, inter-firm collaborative activities form in order to minimize transaction costs in the firm's intermediate product markets. Or in other words, if the costs of the firm's various arms length transactions are more expensive than a strategy of internalization then, under the principles of TCE, the firm should enter into some form of a collaborative agreement (i.e. a joint venture). The degree of cooperation (e.g. equity vs. non-equity) depends on the level of costs associated

with said transactions. Further, collaborative ventures have been shown to reduce the coordination costs of arms length transactions (Dunning, 1995).

Much additional research since this Coase's work has been conducted that implicitly builds upon his notions. In an earlier study, Kogut (1988) provides a comparative analysis where he contrasts the transaction costs perspective with the strategic behavior perspective of joint venture formation. Kogut (1991) examines manufacturing based joint ventures from a real options perspective and provides empirical evidence to support the notion that firms may treat joint ventures as options to be exercised at a future date. Martin, Mitchell, and Swaminathan (1995) take a network perspective of joint ventures the US/Japanese automotive industry. They examine the tie structure and tie formations for Japanese Automotive firms that sell domestically and those that sell internationally. Inkpen and Dinur (1998) investigate the knowledge management and knowledge transfer process in joint ventures, and identify four knowledge specific activities-namely, "technology sharing, alliance-parent interaction, personnel transfers, and strategic integration"(454)-that influence and support how knowledge flows in joint ventures.

Academic work in order to understand JVs has also studied the connection between JVs and performance. Like much other JV research, it has come from a multidisciplinary perspective. For example, leveraging an inherently transaction cost driven perspective, Reuer and Koza (2000) examine two theoretical perspectives of JVs: indigestibility (i.e. the difficulties with which firms can integrate assets into the JV from the different parent organizations) and asymmetric information (i.e. the lack of information about the other parent firms and the consequent costs it can yield). In

examining JVs through this lens and connecting it to firm performance, they find that performance, as measured by stock market returns, increases under conditions of asymmetric information. Pearce (2001), examines the link between inter-firm cooperation and JV performance and finds that various behavioral dimensions such as flexibility and cooperation mediate this relationship. In this context, "performance" was measured objectively (e.g. ROI) and subjectively (e.g. goal achievement).

Gong, Shenkar, Luo, and Nyaw (2007) examine JV performance by looking at the number of parents that the JV has, and hypothesize that contract completeness and partner cooperation mediate this relationship. Interestingly, they find that as the number of partners increases, there is a negative effect on both contract completeness and partner cooperation; but that these two variables have a positive effect on JV performance. Using an event study perspective, Koh and Venkatraman (1991) examine the impact the relatedness of the JV (i.e. similar industry or operating characteristics to the parents) has on performance (i.e. stock market returns). They find that, "parents forming joint ventures in the identical and related-complimentary categories reported higher gains…then those forming other types of ventures,"(Koh & Venkatraman, 1991:888). From a network perspective this result is interesting. In network theory, increasing a firm's position in the network can lead to higher levels of social capital (Oh, Myung-Ho, & Labianca, 2004). Consequently, with network ties between firms in similar industries the development of social capital heightened; and in this case so too is firm performance.

Park and Russo (1996) examine joint venture performance from a the perspective of failure vs. success of the JV. Interestingly, they echo the results of Koh and Venkatraman (1991) wherein they find that industry complementarities decrease the

likelihood of failure. They find that, "the presence of competition between joint venture partners outside of the agreement significantly impairs chances for the operation's chance of survival" (Park & Russo, 1996: 875). This seems to contradict the findings of Gong et al. (2007) wherin they [Park and Russo (1996)] find that the number of parents actually *decreases* the likelihood of performance (i.e. failure). Hill and Hellriegel (1994) examine joint venture formation from the manager's perspective and look at how well a partner's skillsets complement the other firm, the ownership and controlling interest of the joint venture and, finally, its autonomy. Interestingly, they find that partners will different skillsets, may have difficulties exercising these complementarities and that the perception of influence in the decision-making has a vast impact on the success of the venture.

The Theoretical Underpinnings of International Joint Ventures

The trend towards the globalization of the company is particularly strong in the supply chain management arena and global sourcing has become the norm in most industries. Global sourcing is an important tool in developing effective and efficient global value chains and provides significant advantages such as economies of scale and location specific cost benefits and helps the company achieve a global market advantage (Yeniyurt, Cavusgil, & Hult, 2005).

The literature on international joint ventures (IJV) is quite well established. An early antecedent to research in this domain was Stephen Hymer's doctoral dissertation work he began to explain why firms engage in international production (Dunning, 2008; Forsgren, 2008). He tried to suggest an alternative explanation to the traditional portfolio theory of foreign direct investment (FDI), that firms invest in foreign markets in order to diversify their portfolios. As his research evolved he came to the contention that firms go

abroad to exploit their market power in an attempt to create a monopolistic advantage (Forsgren, 2008). Thus, his approach became known as the 'Market Power ' approach. The goal of the firm that exhibits any effort to engage in a collaborative venture, under the Market Power approach, is to maximize profit while simultaneously restraining competition.

Since then, IJV's have been examined from a variety of perspectives in the literature. For example, Kogut and Singh (1988) examine the effect that national culture has in JV performance, and indeed find empirical support for, the entry choice of firms in a new joint venture. In a conceptual article dealing with the development of international joint ventures, Yan (1998) draws from two contrasting organizational theories – structural instability and inertia – from which a testable model is advanced. Buckley and Casson (1996) propose an economic model of international joint venture selection that "explains the formation of IJVs in terms of eight distinct but related factors" (Buckley & Casson, 1996) including market size, technological uncertainty and pace of technological change. Inkpen and Beamish (1997) leverage a bargaining power and dependence perspective on international joint venture stability and articulate that the instability faced by these firms in the venture is due to a shift in bargaining power. Hennart et al. (1998) examine what impacts the longevity of international joint ventures and find vast differences between Japanese and US firm behavior in IJVs. Sea-Jin and Rosenzweig (2001), in a study that examines a firm's choice of foreign market entry mode, empirically test the determinants of collaborative venture formations as a foreign market entry mode. Li, Zhou, and Zajac (2009) study the role of collaboration and control in new joint ventures in foreign emerging markets.

Supply Chain Joint Ventures and the Automotive Industry

Several studies have investigated the effect of network structure on new collaborative venture formations (e.g. Powell et al., 1999). The current study contributes to this stream of research by investigating the effect of network structure on new manufacturing JV formations; in particular it uses those supply chain manufacturing joint venture formations in the automotive industry. The focus herein is the joint ventures formed by an OEM with other firms, either competing OEMs or component suppliers, with the primary purpose of manufacturing components that are utilized in the manufacturing process of the focal OEM. Such joint ventures enable the OEM to expand its manufacturing capabilities while maintaining governance over the joint operations through the equity-based partnership.

The global automotive industry constitutes a suitable context for this study for several reasons. First, manufacturing joint ventures are very common in this industry (Buzacott & Steve Peng, 2012). For example, in the automotive industry, Shanghai General Motors, a joint venture between GM and SAIC Motors has proven to be very productive for both firms (Terlep, 2012). Additionally, Tata Motors and Fiat recently engaged in a joint venture whereby Tata will produce Fiat's premium line of automobiles (Behl, 2007). Johnson Controls, a popular automotive components manufacturer, supplies Fiat with "complete interiors, including door panels, instrument panels, floor consoles and rear quarter panels through a joint venture with PCMA, a division of Magneti Marelli S.p.A" (Francis, 2013:234).

Secondly, the automotive OEMs utilize large numbers of suppliers and frequently engage in collaborative relationships with these suppliers (Choi & Hartley, 1996; Kim et

al., 2011). For example, the Anad and Mando corporations, both Indian automotive components manufacturers, recently merged two of their existing joint ventures with one another in order to achieve marketing and production synergies; the new larger JV will be valued at approximately $200Million (Hilton, 2013a). UC RUSAL and Omen High Pressure Die Casting recently agreed to form "a joint venture ("JV") in Russia to produce automotive components made of aluminium, to be supplied to carmakers in Russia and the CIS" (Hilton, 2013c:18). International Automotive Components (IAC) and Feltex Automotive recently initiated a new JV in order to support component requirements for "Ford, Mercedes-Benz, Toyota and Volkswagen South Africa operations" (Hilton, 2013b:1) Finally, by utilizing this industry, this study contributes to a strong research stream regarding the automotive industry (Adler & Cole, 1993; Choi & Hartley, 1996; Choi & Yunsook, 2002; Dye & Wujin, 2011; Helper, 1991; Kim et al., 2011; MacDuffie, 1997; Novak & Eppinger, 2001; Sako, 1996).

Hypothesis Development

The following hypothesis development is organized into three sections: Ego Network Structure, Overall Network Structure and the Differences in the Effect of Network Structure. The first section, Ego Network Structure, examines the role that various funamental *ego network* level constructs have on the patterns of supply chain JV formation. Next, the Overall Network Structure section expands the view of the network out to a more broad perspective examining constructs that extend beyond the ego network and to the overall network's structure. Finally, Differences in the Effect of Network Structure builds theoretical underpinnings for hypotheses that question the idential explanatory power of certain network constructs under different JV scenarios.

Ego Network Structure

The first line of reasoning in this thesis connects the network structure to new joint venture formations by exploring one of the fundamental building blocks of network structure: the ego network. One of the most fundamental characterisitcs of the network is the *ego network* of a particular firm. The study of ego networks deals specifically with an ego (i.e. a social unit such as a firm), its immediate ties, and the ties among the actors to which the ego is connected (Borgatti & Halgin, 2011; Burt, 1980b; Freeman, 1982). Ego networks have been applied to various contexts such as job acquisition (Granovetter, 1973), power and influence (Burt, 1992), innovation adoption (Ahuja, 2000), as well as knowledge sharing and knowledge networks (Hansen, 2002; Hansen, Mors, & LØVÅS, 2005).

The quantity of actors to whom the ego is connected is known as ego network size (Wei, 2010). A large ego network can generate substantial benefits for the firm. It has been indicated that as the ego networks grow in size, the levels of learning of each network actor also increase (Borgatti & Cross, 2003). Further, increases in the number of ties of a network actor results in higher levels of social capital (Oh et al., 2004). The development of this social capital creates a pattern of interpersonal connections and certain actors become preferred exchange partners who use one another for resources. Larger ego networks, due to the increased number of actors that the focal firm has relationships with, are likely to provide access to superior resources (Zaheer et al., 2010). Network relationships can be regarded as a critical organizational resource, as they facilitate interactions and exchanges that result in a competitive advantage (Gulati, 1999).

Clearly there is a significant importance placed on the size of a firm's ego network. As the size of a firm's ego network grows, the firm will generate greater learning (Borgatti & Cross, 2003), further facilitating the formation of new inter-organizational relationships. It has been shown that as firms engage in collaborative ventures they gain experience and develop the routines and procedures necessary to engage in and manage such collaborative ventures (Yeniyurt, Townsend, Cavusgil, & Ghauri, 2009). Organizational routines, procedures, and structures are vital components for controlling the behavior of the organization and are accumulated over time, establishing conditions for subsequent firm actions and activities (Cyert & March, 1963; March & Simon, 1958). Hence, the size of the ego network is expected to have a positive effect on new manufacturing JV formations.

Uncertainty is perhaps one of the most important obstacles to new partnership formations (Mosakowski, 1997). Uncertainty is defined as the difficulty firms have in predicting the future, which comes from a lack of information (Beckman, Haunschild, & Phillips, 2004). I posit that the nework characteristics of a firm play an important role in manufacturing JV formations by mitigating the effects of uncertainty by providing legitimacy to a potential partner. As such, the size of the ego network can be regarded as an indicator of the legitimacy of the firm. It has been shown that the number of partners that a firm has, constitutes a signal of legitimacy and credibility (Oh et al., 2004; Yeniyurt et al., 2009), making the firm more attractive as a potential partner. It can be expected that as the ego network of a firm increases in size, the firm's legitimacy within the network also increases. This legitimacy mitigates the uncertainty associated with

engaging in new collaborative partnerships (Henisz & Delios, 2001), facilitating new manufacturing JV formations with firms that have larger ego networks.

Due to greater access to resources, experiential learning, and legitimacy effects, it can be expected that the size of the ego network of both the focal OEM and the potential partner has a positive effect on a new manufacturing JV being initiated. This leads to the following hypotheses:

> **Hypothesis 1a:** The ego network size of a focal OEM in the manufacturing JV network has a positive effect on the likelihood of a new manufacturing JV being initiated by that focal OEM.
>
> **Hypothesis 1b:** The ego network size of a potential partner in the manufacturing JV network has a positive effect on the likelihood of a new manufacturing JV being initiated with that potential partner.

Ego Network Density

While the size of a firm's ego network is an important consideration in new JV formation decisions, another important component of network structure is *ego network density*. The density of an ego network is essentially the extent to which the members of the ego network are connected to one another. This variable has been extensively studied in the management literature. Studies have examined the effect of ego network density on knowledge creation in professional networks (McFadyen, Semadeni, & Cannella, 2009), resource access in various industries (Burt, 1992), managerial performance (Rodan, 2010), inter-firm alliances (Ahuja, 2000) and technological diversity (Phelps, 2010).

It has been indicated that loosely connected, sparse networks can generate significant benefits for a firm. Burt (1992), suggests that social units with many loosely

connected, but disjoint, networks are in an advantageous position. When networks are disjoint they have an existence or multiple existences of structural holes. A structural hole exists when two firms share mutual connection but are not connected to one another or, in other words, "a structural hole exists between two actors when they are connected to the same other actor but are not connected to each other," (Zaheer et al., 2010) In sparse networks the organization can benefit from the existence of structural holes (Burt, 1992; Zaheer et al., 2010), and generate advantages from brokering relationships among unconnected partners and by having access to a diverse set of partners and resources (Burt, 1992; Burt, 2004).

Consequently, for either an OEM or a components supplier, it would be advantageous to have a loosely connected ego network, i.e., a low-density ego network. Essentially, by having a low-density ego network, a firm "can build relationships with multiple disconnected clusters and use these connections to obtain information and control advantages over others"(Ahuja, 2000). Dense ego networks will have a negative effect on new JV formations as dense networks are characterized by structural homophily, where the network actors are very similar and access to diverse partners and diverse resources is greatly diminished (Ahuja et al., 2009; Rosenkopf & Padula, 2008). Thus:

> **Hypothesis 2a:** The ego network density of a focal OEM in the manufacturing JV network has a negative effect on the likelihood of a new manufacturing JV being initiated by that focal OEM.
>
> **Hypothesis 2b:** The ego network density of a potential partner in the manufacturing JV network has a negative effect on the likelihood of a new manufacturing JV being initiated with that potential partner.

Ego Network Betweenness Centrality

In network research, centrality is perhaps the most ubiquitously researched variable (Borgatti, 2005). In a broad sense, centrality has been defined as a measure of the position of a particular participant, with respect to other network participants (Borgatti, 2005). Centrality can be thought of as measures, "that describe actors' positions in terms of features of their network environments" (Friedkin, 1991:1497). There have been numerous different centrality measures developed. A fundamental measure of centrality is that of degree, which has been defined as the quantity of incident ties (Freeman, 1979) an actor has with other actors in the network. Scholars have also advanced closeness centrality, which measures the geodesic distances between actors in the network (Frank, 2002; Freeman, 1979). Ego betweenness centrality denotes, "the intermediary location of a node along indirect relationships linking other nodes" (Marsden, 2002:410). As such, ego betweenness centrality reflects the extent to which a network actor is located strictly between other actors, i.e., it is positioned on all the shortest paths connecting them (Freeman, 1982).

Note that, while related, betweenness and density measure two different things. Density is a network-level measure that explains how connected the overall network is (Burt, 1992; Burt, 2004). On the other hand, betweenness is a node specific measure that dictates the extent to which one actor acts as an intermediary between other actors (Freeman, 1979, 1982; Marsden, 2002). The significance of ego betweenness centrality is that a firm having high betweenness is able to facilitate or inhibit communication or interaction to the other actors with which it is connected (Freeman, 1979, 1982; Marsden, 2002). In the context of new JV formation, a firm's betweenness position is likely to have an impact on its JV formation behavior. As a firm builds its network connections through

additional manufacturing JVs, its betweenness centrality increases, it gathers experience and gains access to a greater set of resources and capabilities. Additionally, companies that are more central to the network are more likely to implement innovation activities with strategic partners, and as the inter-organizational activities intensify, the probability of engaging in additional partnerships increases (Pennings & Harianto, 1992).

Overall, it is expected that ego betweenness centrality is beneficial to the focal OEM and any potential partner, facilitating communication and signaling legitimacy and credibility. Therefore, I posit that ego betweenness centrality has a positive effect on new manufacturing JV formations.

> **Hypothesis 3a:** The betweenness centrality of the focal OEM in the manufacturing JV network has a positive effect on the likelihood of a new manufacturing JV being initiated by the focal OEM.
>
> **Hypothesis 3b:** The betweenness centrality of a potential partner in the manufacturing JV network has a positive effect on the likelihood of the focal OEM to initiate a new manufacturing JV with that partner.

Diminishing Returns of Ego Network Betweenness

As the network position of a company increases, so to does the complexity associated with managing network partnerships. It is expected that as the complexity of managing these network relationship increases, governance becomes more difficult and the monitoring costs also increase. For example, it has been shown that having a large number of partnerships decreases the additional benefit of any new similar partnerships (Yeniyurt et al., 2009). Considering cost escalations associated with managing

increasingly complex networks, and the decreasing benefit of each additional partnership, I posit that there are diminishing returns to ego betweenness centrality.

Sometimes referred to as curvilinear effects (Cohen & Cohen, 1983), this idea of diminishing returns has arisen in the management literature before. It has been empirically supported in the context of strategic alliances and the adoption of technological innovation, specifically in terms of the curvilinear relationship between the number of strategic alliances and product development on incumbent alliance partners (Rothaermel, 2001). Similarly, curvilinear relationships have been found between the structural characteristics of networks and organizational performance (Lechner, Frankenberger, & Floyd, 2010; Powell et al., 1999). In the pharmaceutical industry, it has been shown that the number of international marketing alliances of a firm has a positive but diminishing curvilinear effect on the likelihood of new alliance formations (Yeniyurt et al., 2009). In line with these studies, it is expected that the betweenness centrality of the focal OEM will have a positive but diminishing effect on new JV partnerships being formed by the focal OEM.

Scholars have articulated the importance of opportunism in a supply chain network context (Wathne & Heide, 2004; Wever, Wognum, Trienekens, & Omta, 2012). Opportunism is defined as the calculated efforts of an exchange agent to mislead or otherwise obfuscate or distort a transaction (Williamson, 1985). Perhaps more applicable to the supplier relationship management context within the supply chain management literature, opportunism can be described as a partner, within an exchange relationship, not acting in the best interests of the opposing partner (Carter & Stevens, 2007; Doney & Cannon, 1997). Opportunism plays an important role in network relations (Wathne &

Heide, 2004; Wever et al., 2012) and is one of the critical factors that a firm needs to consider when choosing a new manufacturing JV partner.

Considering that the betweenness centrality indicates the extent to which a firm connects two other firms that do not have a direct tie with each other, it can be posited that as the betweenness centrality of a potential partner increases, so does the threat of opportunistic behavior. Hence, for the focal OEM, a potential partner's betweenness centrality would signal legitimacy, but as a partner's betweenness centrality reaches higher levels, the likelihood of opportunism would also increase. From the perspective of an OEM in the evaluative position, the more central the potential partner is to other firms, the greater is the threat of opportunism. Also, the increased threat of opportunism would result in larger monitoring costs. If an OEM knows that a firm is heavily connected to a network, perhaps this could lead to a larger need for more formal safeguards given the increased threat of opportunistic behavior. Given this knowledge of the extent to which the potential partner is embedded within the network, and having gauged the threat of opportunism and the need for safeguards, the focal OEM can anticipate a higher level of monitoring costs to be incurred.

As presented above, network centrality is expected to have a positive effect on manufacturing JV formations. Yet, it is likely that the positive effect diminishes as centrality levels increase. For the focal OEM, coordinating network relationships is expected to become more difficult and more costly. For the potential partner, an increase in likelihood of opportunistic behavior is expected. Thus:

Hypothesis 4a: In the manufacturing JV network, there is a diminishing return to ego betweenness centrality of the focal OEM in manufacturing JV formations.

Hypothesis 4b: In the manufacturing JV network, there is a diminishing return to ego betweenness centrality of the potential partner in manufacturing JV formations.

Overall Network Structure

While the previous section goes into detail regarding the impact that ego networks have on new manufacturing joint venture formations, what is also important is the larger structure of the overall network. While it is argued herein that ego networks play a significant explanatory role in understanding the development of new supply chain manufacturing joint ventures, overarching network structure in which the ego is implicitly embedded is also of significant interest. Thus, the following section builds on the logic presented above, but includes information beyond the firm's ego and takes into account all the ties in the network.

Network Centrality

The next hypothesis further builds upon the concept of centrality. While the above spoke about centrality in terms of an ego's betweenness centrality, a measure localized to just the ego network of a particular firm, now the level of analysis is abstracted out slightly. It was noted above, that centrality can be understood as the quantity of incident ties (Freeman, 1979) a firm has with other firms in the network. In a transactional network such as the automotive parts manufacturing industry, this measure may be thought of as the amount of deals, or sales one firm has in a given period of time. This definition has been recently used in the supply chain management context, by measuring a firms

number of direct supply relationships (Kim et al., 2011). Therefore, in the context of manufacturing JVs, focal OEM centrality is defined as the total number of different manufacturing JVs the focal OEM has at a given point in time.

As the OEM builds its network connections through additional manufacturing JVs, its centrality increases, it gathers experience and gains access to a more diverse set of resources and capabilities. Hence, engaging in new manufacturing JV partnerships is subject to, and engenders the organizational learning processes. That is, the development of insights, knowledge and associations between past actions, the effectiveness of those actions and future actions (Fiol & Lyles, 1985). With increased organizational learning, the firm accumulates significant experience, which is a pattern of recognition, a repetition of activities previously undertaken, and future actions are a function of the accumulated memory of the firm (Sinkula, 1994; Slater & Narver, 1995).

Gaining additional experience, such as that gained by engaging in numerous joint ventures builds and enhances the firm's organizational memory. Organizational memory is the collective beliefs, behavioral routines, or physical artifacts that vary in their content, level of dispersion and accessibility (Moorman & Miner, 1997). Organizational routines, procedures, and structures are vital components for controlling the behavior of the organization and are accumulated over time, establishing conditions for subsequent firm actions and activities (Cyert & March, 1963; March & Simon, 1958). With increased experience organizations improve the capability of partnership management (Anand & Khanna, 2000). Additionally, companies that have a larger number of network connections are more likely to implement innovation activities with strategic partners. Furthermore, as the inter-organizational activities intensify, the probability of engaging in

additional partnerships increases (Pennings & Harianto, 1992). Due to all these processes, accumulated partnership experience facilitates future partnership formations (Yeniyurt et al., 2009). With increased partnership experience, organizations improve the capability of partnership management (Anand & Khanna, 2000). Therefore, it can be expected that companies that have a greater number of manufacturing JVs are more likely to form additional manufacturing JVs in the future.

While a lack of information is one of the most important obstacles in new partnership formations (Mosakowski, 1997), an increase in the number of network connections of a firm signals legitimation and credibility to other network (Zaheer et al., 2010). Within the context of supply chain management, and the literature thereof, credibility is a strongly related to trust (Ganesan, 1994; Morgan & Hunt, 1994; Suh & Houston, 2010). Credibility is defined as the belief that the partner will fulfill its promises while being reliable and consistent in its commitments. This definition is in line with extant literature (Dwyer, Schurr, & Oh, 1987). Credibility is a critical component to relational exchange (Ganesan, 1994). Relational exchange in the supplier selection process refers to the firm's desire and perception of the possibility to achieve a rapport with a sourcing firm (Dwyer et al., 1987). Therefore, a firm that has a high degree of network centrality is a more attractive potential partner than a firm with a low degree of network centrality. This thesis addresses the initial stage in the formation of a new JV between firms and thus I suggest that in the initial stages of partnership formation, credibility will play a large role in the decision making process. The process of choosing a new business partner is an inherently risky activity, as engaging in a business transaction requires significant trust in both parties. It is well documented that credibility,

also labeled honesty or integrity, is an important factor that firms consider when they choose a strategic partner (Morgan & Hunt, 1994). Credibility is commonly referred to in the supply chain management literature as a critical component of relationship management (Ganesan, 1994; Zaheer et al., 2010).

It has been suggested that networks, or better yet the structural characteristics of the network, can be used to assess the credibility of a potential partner (Zaheer et al., 2010). Within the context of new manufacturing JVs, the focal OEM can infer the credibility of a potential partner via the network position occupied by each specific firm. As noted above, to consider centrality as a critical component to social networks is in line with extant literature (Borgatti, 2005; Freeman, 1979; Kim et al., 2011). Hence it is posited that, centrality is used by a firm as a proxy measure to infer the credibility of a potential partner. Hence, an OEM that is in a position to select a partner for a new manufacturing JV will prefer a firm that has a greater degree of network centrality.

Overall, it is expected that as the number of JV partnerships a company is involved in increases, the processes of experiential learning and legitimation facilitate future JV formations. Hence:

> **Hypothesis 5a:** The network centrality of the focal OEM in the manufacturing JV network has a positive effect on the likelihood of a new manufacturing JV being initiated by the same OEM.
>
> **Hypothesis 5b**: The network centrality of a potential partner has a positive effect on the likelihood of the focal OEM to initiate a new manufacturing JV with that partner.

Diminishing Returns to Network Centrality

As presented above, network centrality provides legitimation and credibility to the network member (Zaheer et al., 2010). Potential partners are more likely to trust a company that has a central role in its network and consider that company for a new JV partnership. Yet, it is likely that the increase in credibility that additional partnerships provide is larger for the first few partnerships and it increases at a decreasing rate as the number of partnerships that a company is involved in increases.

Further, as the number of JV partnerships increases, so does the complexity associated with managing different partners. It can be expected that it will become increasingly difficult for the focal OEM to effectively manage all its manufacturing JV partnerships. Besides this increase in the complexity of coordination, an increased number of partnerships decreases the additional benefit of any new partnerships (Yeniyurt et al., 2009). It is posited that after a certain point there are diminishing returns to added partnerships and therefore the total number of manufacturing JV partnerships of an OEM has a non-monotonic (i.e. curvilinear) effect on the likelihood of new JV formations by the same OEM. This has been shown to be present in other applications (Lechner et al., 2010; Powell et al., 1999; Rothaermel, 2001)

Therefore, the network centrality that the focal OEM has in the manufacturing JV network is expected to have a diminishing effect on new JV partnerships being formed by the same OEM. It is expected that:

> **Hypothesis 6a**: There is a diminishing return to the network centrality of the focal OEM in manufacturing JV formations.

Opportunism is one of the critical considerations that a sourcing firm needs to consider when choosing a new sourcing partner. Opportunism is defined as the calculated efforts of an exchange agent to mislead or otherwise obfuscate or distort a transaction (Williamson, 1985). Above it was suggested that opportunism can be described as a partner, within an exchange relationship, not acting in the best interests of the opposing partner (Doney & Cannon, 1997) or purposively obfuscating or distorting a transaction (Williamson, 1985). The threat of opportunistic behavior is inherently higher in the search for a new manufacturing JV partner as there exists uncertainty between exchange agents, thus a lack of trust one firm maintains for another firm increases the perception of opportunistic behavior.

Leveraging the network theory literature, opportunism can be assessed using the structural embededness of a network participant. Structural embededness has its roots from two concepts in networks: structure and embededness (Choi & Kim, 2008). Structure refers to the characteristics of the network, i.e., how many suppliers and customers does a firm work with, and what other alliances are present in the extended global supplier network. Embededness refers to the state dependence of a firm on its suppliers within a network. An important distinction to note is that, these two concepts focus on the overall network rather than just focusing on the localized ego network of a particular firm. When embededness and structure are combined to form structural embededness, it represents how a supplier's performance is contingent upon the connectedness and ties it has within the network (Choi & Kim, 2008).

If an OEM can ascertain the level of structural embededness that a potential partner has by using the constructs from social network analysis, it may be able to

quantify the threat of opportunism more accurately than without using said constructs. For example, from the perspective of an OEM in the evaluative position, the more connected the potential partner is to other firms, the higher the threat of opportunism can be. If an OEM knows that a firm is heavily connected to a network, perhaps this could lead to a larger need for more formal safeguards given the increased threat of opportunistic behavior. Given this knowledge of the extent to which the potential partner is embedded within the network, and having gauged the threat of opportunism and the need for safeguards, the focal OEM can anticipate a higher level of monitoring costs to be incurred.

As presented above, the number of JV partnerships of a firm provides legitimation and increases the credibility of that firm. On the other hand, a firm that has a large number of partners has a higher probability of exhibiting opportunistic behavior and engaging in actions that would be detrimental to the focal OEM. Hence, a non-monotonic relationship can be expected between the number of JVs a potential partner has and the chances of that firm to be selected as a new JV partner. Hence:

> **Hypothesis 6b:** The total number of manufacturing JVs of a potential partner has a diminishing effect on the likelihood of a new manufacturing JV being initiated with that partner.

Network Remoteness

Another important issue relating to global supply chain network structure is the network distance between two companies. Moving from one to the other is known as a trail, which is the sequence of incident links, beginning at one node (or vertex) and arriving at another, in which no link (edge or connection) is repeated (Borgatti, 2005). Further, its been noted, "the average number of edges that must be traversed in the shortest path

between any two pairs of vertices is called the *'*characteristic path length' " (Watts, 1999*)*. Building upon this dimension of network structure and postulate that an OEM in a position to initiate a new JV will have a difficult time gathering information and establish contact with a supplier that is remotely located in the network.

Freeman (1979) refers to closeness, or the distance of a network member from all other members in the network. Beauchamp (1965) posits that more remote network participants are likely to receive the information communicated through the network later than other network members, if at all. Therefore, network remoteness can be thought of as the lack of connections between a particular network member and the other members. Network remoteness creates a barrier for the selection of the particular supplier as the new manufacturing JV partner. Therefore, it can be expected that as the network remoteness of a firm increases, the likelihood of that firm to be part of a new manufacturing JV decreases. Thus it is suggested that:

> **Hypothesis 7a**: The network remoteness of a focal OEM has a negative effect on the likelihood of a new manufacturing JV being initiated by the same OEM.
>
> **Hypothesis 7b**: The network remoteness of a potential partner has a negative effect on the likelihood of the focal OEM to initiate a new manufacturing JV with that partner.

Differences in the Effect of Network Structure

The following section leverages the constructs noted above, questions the idential explanatory power of certain network constructs under different JV scenarios. Specifically, this section examines JVs that occur between OEMs and suppliers, as well as those JVs that occur in an international context.

Differences between OEMs and Suppliers

In a manufacturing based supply chain network there two main types of firms involved in production: the OEMs and the component suppliers. While OEMs produce similar finished products and compete with eachother for the same cusumers, suppliers compete with other suppliers but for the most part do not directly compete with the OEMs as these companies do not produce finished products that are intended for the end consumer. Due to this important difference, OEMs and component suppliers play different roles in the sourcing network. As the general principles of the network theory are expected to apply to both types of companies, significant differences are likely to exist with respect to the effects of network variables on new manufacturing JV formations.

For example, the legitimation effect of network centrality and the associated increase in the credibility of the potential partner is expected to be different for an OEM that is a direct competitor to the focal OEM and for a supplier that provides components to the OEMs in the network. Similarity, the potential for opportunistic behavior is expected to be higher for a supplier that has multiple manufacturing JVs than for a competing OEM with the same number of manufacturing JVs. Differences can be expected in the effect of network remoteness too, as an OEM and a supplier sharing the same level of remoteness in terms of their manufacturing JV ties to the sourcing network are inherently different types of network players.

Therefore, it is postulated that the effect of network centrality and network remoteness on new manufacturing JV formations has different effects in partnerships between two OEMs and partnerships between an OEM and a supplier. Hence:

Hypothesis 8a: The effect of potential partner's network centrality on new manufacturing JV formations differs among potential partners that are OEMs and those that are suppliers.

Hypothesis 8b: The effect of potential partner network remoteness on new manufacturing JV formations differs among potential partners that are OEMs and those that are suppliers.

International vs. Domestic Joint Venture Formation

In any given supply chain collaborative venture, there exist inherent risks that a partner will act opportunistically (Chiles & McMackin, 1996) as suggested above. Yet, while above the hypothesis development focused on equity-based joint ventures in general, an international joint venture (IJV) raises certain challenges that domestic JVs don't. That is to say that although in domestic partnerships there are inherent ambiguities between management, "contracts between IJV partners are often executed under conditions of high uncertainty,"(Inkpen & Beamish, 1997). Uncertainty is defined as the difficulty firms have in predicting the future, which comes from a lack of information (Beckman et al., 2004). Uncertainty presents a serious problem in the process of partnership development (Dwyer et al., 1987; Morgan & Hunt, 1994).This uncertainty also leads to ambiguity in the descision making processes which has been cited as a critical issue in international partnership formation (Inkpen, 2008). Additionally, IJV formation involves heightened levels of complexity as compared to that of a domestic venture (Li et al., 2009; Yan, 1998). While again, the general principles of network theory are expected to apply to both types of ventures, significant differences are likely to exist with respect to the effects of network variables on these new JV formations.

Above it was suggested that engaging in new manufacturing JV partnerships engenders the organizational learning processes. With increased levels of organizational learning, the firm accumulates significant experience and future actions are a function of the accumulated memory of the firm (Sinkula, 1994; Slater & Narver, 1995). A sourcing firm looking to engage in an IJV will be faced with a potentially limited and ambiguous network; perhaps decelerating this process. Furthermore, extant research in internationalization indicates that firms enter into foreign markets gradually, as risks decrease (Cavusgil, 1980; Czinkota, 1982; Johanson & Vahlne, 1977; Yeniyurt et al., 2009). The assumption underlying this notion is that firms tend to first enter into markets that are similar to their home market and as experience is gained, firms venture into countries increasingly more different than their home country (Johanson & Vahlne, 1977; Johanson & Weidersheim-Paul, 1975). Further, it is known that firms learn as they engage in international business activities, and as they accumulate international experience forming new international partnerships becomes easier (Yeniyurt et al., 2009). While some of this knowledge is market specific, some is general and can be utilized in generating new sourcing ties internationally. Thus given this proclivity that firms have towards entering markets at a gradual pace it is suggested that:

> **Hypothesis 9a**: The greater the country specific JV experience of a sourcing firm, the greater the likelihood of a JV being formed between the sourcing firm and a supplier from that country.
>
> **Hypothesis 9b:** The greater the country specific JV experience of a supplying firm, the greater the likelihood of a JV being formed between the supplying firm and a sourcing firm from that country.

There are significant challenges that firms while attempting to acquire and maintain successful ventures and these challenges are only amplified as the differences between management styles and cultures increases. These differences are a critical element of conducting global business as they can mold the beliefs and attitudes and behaviors of managers (Markus & Kitayama, 1991; Triandis, 1989). Cultural distance is one of the most important considerations to internationalization and has been utilized in a variety of studies (Benito & Gripsurd, 1992; Kogut & Singh, 1988; O'Grady & Lane, 1996; Yeniyurt et al., 2009). Additionally, previous research has demonstrated that cultural distance is a significant factor in global relationships (Barkema, Bell, & Pennings, 1996) and it has been demonstrated to be important in market selection (Erramilli, 1991; Erramilli & Rao, 1993; Kogut & Singh, 1988). For example, relationships between partners with dramatically different home countries has been noted to "lead to endless, energy and time consuming debates, futile talk that produces a lot of heat and prevents the company making the decisions it has to"(Jones & Shill, 1993). Furthermore, it has been empirically demonstrated that as levels of cultural distance decrease between two firms the likelihood of a venture decreases (Yeniyurt et al., 2009). Thus, it can be expected that:

> **Hypothesis 10**: The higher the cultural distance between the home countries of the sourcing and the supplying firms, the lower the likelihood of the sourcing firm to initiate a new manufacturing JV with that supplier.

Furthermore, it has been suggested that when looking at IJVs, "prior research has paid less attention to a local partner's network position as an important selection criterion" (Shi, Sun, & Peng, 2012); this is a significant gap in the literature on IJV formation.

There are a number of particularly poignant issues in the context of IJV partner selection, things like cultural differences between the firms for example, can exacerbate the uncertainty in a transaction (Kogut & Singh, 1988) and thus hinder the choice of a joint venture partner. Within the preliminary phases of the supplier selection process (i.e. in selecting a new joint venture partner) there is a significant amount of trepidation on both parties if they do not have an existing business relationship. Relationship exchanges are ever-evolving processes that are developed over time (Dwyer et al., 1987; Morgan & Hunt, 1994). Consequently, the cost of monitoring the exchange partner is expected to be higher in the relationship initiation stage, particularly in an international context. As a practical example take two firms who share drastically different home countries, China and Brazil for example. The two firms do not share the same national language and the national cultures are quite different. Thus, if these two firms were to engage in an IJV, not only would there be the normal uncertainty that arises in a joint venture, but the increased cultural variations might further exacerbate its impact on new joint venture formation.

Above it was articulated that network centrality was one way in which an OEM can more accurately assess the degree to which a partner firm is a viable partner. Essentially, centrality can be used by the focal OEM as a proxy to infer the credibility of a particular supplier. Yet, international JVs are structurally different than domestic JVs in that “a key feature of IJVs is shared management between partners from different countries” (Aimin & Ming, 1999). Further it has been suggested that, “decision makers' choices of foreign entry mode are significantly influenced by isomorphic pressures embedded in foreign national environments” (Yiu & Makino, 2002). When there is such

contrast in the formation of an IJV relative to a domestic JV, it seems reasonable to question the identical explanatory power of network centrality in these contexts. Thus, the legitimation effect of network centrality and the associated increase in the credibility of the potential partner is expected to be different for firms in different countries given various cultural uncertainties that may exist.

> **Hypothesis 11**: The effect of potential partner's JV network centrality on new JV formations differs among domestic and international JVs.

Further, when a firm looks to expand internationally the firms proximity and relation to the rest of the network is also a key consideration. Above it was suggested that network remoteness creates a barrier for the selection of the particular supplier as the partner. In an international setting, in addition to cultural and environmental uncertainly, lack of experience in the market or no prior history with any particular partner only exacerbates the impact that remoteness plays. Arguably this is a result of the dynamic composition of international networks. This has been empirically shown in the case of a reemerging economy, foreign networks formed tightly cohesive structures (Stark & Vedres, 2006). It has been noted that there are two types of networks related to IJVs, the focal firm's "network which consists of core firm, subsidiaries, and partners worldwide; and (2) local partner's business network which involves suppliers, technical institutes, production partners, distributors, and public agencies" (Zhao, Anand, & Mitchell, 2005). Further, it has been shown that the success of a JV can be amplified when there are contemporaneous within the network (Kogut, 1989). Thus, because of the suggested importance of *network remoteness* with respect to the likelihood of new JV, and because of the inherent uncertainty in JV formation process it can be expected that a firm who

shares sourcing ties in the same country with a buyer firm has a larger chance of being selected.

> **Hypothesis 12**: The effect network remoteness on new manufacturing JV formations differs among domestic and international JVs.

Additionally, while it is expected that in a domestic setting there is a balance between legitimation and opportunistic behavior as the number of ties that a supplier has increases (i.e. the non-monotonic effect noted above) it is also expected that a there are significant differences between JVs between domestic and international JVs. That is, the potential for opportunistic behavior is expected to be higher for a supplier that has multiple manufacturing JVs in various countries than for a competing supplier with the same number of manufacturing JVs domestically. For example it has been suggested that in IJVs with competitors, "each party devotes time and energy to the acquisition of specific knowledge from its counterpart, and then employs this knowledge to compete in its other business spheres" (Kwon, 2008).

Thus the above logic related to the differences on new IJV formation and the relationship between the diminishing effect that centrality plays, leads to the following hypothesis:

> **Hypothesis 13**: The non-monotonic effect that JV network centrality has on the likelihood of a new JV formation differs among domestic and international JVs.

Figure 1, Figure 2 and Figure 3 show the conceptual models that guide the remainder of this thesis.

Figure 1: Conceptual Model for Ego Network Structure and JV Formation

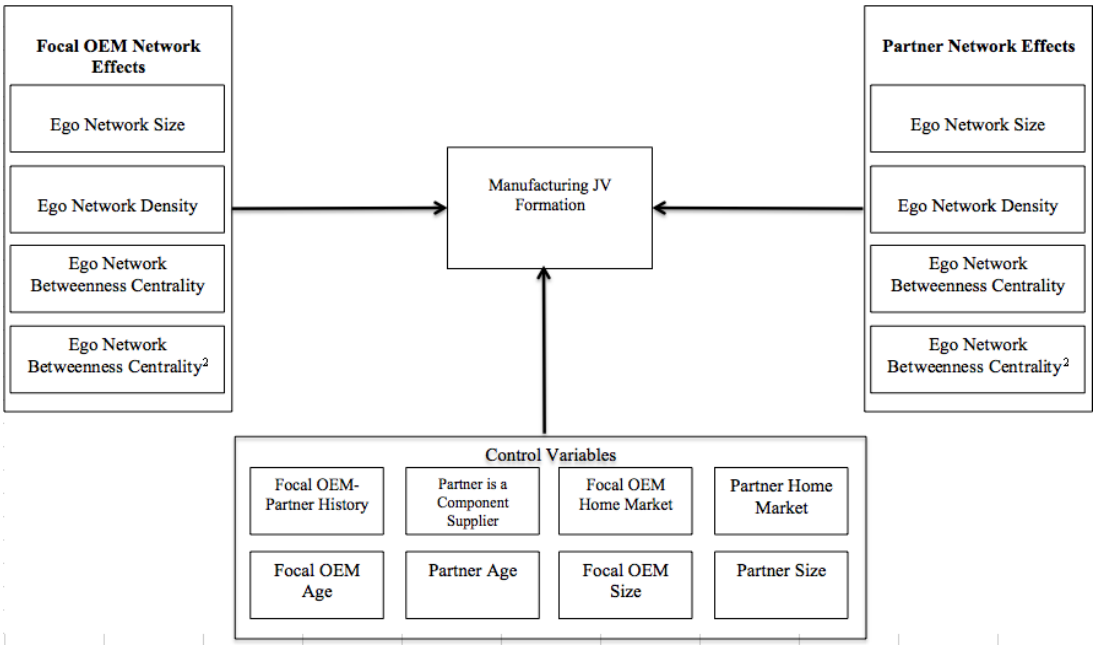


Figure 2: Conceptual Model for Overall Network Structure and JV Formations

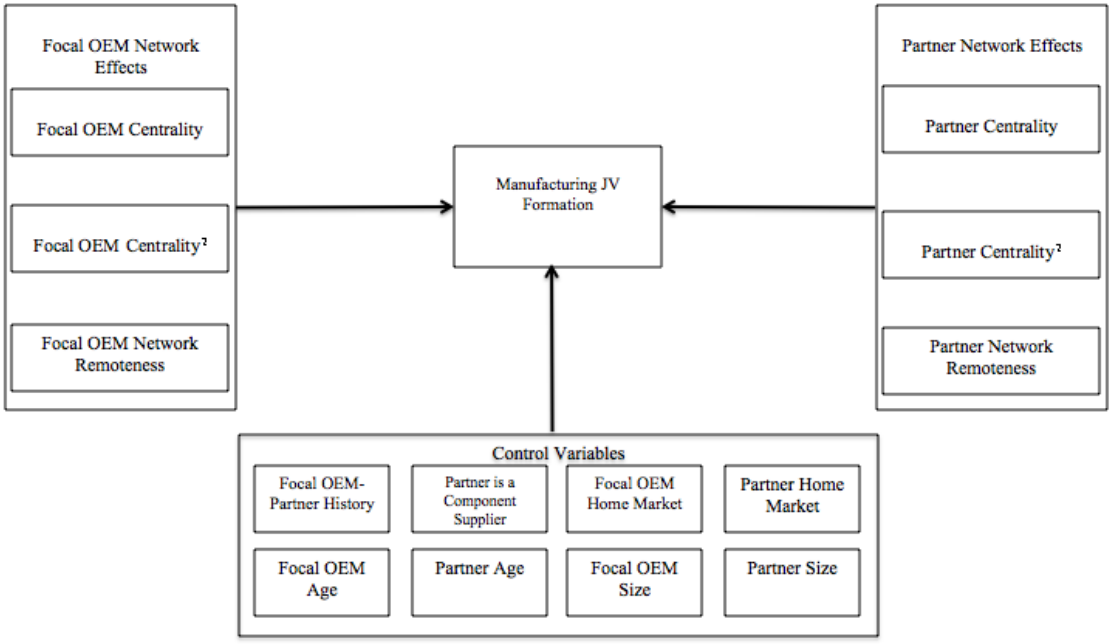
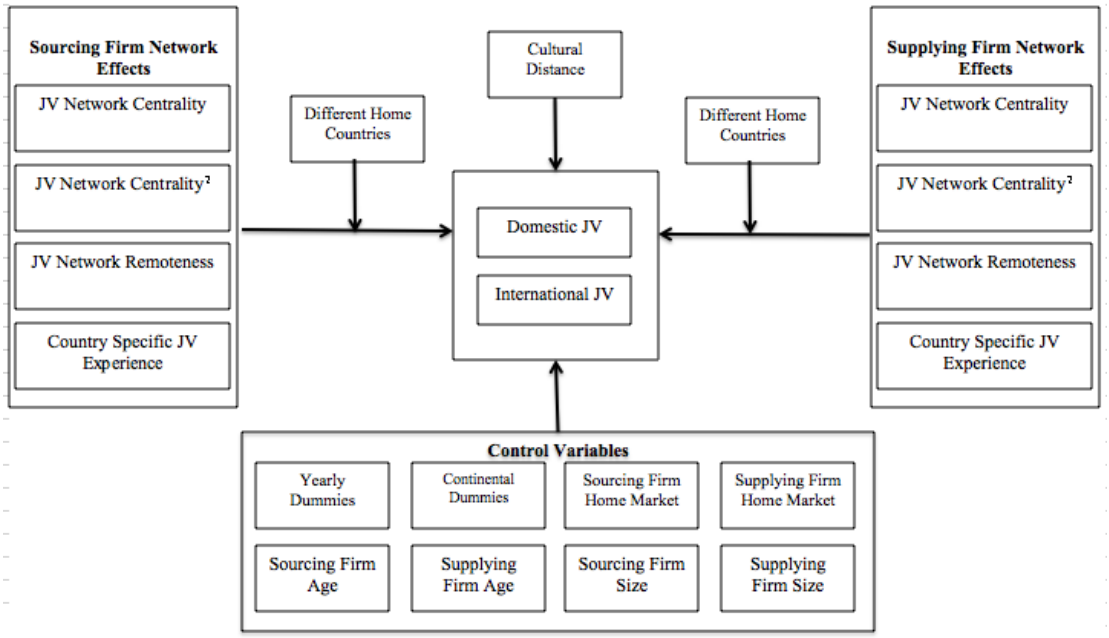


Figure 3: Conceptual Model for International vs. Domestic Network Structure and JV Formations



CHAPTER 3: METHODS

The following section provides an overview of the methodology that will be used in order to test the hypotheses presented above. It will include a description of the dataset and the way in which it was coded and formulated, the operationalization of the variables to be used and, finally, a description with complete specification of the empirical models that will be estimated.

Dataset

The data for this study were extracted from the Thomson Financial Security's SDC Platinum database. This source contains comprehensive information regarding all manufacturing joint ventures since 1985. Each new partnership is precisely recorded, including the timing of the deal, the parties involved, and the activities that the joint venture is expected to perform. This dataset facilitates the development of a complete network that includes all inter-company connections in a given manufacturing industry. For this thesis, I have chosen to study the global automotive manufacturing industry. The global automotive industry constitutes a suitable context for this study for several reasons. First, manufacturing joint ventures are very common in this industry (Buzacott & Steve Peng, 2012). Secondly, the automotive OEMs utilize large numbers of suppliers and frequently engage in collaborative relationships with these suppliers (Choi & Hartley, 1996; Kim et al., 2011). Finally, by utilizing this industry, this study contributes to a strong research stream regarding the automotive industry (Adler & Cole, 1993; Choi & Hartley, 1996; Choi & Yunsook, 2002; Dye & Wujin, 2011; Helper, 1991; Kim et al., 2011; MacDuffie, 1997; Novak & Eppinger, 2001; Sako, 1996).

The sample contains 1,158 firms, both automotive OEMs and automotive parts suppliers, that collectively engaged in 509 manufacturing based joint ventures observed over a period of 19 years (1985-2003). The dynamic network structure was developed by enumerating all manufacturing joint ventures linking all firms to one another (e.g. Marsden, 1990). The thesis focuses on the JV formation process from the focal OEM point of view and thus, the OEM is defined as a firm that manufactures automobiles and markets them under its own brands. In the sample, a total of 217 firms are OEMs. Supplier-supplier JVs have been omitted from analysis, as these types of partnerships are likely to have a different formation process and characteristics as the relationship between two suppliers is typically one characterized by one supplier subcontracting to meet an emergency demand or when a different skillset is required for production (Hines, 1996).

As the understanding of the network's structure is of paramount importance, I assembled all possible combinations of dyadic pairs of OEMs and potential JV partners over each year. This is a common method for constructing a network's structure (Marsden, 1990). Denote j for the focal OEM and k for potential manufacturing JV partner, which can be a component supplier or another OEM ($j \neq k$). In cases where both partners are OEMs, the focal OEM is identified based on the activities performed by the newly established JV, with the firm primarily utilizing the components produced by the JV being denoted as the focal OEM. The full dataset has 3,247,124 observations and includes dyadic information on all possible OEM-potential partner combinations over the 19 years. The large number of observations is due to the large matrix structure of the dataset, with variables being updated every year and any changes in the network structure

being captured dynamically. Having a large number of observations while the actual number of JV events is smaller is common in this type of study (e.g. Henisz & Delios, 2001; Yeniyurt et al., 2009).

Variables

The following will precisely detail the operationalization of all variables, both dependent and independent, that are used in this study. For ease of exposition and overall organization the variables are broken down by their levels of granularity.

Dependent Variables

In this thesis there are three dynamics that are being studied. The first is the impact that ego and larger, overall structural, network variables have on new JV formations; the second is the way in which these network variables affect OEMs in new JV formations differently than the suppliers and, finally, the differences between the impact of certain network constructs in domestic vs. international JV formation. Thus, given these three dynamics under investigation there is a need to operationalize three dependent variables for the empirical estimations of the various models.

The first dependent variable specifically speaks to the new joint venture formations in the network. The unit of analysis is the dyadic pair of two companies that, over the span of the dataset, have the potential to form a new manufacturing JV, one of which is the focal OEM and the other of which can be a competing OEM or a components supplier. Thus, to capture the likelihood of the establishment of a new supply chain manufacturing JV between an OEM and a potential partner, in both the ego and overall network structure, the dependent variable was measured as follows:

$$New\ JV\ Formation_{j,k,i} = \begin{cases} 1 & \text{if in year } i \text{ companies } j \text{ and } k \text{ formed a new JV,} \\ & \text{with the purpose of manufacturing components for } j \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

It is important to note that *j* is the focal OEM and the dependent variable is coded as 1 if the JV is manufacturing components for the focal OEM. The SDC Platinum Database provides detailed information regarding the activities and the scope of the newly established partnership. Using this information, the company that is the firm sourcing the components was identified as the focal OEM.

A significant argument in this thesis is that the effect of various network constructs on the likelihood of new JV formation differs among OEMs and potential partners. Accordingly, it is important to note that in a supply chain network, most firms act as both suppliers and sourcing firms, as a component manufacturer for a particular OEM will likely source components from other suppliers. For example, Toyota may procure a structural component for a new vehicle from GM; thus rendering GM as a parts supplier *and* an OEM simultaneously. To capture this complexity, in each manufacturing JV each participant was classified as a sourcing firm or a supplier. That is, I identified who acted as the purchasing organization that utilizes the components manufactured in the JV for its own production process. Additionally, I found who acted as a supplier, without utilizing any of the produced components in its own production process, this information was ascertained from a section of the output of the SDC database that describes the activity each firm performs in the JV partnership. Thus, in order to capture this varying effect between OEM-OEM JVs vs. OEM-Supplier JVs it is necessary to capture the following categorical variable:

$$OEM \text{ vs Suppliers}_{j,k,i} = \begin{cases} 0 & \text{if in year } i, j \text{ and } k \text{ did not form a new JV} \\ 1 & \text{if in year } i, j \text{ and } k \text{ formed a new JV } (k \text{ is an OEM}) \\ 2 & \text{if in year } i, j \text{ and } k \text{ formed a new JV } (k \text{ is not an OEM}) \end{cases} \quad (2)$$

This variable captures new JV formation where *j* is the focal OEM and is coded: 0 if there was no JV at all, 1 if *j* is an OEM and *k* is an OEM-supplier or 2 if *j* is an OEM sourcing from only other non-OEM suppliers.

Finally, to suitably test all of the hypotheses herein, a final dependent variable in this thesis must also capture the likelihood of the establishment of a new manufacturing International JV, rather than simply a domestic JV, between an OEM organization and a particular supplier. With respect to a new venture formation two possibilities arise: two organizations that share the same home country or two firms who have different home countries (note that equation (1) captures all JVs and does not make a distinction for home countries). Thus, in order to properly define an international JV formation the following categorical variable is constructed:

$$Domestic\ vs.\ Intl.\ JVs_{i,j,k} = \begin{cases} 0 & \text{no new } JV \\ 1 & \text{if firm } j \text{ and k share a home country, and formed a JV} \\ 2 & \text{if firm } j \text{ and k dont share a home country, and formed a JV} \end{cases} \quad (3)$$

where *i* represents the year, *j* represents the focal OEM and *k* represents the supplier in the dyad. This variable suitably captures the three possibilities needed to explore the differences between international and domestic JV formations.

Independent Variables

The following will now detail the operationalization of all of the independent variables used in the empirical estimations of this thesis.

Ego Network Variables

First, this section begins with the operationalization of the ego network variables mentioned above. Ego network size refers to the quantity of other network participants with which the firm has developed an existing tie, in this context, a JV partnership. Thus, ego network size has been operationalized as follows:

$$Ego\ Network\ Size_{f,i} = \sum_{f,i} JV_{f,i}(j,k) \tag{4}$$

where $f = j,k$ and $j \neq k$, i is the year, and JV is equal to 1 if firm j is engaged in a manufacturing JV with firm k in year i, and 0 otherwise $j \neq k$. Essentially, each time a new joint venture is formed by firm f with a new firm the firm adds one to its ego network size.

Recall that density measures the connectedness of a network, in this case an ego network of a particular firm within the automobile manufacturing industry spanning the sampling frame. To measure ego network density I follow Borgatti, Everett, and Freeman (2002) and calculate it as:

$$Ego\ Network\ Density_{f,i} = Actual\ Ties_{f,i} \big/ Maximum\ Number\ of\ Pairs_{f,i} \tag{5}$$

with $f = j,k$ where $j \neq k$, i is the year, *actual ties* refers to the number of JV ties that exist in the ego network and *maximum number of pairs* refers to the number of possible ties within the ego network (Borgatti et al., 2002) .

Ego betweenness centrality was measured by the extent to which a firm lies on paths linking other firms and captures how "in the mix" a particular firm is within the industry (Freeman, 1982; Marsden, 2002):

$$Ego\ Betweenness\ Centrality_{f,i} = \sum_{u=1}^{N}\sum_{v=1}^{u-1} p_{uv}(f)/p_{uv} \quad (6)$$

where u and v are firms in the ego network of firm f, N is the total number of firms in the ego network, p_{uv} is the total number of network paths linking firm u and firm v and $p_{uv}(f)$ represents the number of those paths that include firm f.

To test the diminishing effect of ego betweenness centrality I utilize a curvilinear effect (Cohen & Cohen, 1983) by including the quadratic term of ego betweenness centrality in the model specification. This method has been used in network studies before (Powell et al., 1999). Thus:

$$Ego\ Betweenness\ Centrality\ Squared_{f,i} = \left(Ego\ Betweenness\ Centrality_{f,i}\right)^2 \quad (7)$$

Table 1 shows the summary statistics and correlations between the ego network variables.

Table 1: Ego Network Summary Statistics and Correlations

Variable	1	2	3	4	5	6	7	8	9
1.New JV Formation	1								
2.Focal OEM Ego Network Size	0.0101*	1							
3.Partner Ego Network Size	0.0061*	0.1971*	1						
4.Focal OEM Ego Network Density	-0.0006	0.3355*	0.0856*	1					
5.Partner Ego Network Density	0.0025*	0.0717*	0.2460*	0.0287*	1				
6.Focal OEM Ego Betweenness Centrality	0.0089*	0.5705*	0.0794*	0.0007	0.0322*	1			
7.Partner Ego Betweenness Centrality	0.0025*	0.0516*	0.4861*	0.0247*	0.0081*	0.0198*	1		
8.Focal OEM Ego Betweenness Centrality^2	0.0047*	0.4211*	0.0537*	0.0093*	0.0233*	0.8835*	0.0135*	1	
9.Partner Ego Betweenness Centrality^2	0.0008	0.0338*	0.3685*	0.0172*	0.0061*	0.0135*	0.8857*	0.0093*	1
10.Focal OEM – Partner History	0.0479*	0.0545*	0.0771*	-0.0008	0.0297*	0.0664*	0.0401*	0.0524*	0.0262*
11.Partner is a Components Supplier	-0.0079*	0	-0.1506*	0	-0.0709*	0	-0.1147*	0	-0.0511*
12.OEM Home Market	0.0089*	0.2164*	0.0181*	0.0725*	0.0058*	0.1898*	0.0043*	0.1540*	0.0029*
13.Partner Home Market	-0.0002	0.0055*	0.0499*	0.0026*	-0.0133*	0.0021*	0.0548*	0.0016	0.0390*
14.OEM Age	0.0009	0.1069*	0.0418*	0.1431*	0.0139*	0.0969*	0.0112*	0.0867*	0.0076*
15.Partner Age	0.0013	0.0454*	0.1464*	0.0193*	0.0218*	0.0187*	0.0900*	0.0132*	0.0703*
16.Focal OEM Size	0.0083*	0.0757*	-0.0002	-0.0035*	0	0.0625*	-0.0002	0.0645*	-0.0002
17.Partner Size	0.0064*	-0.0001	0.1323*	0	0.0838*	-0.0001	0.0890*	-0.0001	0.0684*
Mean	0.0002	0.9005	0.4721	0.7152	0.3526	0.2524	0.0411	1.5725	0.2998
S.D	0.0140	1.3954	0.8720	3.7370	3.8421	1.2283	0.5460	12.2500	6.6102

*** p<.05**

Table 1: Ego Network Summary Statistics and Correlations

Variable	10	11	12	13	14	15	16	17
1.New JV Formation								
2.Focal OEM Ego Network Size								
3.Partner Ego Network Size								
4.Focal OEM Ego Network Density								
5.Partner Ego Network Density								
6.Focal OEM Ego Betweenness Centrality								
7.Partner Ego Betweenness Centrality								
8.Focal OEM Ego Betweenness Centrality^2								
9.Partner Ego Betweenness Centrality^2								
10.Focal OEM – Partner History	1							
11.Partner is a Components Supplier	-0.0207*	1						
12.OEM Home Market	0.0264*	0	1					
13.Partner Home Market	0.0021*	0.1193*	-0.0004	1				
14.OEM Age	0.0072*	0	0.2421*	0.001	1			
15.Partner Age	0.0093*	-0.0209*	0.0043*	0.2593*	0.0081*	1		
16.Focal OEM Size	0.0216*	0	0.1744*	-0.0003	0.1776*	-0.0004	1	
17.Partner Size	0.0185*	-0.2763*	-0.0003	0.0470*	-0.0003	0.2168*	-0.0016	1
Mean	0.0018	0.1936	2.3533	2.2107	57.7022	48.4252	4.5066	4.0651
S.D	0.0475	0.3951	2.6011	2.9567	36.4800	36.5680	0.7268	0.9570

*** p<.05**

Structural Network Variables

In order to begin to study the structure of the automotive supply network, it is critical to separate *sourcing* centrality and *supplying* centrality. That is to say, the number of times that a particular firm acted as the organization procuring components vs. the amount of times that an organization sold components. Hence, a tie was operationalized dichotomously for the firm acting as the supplier and the firm acting as the sourcing firm. Consequently, a firm's *Sourcing* and *Supplying JV centrality* is:

$$Sourcing\ JV\ centrality_f = \sum_{k,i} JV\ \text{sourcing tie}_{k,i}(j,k) \tag{8}$$

$$Supplying\ JV\ centrality_f = \sum_{j,i} JV\ \text{supplying tie}_{j,i}(j,k) \tag{9}$$

with $f = j,k$ where $j \neq k$ i is each year. In (3), JV sourcing tie *(j, k)* is equal to 1 if firm j utilized a manufacturing JV with firm k to source components and 0 otherwise, with $j \neq k$. In (4), JV supplying tie *(j, k)* is equal to 1 if firm j is part of a manufacturing JV that supplies components to firm k, and 0 otherwise, with $j \neq k$.

Recall also, that I have defined firm centrality as the amount of ties a firm has with other firms in the network. Hence, to measure individual firm centrality I calculated the number of manufacturing JVs firm j has in year i. Thus, *JV Network Centrality* for firm f was measured as:

$$JV\ Network\ centrality_f = Sourcing\ JV\ Centrality_f + Supplying\ JV\ Centrality_f \tag{10}$$

with $f = j,k$ where $j \neq k$ i is each year. This adaptation is in line with other scholars' operationalization of the variable (e.g. Kim et al., 2011). It is important to note that while this variable is similar to Ego Network Size it differs in the sense that Ego Network Size indicates the degree to which a firm is connected to other firms in the network whereas firm centrality measures the degree to which a firm is involved in new JV formations in the network.

Above it has been argued that remoteness creates a barrier for the selection of the particular supplier given a firm's position is far removed from the rest of the network. In order to capture the remoteness of a particular firm within the network, I use an adaptation of the concept of *node closeness centrality*. According to Freeman (1979), a node's closeness is the sum of graph-theoretic distances from all other nodes, where the distance from a node to another is defined as the length (in links) of the shortest path from one to the other. In the context of the current study, what Freeman refers to as "graph theoretic distances" can presently be thought of as a *trail*, which is the sequence of incident links, beginning at one node (firm) and arriving at another, in which no link is repeated (Borgatti, 2005). Firm remoteness is operationalized as follows:

$$\text{Remoteness}(f)_i = -1 * \left(\sum_{f=1}^{1158} d(j,k)^{-1} \right) \qquad (11)$$

where $d(j,k)$ represents the distance (in a graph theoretic sense) from firm *j* to firm *k,* $f = j,k$ and $j \neq k$, i represents the year under analysis. Normally, closeness is operationalized as the inverse of equation (11); hence its naming convention of *Closeness*. For the current application however, it is the *farness* that is of the utmost importance.

Further, because the current network is not fully connected the method used here is "an alternative to taking the reciprocal after the summation…in this case the closeness is the sum of the reciprocated distances so that infinite distances contribute a value of zero" (Borgatti et al., 2002).

To test the non-monotonic effects of the quantity of sourcing ties on the propensity to engage in a joint venture (i.e. curvilinear effect), I again take the quadratic versions of equation (10) for both the sourcing firm and the supplying firm. The logic being that if the sign is negative this implies that there exist decreasing returns to added centrality and thus providing support for the non-monotonic effect of increased centrality.

$$JV\ Network\ Centrality\ Squared_{\ j} = \left(JV\ Network\ Centrality_j\right)^2 \qquad (12)$$

Table 2 shows the correlations and summary statistics for the overall structural network independent variables.

Table 2: Structural Network Variables Correlations and Summary Statistics

Correlations	1	2	3	4	5	6	7
1.New JV Formation	1						
2. Focal OEM Centrality	0.0130*	1					
3. Focal OEM Centrality^2	0.0095*	0.9051*	1				
4. Partner Centrality	0.0035*	0.1115*	0.0644*	1			
5. Partner Centrality^2	0.0026*	0.0368*	0.0211*	0.8646*	1		
6. Focal OEM - Partner History	0.0296*	0.0908*	0.0858*	0.0457*	0.0299*	1	
7. Focal OEM Remoteness	-0.0060*	-0.0858*	-0.0561*	-0.0055*	0.0015*	-0.0098*	1
8. Partner Remoteness	-0.0042*	-0.0082*	0.0018*	-0.0565*	-0.0395*	-0.0124*	0.0517*
9. OEM Home Market	0.0072*	0.2339*	0.1977*	0.0131*	0.0043*	0.0223*	-0.0540*
10.Partner Home Market	0.0003	0.0054*	0.0033*	0.0893*	0.0678*	0.0028*	0.0012*
11.OEM Age	0.0028*	0.1362*	0.1114*	0.0239*	0.0082*	0.0114*	-0.0072*
12. Partner Age	0.0016*	0.0259*	0.0153*	0.1100*	0.0650*	0.0085*	-0.0002
13. Focal OEM Size	0.0071*	0.1812*	0.1758*	-0.0004	-0.0004	0.0203*	-0.0917*
14. Partner Size	0.0048*	-0.0003	-0.0003	0.1644*	0.1275*	0.0140*	0.0001
Mean	0.0001	1.9319	26.7694	0.886	6.7383	0.0012	-0.166
SD	0.0113	4.7997	139.3073	2.44	63.7433	0.0381	0.5485

*** p<.05, two-tailed**

Table 2: Structural Network Variables Correlations and Summary Statistics

Correlations	8	9	10	11	12	13	14
1.New JV Formation							
2. Focal OEM Centrality							
3. Focal OEM Centrality^2							
4. Partner Centrality							
5. Partner Centrality^2							
6. Focal OEM - Partner History							
7. Focal OEM Remoteness							
8. Partner Remoteness	1						
9. OEM Home Market	-0.0004	1					
10.Partner Home Market	-0.0141*	0.0003	1				
11.OEM Age	-0.0479*	0.0031*	0.2530*	1			
12. Partner Age	0.0001	0.2935*	0.0011*	0.0051*	1		
13. Focal OEM Size	0.0001	0.1744*	-0.0001	-0.0002	0.1776*	1	
14. Partner Size	-0.0459*	-0.0003	0.0470*	0.2168*	-0.0003	-0.0016	1
Mean	-0.1211	1.7733	2.2112	49.0572	48.4344	4.5066	4.0655
SD	0.484	2.5229	2.9567	35.5815	36.5701	0.7268	0.9569

*** p<.05, two-tailed**

International Independent Variables

I also hypothesized that higher levels of cultural distance between sourcing and supplying firms would negatively impact the propensity to form a manufacturing based IJV. In order to capture this distance I computed it the conventional manner using the Kogut and Singh (1988) approach of averaging the deviations in cultural scores (Hofstede, 1980, 1991) after adjusting for the differences in variations of each of the four dimensions:

$$CD_j = \sum_{i=1}^{4} \left\{ \frac{\left(I_{ij} - I_{ik}\right)^2}{V_i} \right\} \Big/ 4 \qquad (13)$$

where I_{ij} represents the *ith* cultural dimension and *j* denotes the sourcing firm, *k* denotes the supplying firm and V_i represents the variance across the *ith* dimension. This operationalization has been used by numerous other researchers (e.g. Contractor & Lorange, 1988; Nordstrom & Vahlne, 1994).

To measure the sourcing firm's history with the potential supplier's country all of the sourcing firm's transactions (buying from and supplying to) with the potential partner's home country were summed over the sampling frame.

Table 3: International Network Variables Summary Statistics and Correlations

Variable	1	2	3	4	5	6	7	8
1. JV Sourcing Tie	1							
2. Sourcing Firm JV Network Centrality	0.0130*	1						
3. Sourcing Firm JV Network Centrality^2	0.0096*	0.9051*	1					
4. Supplying Firm JV Network Centrality	0.0034*	0.1115*	0.0644*	1				
5. Supplying JV Network Centrality^2	0.0027*	0.0368*	0.0211*	0.8646*	1			
6. Supplying Firm JV Network Remoteness	-0.0059*	-0.0858*	-0.0561*	-0.0055*	0.0015*	1		
7. Sourcing Firm JV Network Remoteness	-0.0040*	-0.0082*	0.0018*	-0.0565*	-0.0395*	0.0517*	1	
8. Sourcing Firm Country Specific JV Experience	0.0091*	0.5082*	0.4726*	0.0822*	0.0394*	-0.0466*	-0.0081*	1
9. Supplying Firm Country Specific JV Experience	0.0073*	0.0959*	0.0709*	0.4895*	0.4368*	-0.0050*	-0.0275*	0.1405*
10. Cultural Distance	0.0001	0.0142*	0.0092*	0.0215*	0.0122*	0.0027*	-0.0108*	-0.0378*
11. Sourcing Firm Home Market	0.0070*	0.2339*	0.1977*	0.0131*	0.0043*	-0.0540*	-0.0004	0.1308*
12. Supplying Firm Home Market	-0.0002	0.0054*	0.0033*	0.0893*	0.0678*	0.0012*	-0.0141*	0.1068*
13. Sourcing Firm Age	0.0015*	0.0259*	0.0153*	0.1100*	0.0650*	-0.0002	-0.0479*	0.0399*
14. Supplying Firm Age	0.0028*	0.1362*	0.1114*	0.0239*	0.0082*	-0.0072*	0.0001	0.0628*
15. Sourcing Firm Size	0.0069*	0.1812*	0.1758*	-0.0004	-0.0004	-0.0917*	0.0001	0.0813*
16. Supplying Firm Size	0.0049*	-0.0003	-0.0003	0.1644*	0.1275*	0.0001	-0.0459*	0.0014
Mean	0.0002	1.9319	26.7694	0.8860	6.7383	-0.1660	-0.1211	0.1509
SD	0.0204	4.7997	139.3073	2.4400	63.7433	0.5485	0.4840	0.7578

*p<.05

Table 3: International Network Variables Summary Statistics and Correlations

Variable	9	10	11	12	13	14	15	16
1. JV Sourcing Tie								
2. Sourcing Firm JV Network Centrality								
3. Sourcing Firm JV Network Centrality^2								
4. Supplying Firm JV Network Centrality								
5. Supplying JV Network Centrality^2								
6. Supplying Firm JV Network Remoteness								
7. Sourcing Firm JV Network Remoteness								
8. Sourcing Firm Country Specific JV Experience								
9. Supplying Firm Country Specific JV Experience	1							
10. Cultural Distance	-0.0252*	1						
11. Sourcing Firm Home Market	0.1030*	0.0065*	1					
12. Supplying Firm Home Market	0.0595*	0.1104*	0.0003	1				
13. Sourcing Firm Age	0.0540*	0.0434*	0.0031*	0.2530*	1			
14. Supplying Firm Age	0.0309*	-0.0355*	0.2935*	0.0011*	0.0051*	1		
15. Sourcing Firm Size	0.0119*	-0.0241*	0.1744*	-0.0001	-0.0002	0.1776*	1	
16. Supplying Firm Size	0.0755*	-0.0049*	-0.0003	0.0470*	0.2168*	-0.0003	-0.0016	1
Mean	0.0718	2.0663	1.7733	2.2112	48.4344	49.0572	4.5066	4.0655
SD	0.4249	1.4176	2.5229	2.9567	36.5701	35.5815	0.7268	0.9569

*p<.05

Control Variables

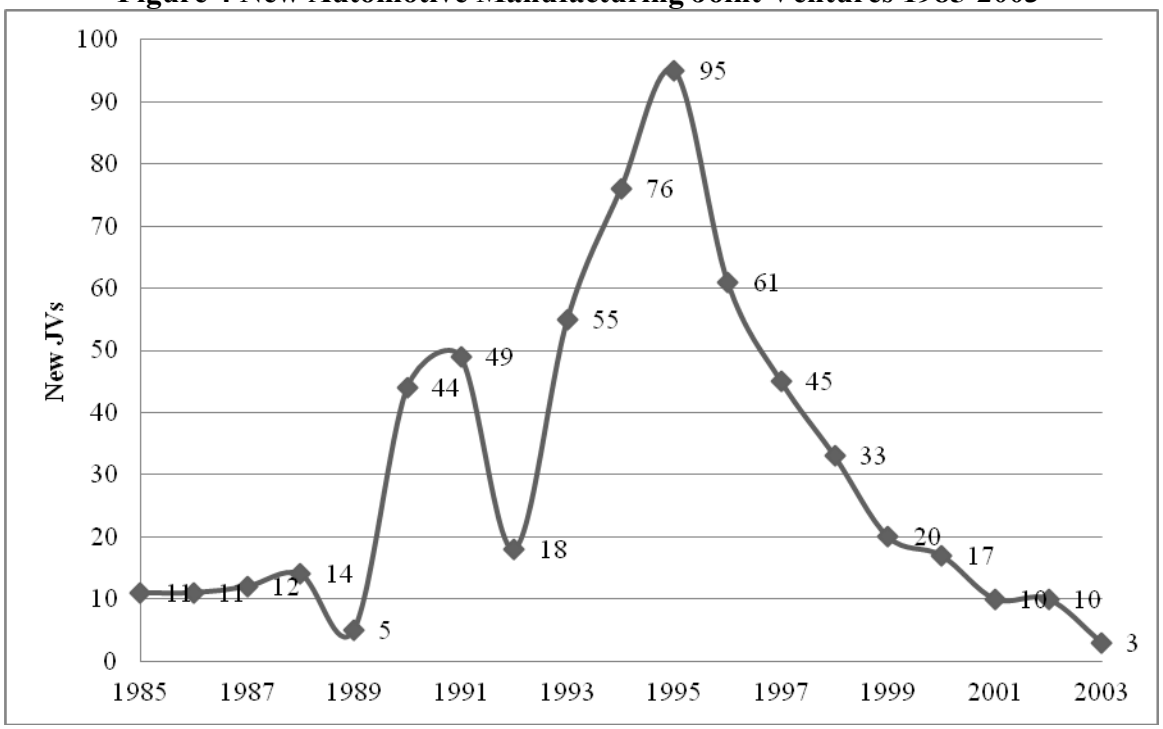
Several variables have been included as controls. First, history with partners has been shown to be important in the context of alliances (Gulati, 1995, 1999). Similar to Gulati (1999), I control for previous dyadic relationships by including the focal OEM-partner history, operationalized as the number of JV's that the focal OEM has engaged in with that particular partner in the past.

Partner characteristics such as technical specialization also play a significant role in partner selection (Inkpen & Dinur, 1998; Martin et al., 1995; Zhao et al., 2005). Therefore, a dummy variable that indicates the characteristic of the potential partner as either an OEM or a components supplier has been included in the specifications. The size of each firm is also included, operationalized as the log number of employees of each focal OEM and potential partner. I also control for the market conditions in the home market of the focal OEM and the home market of the potential partner. The market conditions were captured in terms of the yearly number of automotive registrations, measured in millions of vehicles. Experiential effects were further controlled for by including the age of each firm as a variable in the specifications. The age of each company was calculated by subtracting the founding year of firm *f* from year *i*.

One important consideration is temporal changes that can affect the JV formation behavior in the dataset. When joint venture formations are plotted, significant differences can be observed over time. As can be seen in Figure 4, JV formations rise from 1989 to 1991 and peak in 1995, then subsequently decline rapidly afterwards. Given this

variation a set of eighteen yearly dummies was included, denoting years 1986 to 2003 to capture these yearly variations.

Figure 4 New Automotive Manufacturing Joint Ventures 1985-2003



Empirical Models

The following section will detail the motivation, specification and formalization of all the empirical models to be estimated in this thesis.

Ego Network Structure

In order to test the effect that various dimensions of ego network structure have on new JV formation it is critical to recall that I have defined the dependent variable, New JV Formation dichotomously (see equation (1)). Furthermore, the intent of this thesis is to understand to what degree will the exogenously defined network variables (from all levels of abstraction) affect the *probability* of selecting a specific supplier in a new JV formation. As this is a probability model there are few choices analytically. Multiple linear regression is not acceptable because of the possibility that the results are not bound to the interval [0,1] (Wooldridge, 2010). The logistic regression model (or logit model) is a common method to address this issue and is ideal for estimating both a dichotomous dependent variable and ascertaining a closed form probability expression (Train, 2003). The following logit model was specified to test the probability of a manufacturing JV being formed between OEM j and potential partner k based on the ego network hypothesis development above. This specification is similar to the one used by Hosmer and Lemeshow (2000):

$$\begin{aligned}
&\lambda_{j,k,i} = \frac{e^{g(x)}}{1+e^{g(x)}} \\
&g(x) = \beta_0 + \beta_1 \text{Focal OEM Ego Network Size} + \beta_2 \text{Partner Ego Network Size} \\
&\quad + \beta_3 \text{Focal OEM Ego Network Density} + \beta_4 \text{Partner Ego Network Density} \\
&\quad + \beta_5 \text{Focal OEM Ego Betweenness Centrality} + \beta_6 \text{Partner Ego Betweenness Centrality} \\
&\quad + \beta_7 \text{Focal OEM Ego Betweenness Centrality}^2 + \beta_8 \text{Partner Ego Betweenness Centrality}^2 \\
&\quad + \beta_m CONTROLS + \varepsilon
\end{aligned} \tag{14}$$

where, $\lambda_{j,k,i}$ represents the likelihood of establishing a new manufacturing JV between OEM *j* and potential partner *k* in year *i*. Additionally, $\beta_m CONTROLS$ represents the product of the vector of the remaining *m* coefficients to be estimated and the matrix of control variables that are included in the model. Finally, to account for additional disturbances to the model, I include an error term ε. All network variables have been lagged by one year.

Overall Network Structure

Recall once more that the dependent variable used above to test how the likelihood of forming a new JV between two firms is affected based on ego network constructs was dichotomous. Furthermore, in addition to ego network variables, this dissertation also investigates the impact that the overall network structural variables have on new JV formations. Thus, multiple linear regression is again not acceptable because of the possibility that the results are not bound to the [0,1] interval (Wooldridge, 2010) and as such, the logistic regression model is used. The following logistic regression was specified to test the affect on the likelihood of a manufacturing JV being formed between OEM *j* and potential partner *k* based on the overall network structure hypothesis development above:

$$\lambda_{j,k,i} = \frac{e^{g(x)}}{1+e^{g(x)}}$$

$$where:$$

$$\begin{aligned} g(x) = {} & \beta_0 + \beta_1 \text{focal OEM centrality} + \beta_2 \text{focal OEM centrality}^2 + \beta_3 \text{partner centrality} \\ & + \beta_4 \text{partner centrality}^2 + \beta_5 \text{focal OEM remoteness} + \beta_6 \text{partner remoteness} + \\ & + \beta_m CONTROLS + \varepsilon \end{aligned} \tag{15}$$

where, $\lambda_{j,k,i}$ represents the likelihood of establishing a new manufacturing JV between OEM j and potential partner k in year i. Additionally, $\beta_m CONTROLS$ represents product of the vector of the remaining m coefficients to be estimated and the matrix of control variables that are included in the model. Finally, to account for additional disturbances to the model, I include an error term ε.

Differences Between OEMs and Suppliers

The logistic regression model noted above measures the likelihood of a new JV formation between an OEM and a potential partner, regardless if that partner is another OEM or a component supplier. While such a model specification can be used to determine the overall effects of the network variables on new JV formation, it does not account for the variation between partnerships with other OEMs and partnerships with component suppliers. Recall as well that above the variable "OEMs vs. Suppliers" the three possible scenarios: (1) no JV at all, (2) OEMs sourcing from only other OEMs or (3) OEMs sourcing from only other non-OEM suppliers (see equation (2)).

In order to model the nuances between these two alternatives, I also estimate a multinomial logistic regression model. Note that now, the dependent variable is categorical not dichotomous and thus pure logistic regression is not suitable (Wooldridge, 2010). In this specification new JV formations with competing OEMs are treated differently from partnerships with component suppliers. The multinomial logit model is a common approach for testing the probabilities or likelihoods of such categorical outcomes (Parks, 1980). In this model, the differences in the effects of the independent variables on the likelihood of forming a new JV are tested using equality constrains and

χ^2 difference tests. Consequently, the following model following McFadden (1989) is specified:

$$\Lambda(C)_{i,j,k} = \frac{\exp(\mathbf{x}_C'\beta_M)}{\sum_{C=1}^{3}\exp(\mathbf{x}_C'\beta_M)} \tag{16}$$

where $\mathbf{x_C}$ is the a (*C* x *m)* matrix of independent variables with rows corresponding to each of the three choices, β_M is the (*C* x *M*) matrix of coefficients to be estimated with rows representing the coefficients corresponding to each of the three choices.

Differences Between Domestic and International JVs

Recall again, that that unit of analysis is the dyadic pair of two companies whom, over the span of time that the dataset covers, have the potential to form a new manufacturing JV. The additional complexity arises in that these two firms can share a home country or not. Recall that in order to address the hypotheses the empirical context of this dissertation must also capture the likelihood of the establishment of a new manufacturing International JV, rather than simply a domestic JV, between an OEM organization and a particular supplier. Note that equation (3) is also categorical and thus, linear regression is not suitable (Wooldridge, 2010). Thus, in order to model the nuances between these competing alternatives, I again estimate a multinomial logistic regression. In this model, the differences in the effects of the independent variables on the likelihood of forming a new JV are tested using equality constrains and χ^2 difference tests. The model is identical to the above:

$$\Lambda(C)_{i,j,k} = \frac{\exp(\mathbf{x}_C'\beta_M)}{\sum_{C=1}^{3}\exp(\mathbf{x}_C'\beta_M)} \tag{17}$$

where $\mathbf{x_C}$ is the a (C x m) matrix of independent variables with rows corresponding to each of the three choices, β_M is the (C x M) matrix of coefficients to be estimated with rows representing the coefficients corresponding to each of the three choices.

CHAPTER 4: ANALYSIS AND FINDINGS

The following section details the results of the empirical models presented above. To ensure methodological rigor, the estimation techniques are briefly discussed. For clarity the components of this section are broken up based on the empirical models described above.

Ego Network Results

First, the effects of the ego network variables on the propensity of an OEM to form a manufacturing joint venture with another OEM or a supplier were estimated using Stata 12's logistic regression routine. This method calculates the parameters of the model using maximum likelihood estimation. Given that relatively limited amounts of information was available for the firm size, there is a large decrease in sample size when the OEM and partner size are included. Thus, two alternative specifications were estimated: one without size variables, and one that includes size as a control (see Table 4).

Table 4: Logit Estimates of Ego Variable Effects on New Manufacturing JVs [a]

Independent Variable	Without Size Variables			Size Included as Control Variables		
	B		**S.E**	**B**		**S.E**
Focal OEM ego network size	0.3969	***	0.0335	0.2709	***	0.0583
Partner Ego network size	0.1101	**	0.0382	0.1458	***	0.0410
Focal OEM ego network density	-0.0482	**	0.0175	-0.0189		0.0281
Partner Ego network density	-0.0088		0.0117	0.0102		0.0156
Focal OEM ego betweenness centrality	0.1974	**	0.0850	0.3931	***	0.1211
Partner ego betweenness centrality	0.1917		0.1787	0.0456		0.1442
Focal OEM ego betweenness centrality^2	-0.0393	***	0.0115	-0.0527	***	0.0155
Partner ego betweenness centrality^2	-0.0346		0.0268	-0.0119		0.0169
Focal OEM – partner history	1.5930	***	0.0933	1.2220	***	0.1391
Partner is a components supplier	-0.7822	***	0.0911	-0.5226	**	0.1683
OEM home market	0.1316	***	0.0148	0.1269	***	0.0281
Partner home market	0.0054		0.0154	0.0158		0.0283
OEM age	0.0019		0.0013	-0.0007		0.0027
Partner age	0.0031	***	0.0012	-0.0028		0.0024
Intercept	-11.5561		0.4386	-13.6476		0.9917
Focal OEM size				0.4540	***	0.1368
Partner size				0.3919	***	0.1033
Model fit						
Joint ventures	589			509		
Observations	3,247,124			514,712		
Likelihood ratio χ^2 (DF)	903.09*** (31)			338.81*** (33)		
Log-Likelihood	-4848.20			-1379.23		
Pseudo R^2	0.09			0.11		

a. The models were estimated using the yearly dummy variables but were not included for space considerations
***p<.001, **p<.05, *p<.1

The specification that includes size has a Likelihood Ratio χ^2 statistic of 338.81 with 33 degrees of freedom that is statistically significant ($p < .001$). Additionally, the model results in a Psuedo-R^2 of .11. These two measures indicate a good overall fit to the data. Although there is a large decrease in the sample size when firm size is controlled for, the coefficients are largely stable, indicating that the results are relatively robust. The

interpretation of the coefficients can be enhanced by taking the exponential value of each estimated effect. The result denotes the changes in the odds ratio of the new JV being formed, while all other predictor variables are held constant (Kutner, Nachtsheim, Neter, & Li, 2004). Table 5 provides the effect of each coefficient presented in this way.

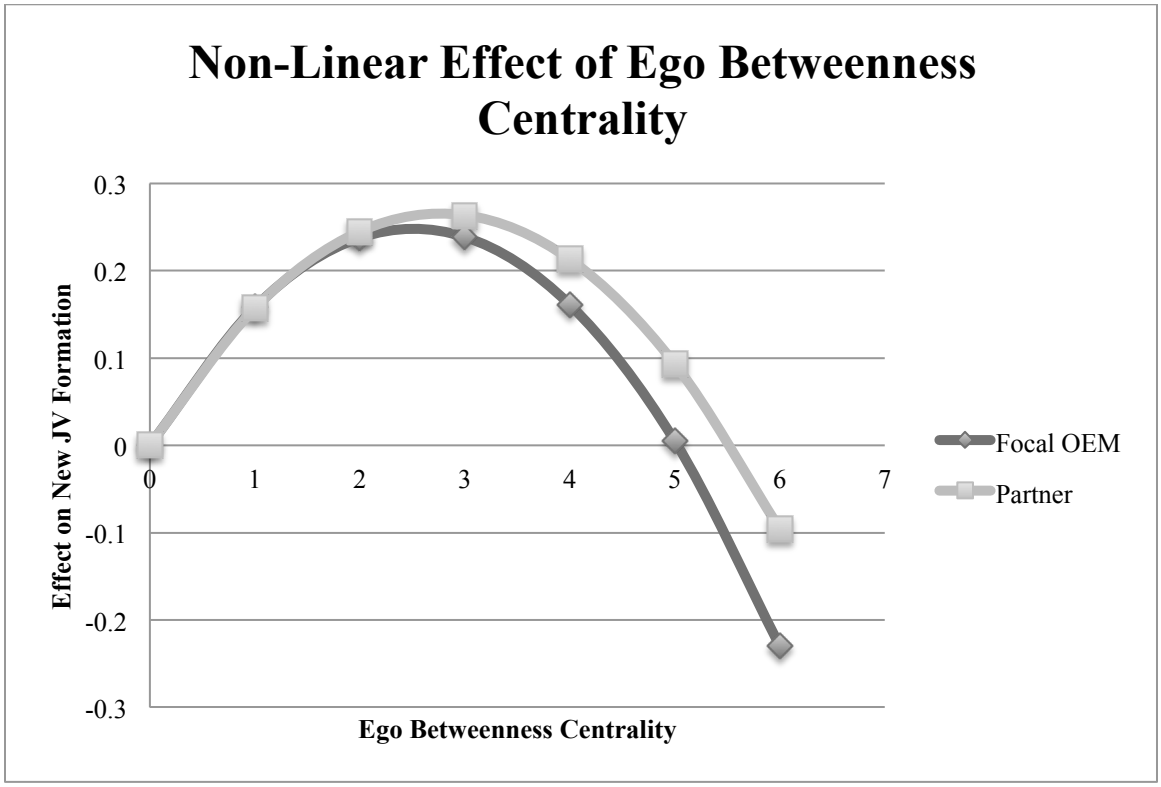
Focal OEM Network Effects

It was hypothesized that the size of a firm's ego network would impact its propensity of new JV formation. Consequently, the coefficient of the focal OEM's ego network size is positive and statistically significant ($p < .001$). Due to the large sample size, statistical significance needs to be supplemented with practical significance, therefore the change in odds ratio of forming a new JV for one unit increase in each of the variables (see Table 5) is considered. Focal OEM ego network size results in an approximately 31.11% increase in the odds of forming a new JV per unit increase in the size of the ego network of the focal OEM. Thus, Hypothesis 1a is strongly supported. It was also hypothesized that the density of the focal OEM's ego network would negatively impact its likelihood of new JV formation. In the specification without firm size the coefficient on focal OEM ego network density is negative and statistically at the .05 confidence level. When firm size is included, the coefficient is negative and results in a roughly 1.8% decrease per unit increase in density, yet it is not statistically significant. Thus, limited support for Hypothesis 2a was found.

In the case of ego network betweenness centrality of the focal OEM, the linear coefficients are positive and statistically significant ($p < .001$) in both specifications. Additionally, the odds of forming a manufacturing JV increase by 48.16% for each unit change in the ego network betweenness centrality of the focal OEM. Thus, Hypothesis

3a is strongly supported. It was also hypothesized that there would be a decreasing return to ego network betweenness centrality for the focal OEM. The results indicate that the coefficient of focal OEM ego betweenness centrality squared is negative and statistically significant ($p < .001$), and a one-unit increase in squared ego network betweenness centrality decreases the odds of forming a new tie by roughly 5.13%. Thus, Hypothesis 4a is supported. A graphical representation of the non-monotonic effect of focal OEM centrality on new manufacturing JV formation can be seen in Figure 5.

Figure 5: Non-Linear Effect of Ego Betweenness Centrality



Partner Network Effects

It was hypothesized that the size of a potential partner's ego network would positively impact the propensity of that firm being included in a new JV. The coefficient for the partner's ego network size is positive and statistically significant ($p < .001$) in both specifications, and results in an approximately 15.7% increase in the odds of

forming a new JV per unit increase in the size of the ego network of the focal OEM. Thus, Hypothesis 1b is strongly supported. It was also suggested that the density of a potential partner's ego network would negative impact its likelihood of new JV formation. In both specifications, the partner's ego network density is insignificant, failing to provide support for Hypothesis 2b.

The effect of firm ego betweenness centrality for the potential partner in the manufacturing JV is positive and results in an approximately 4.67% increase in the odds of forming a manufacturing JV per unit change in potential partner ego network betweenness centrality, yet it is not statistically significant. Thus Hypothesis 3b is not supported. Similarly, the squared term of partner ego betweenness centrality is also statistically insignificant, failing to support Hypothesis 4b.

Table 5: Odds Ratio Change for One Unit Increase in Each Independent Variable

Independent Variables	B	OR Change
Focal OEM ego network size	0.2709	31.114%
Partner Ego network size	0.1458	15.695%
Focal OEM ego network density	-0.0189	-1.871%
Partner Ego network density	0.0102	1.028%
Focal OEM ego betweenness centrality	0.3931	48.160%
Partner ego betweenness centrality	0.0456	4.668%
Focal OEM ego betweenness centrality^2	-0.0527	-5.134%
Partner ego betweenness centrality^2	-0.0119	-1.185%
Focal OEM – partner history	1.2220	239.394%
Partner is a components supplier	-0.5226	-40.702%
OEM home market	0.1269	13.528%
Partner home market	0.0158	1.590%
OEM age	-0.0007	-0.068%
Partner age	-0.0028	-0.277%
Focal OEM size	0.4540	57.453%
Partner size	0.3919	47.986%

Overall Network Results

The effects of the network variables on the propensity of an OEM to form a manufacturing joint venture with another OEM or a supplier were estimated using Stata 12's logistic regression routine. This method calculates the parameters of the model using maximum likelihood estimation. All time varying variables were lagged by one year.

Table 6: Logit Estimates of Structural Network Variable Effects on New Manufacturing JVs[a]

Independent Variable	Without Size Variables			Size Included as Control Variables		
	B		S.E	B		S.E
Focal OEM JV Network Centrality	0.2173	***	0.0143	0.1863	***	0.0198
Focal OEM JV Network Centrality^2	-0.0039	***	0.0005	-0.0032	***	0.0006
Partner JV Network Centrality	0.1143	***	0.0250	0.1019	***	0.0292
Partner JV Network Centrality^2	-0.0018	**	0.0009	-0.0019	*	0.0010
Focal OEM - Partner History	1.2721	***	0.0936	1.3266	***	0.1169
Focal OEM Remoteness	-0.2062	***	0.0523	-0.1539	*	0.0818
Partner Remoteness	-0.1581	***	0.0481	-0.2214	***	0.0617
OEM Home Market	0.0602	***	0.0166	0.0509	**	0.0239
Partner Home Market	-0.0134		0.0154	-0.0215		0.0224
OEM Age	0.0007		0.0014	-0.0041	*	0.0022
Partner Age	0.0028	**	0.0011	-0.0001		0.0017
Focal OEM Size				0.4402	***	0.1175
Partner Size				0.3834	***	0.0794
Intercept	-12.3261	***	0.4306	-14.4086	***	0.7536
Model fit						
Joint ventures			589			509
Observations			3,253,758			976,707
Likelihood ratio χ^2 (DF)			1053.48*** (28)			582.32*** (30)
Log-Likelihood			-4774.1196			-2215.6149
Pseudo R^2			0.10			0.12

a. The models were estimated using the yearly dummy variables but were not included for space considerations

***p<.001, **p<.05, *p<.1

The final model with size as a control variable has a Likelihood Ratio χ^2 statistic of 582.32 with 30 degrees of freedom that is statistically significant ($p < .001$). Additionally, the model results in a Psuedo-R^2 of .12. These two measures indicate a good overall fit to the data. The interpretation of the coefficients presented in Table 6 can be enhanced by taking the exponential value of each (see Table 7). The result denotes the changes in the odds ratio of the new JV being formed, while all other predictor variables are held constant (Kutner et al., 2004).

Table 7: Odds Ratio Change for One Unit Increase in Each Structural Network Variable

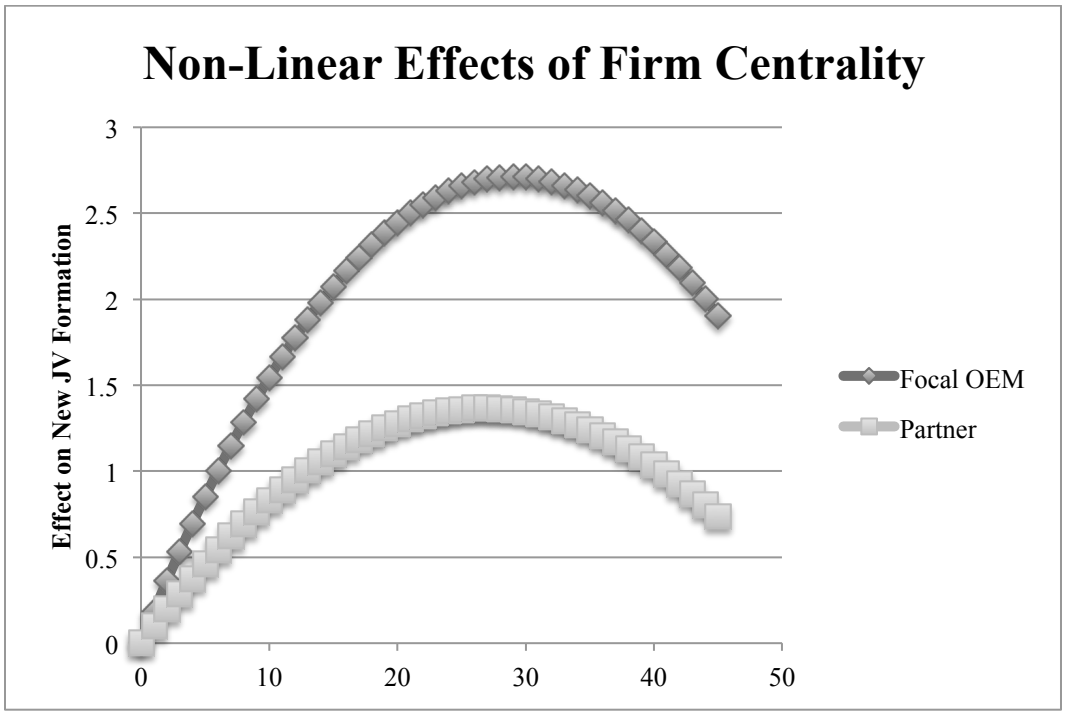
Independent Variables	B	OR Change
Focal OEM JV Network Centrality	0.1863	120.48%
Focal OEM JV Network Centrality^2	-0.0032	99.68%
Partner JV Network Centrality	0.1019	110.73%
Partner JV Network Centrality^2	-0.0019	99.81%
Focal OEM - Partner History	1.3266	376.82%
Focal OEM Remoteness	-0.1539	85.73%
Partner Remoteness	-0.2214	80.14%
OEM Home Market	0.0509	105.22%
Partner Home Market	-0.0215	97.88%
OEM Age	-0.0041	99.59%
Partner Age	-0.0001	99.99%
Focal OEM Size	0.4402	155.30%
Partner Size	0.3834	146.73%

Focal OEM Effects

In the case of JV Network centrality of the OEM it can be seen that the linear coefficients are positive and statistically significant ($p < .001$). Additionally, the odds of forming a manufacturing JV increase by 120.48% for each unit change in the network centrality of the focal OEM. Thus, Hypothesis 5a is strongly supported.

I also hypothesized that there would be a decreasing return to centrality for the focal OEM. The results indicate that the coefficient of focal OEM JV Network centrality^2 is negative and statistically significant ($p < .001$), and while controlling for the remaining covariates in the model, a one-unit increase in squared firm centrality decreases the odds of forming a new tie by roughly 99.68%. Thus Hypothesis 6a is supported. See Figure 3 for a graphical representation of the non-monotonic effect of focal OEM centrality.

Figure 6: Non-Linear Effects of Firm Centrality on New JV Formation



In a vast network of firms, I posited that if an OEM is very distant from the rest of the network (i.e. a large network remoteness score) it has a lower propensity to be part of a new manufacturing JV. Hence, shifting focus to the coefficients of remoteness for the focal OEM it can be seen that the coefficient is negative and statistically significant ($p < .001$) without size as a control variable, and marginally significant ($p<.1$) when size is

included. This effect, relates to a decrease in the odds of new manufacturing JV formation by 85.73%. Thus, Hypothesis 7a is strongly supported.

Partner effects

The effect of JV Network centrality for the potential partner in the manufacturing JV is positive and statistically significant ($p < .001$) and it results in a 110.73% increase in the odds of forming a manufacturing JV per unit change in potential partner centrality. Thus Hypothesis 5b is strongly supported. I postulated that the structural embededness of a firm in its network would negatively impact the propensity of an OEM to engage in a new JV with that firm. While at lower levels of centrality it was suggested that the supplying firm would appear credible, it was also suggested that there would be a decreasing return to centrality (i.e. a curvilinear effect). Hence, observing the coefficient on quadratic form of JV Network centrality for the partner firm it can be seen that it is negative and statistically significant ($p < .001$) without size added as a control variable and marginally significant ($p<.1$) with size as a control variable. Furthermore, a one-unit increase in squared potential partner centrality decreases the odds of forming a new JV by 99.68%. Thus Hypothesis 6b is supported.

It was also hypothesized that within a network of potential partners, those firms with more remote positions in the network will have smaller chances of being selected as a JV partner. The coefficients for partner remoteness are negative and statistically significant ($p < .001$). This effect relates to a decrease in the odds of new manufacturing JV formation of just over 80% for each unit increase in network remoteness. This result provides strong support for Hypothesis 7b.

Differences in the Effect of Network Structure

Differences Between OEMs and Suppliers

The effects of the network variables on the propensity of an OEM to choose among a competing set of alternative partners (another OEM or a component supplier) for a new manufacturing based joint venture were estimated using Stata 12's multinomial logistic regression routine. This method calculates the parameters of the model using maximum likelihood estimation. To identify the differences in effects of the network variables across the two groups of potential partners (OEM versus Suppliers), I employed the constrained multinomial logistic regression estimation. First, the model was estimated with all coefficients constrained equal between the two groups. Next, the constraint for each coefficient was tested for significance using the χ^2 difference statistic (i.e. the difference between the model without the particular equality constraint and the fully constrained model). The χ^2 test indicated that only two equality constraints were statistically significant at .05 confidence level. The effects of the linear and quadratic version of partner centrality significantly differ for potential partners that are OEMs and those that are suppliers, with χ^2 difference statistics of 85.56 and 68.89 respectively ($p < .001$). The estimated coefficients and the resulting χ^2 difference statistics can be seen in Table 8 and Table 9.

Table 8: Constrained Multinomial Logit Estimates of Variable Effects on New Manufacturing JVs[3]

Independent Variables	OEM-OEM JVs		OEM-Supplier JVs		χ^2 *Difference*[4]
	b	*Std. Error*	*b*	*Std. Error*	
Focal OEM JV Network Centrality	.1940 ***	.0161	.1940***	.0161	Not significant
Focal OEM JV Network Centrality^2	-.0033 ***	.0005	-.0033***	.0005	Not significant
Partner JV Network Centrality	**.2304** ***	**.0363**	**.0187**	**.0840**	**86.56*** **
Partner JV Network Centrality^2	**-.0058** ***	**.0016**	**-.0078**	**.0082**	**68.89*** **
Focal OEM Remoteness	-.5811 ***	.1592	-.5811***	.1592	Not significant
Partner Remoteness	-1.3828 ***	.1599	-1.3828***	.1599	Not significant
Domestic JV	1.2717 ***	.1148	1.2717***	.1148	Not significant
OEM Home Market	.1415 ***	.0308	.1415***	.0308	Not significant
Partner Home Market	-.0001	.0277	-.0001	.0277	Not significant
OEM Age	.0040 ***	.0013	.0040***	.0013	Not significant
Partner Age	.0002	.0016	.0002	.0016	Not significant
Intercept	-14.3453 ***	1.1816	-14.3453***	1.1816	Not significant
Model fit					
Joint-Ventures	589				
Observations	3,249,051				
Likelihood Ratio χ^2 (Degrees of freedom)	1,188.61*** (36)				
Log Pseudolikelihood	-4,678.80				

[3]The model was estimated using the yearly and continental dummy variables that are not included in the table for space considerations

[4]The difference indicates the improvement (increase) in χ^2 statistic when the equality constraint is released.

*** p < .001, ** p < .05, * p < .1, two tailed

The model has a Likelihood Ratio χ^2 statistic of 1188.61 with 36 degrees of freedom that is statistically significant ($p < .001$); this indicates a good overall fit to the data. The results indicate no differences in focal firm JV Network centrality effects on new JV formation. On the other hand, the JV Network centrality of the firm acting as the potential partner carries more weight in the case of other OEM partners than for suppliers. The coefficient for firm centrality of the OEMs is .2304 ($p < .001$) as compared with .0187 (statistically not significant) for the suppliers. In the case of OEM partners the coefficient corresponds to a 25.91% increase in the odds ratio as compared with an 1.89% increase for supplier partners. The quadratic effect of firm centrality is also

different, in the OEM partner case the coefficient of this variable is -.0058 while in the supplier partner case it is -.0078. For one unit increase in the squared firm centrality the change in the odds ratio is just under -.58% in the OEM partner case as compared to -.78% in the supplier partner case. Therefore, Hypothesis 8a is strongly supported. There are no differences in the effects of focal company or partner remoteness. This result fails to provide support for Hypothesis 8b.

Table 9: Odds Ratio Change for One Unit Increase in Each Independent Variable (Differences Between OEMs and Suppliers)

Independent Variables	All JVs	OEM – OEM JVs	OEM – Supplier JVs
Focal OEM JV Network Centrality	21.41%	21.41%	21.41%
Focal OEM JV Network Centrality^2	-.33%	-.33%	-.33%
Partner JV Network Centrality	**11.20%**	**25.91%**	**1.89%**
Partner JV Network Centrality^2	**-.28%**	**-.58%**	**-.78%**
Focal OEM Remoteness	-44.08%	-44.07%	-44.07%
Partner Remoteness	-75.51%	-74.91%	-74.91%
Domestic JV	256.80%	256.80%	256.80%
OEM Home Market	15.20%	15.20%	15.20%
Partner Home Market	-.02%	-.01%	-.01%
OEM Age	.40%	.40%	.40%
Partner Age	.02%	.02%	.02%

International vs. Domestic Joint Venture Formation

To identify the differences in effects of the network variables across the two JV types (domestic and international) we employed the constrained multinomial logistic regression estimation. First, the model was estimated with all coefficients constrained equal between the two joint venture possibilities. Next, the constraint for each variable under scrutiny was released and the equality of each coefficient across the two outcomes (domestic vs. international JV) was tested using the χ^2 difference statistic (i.e., the difference between the model without the particular equality constraint and the fully

constrained model against the χ^2 statistic with 1 degree of freedom). This is a common method to test the differences in coefficients across competing alternatives (Greve, 1998). Upon estimation of the model and testing for significant differences between the two outcomes, there were three main effects that are significantly different for domestic and international JVs. These were the linear and quadratic coefficients of the JV Network centrality of the sourcing firm, and the coefficient of the sourcing firm's country experience. Additionally, the coefficients of firm size for both sourcing and supplying firms were significantly different across the two outcomes. Thus, in the final estimation all but these five (5) variables were constrained to be equal. The Wald χ^2 statistic is statistically significant at the 0.001 confidence level, indicating good overall fit to the data. The results of the multinomial logistic regression analysis can be seen in Table 10.

Table 10: Constrained Multinomial Logistic Regression Analysis (International vs. Domestic)

	Domestic JV		International JV		χ^2
Independent Variables[a]	*Coefficient*	*Std. Error*	*Coefficient*	*Std. Error*	*Difference Test*
Sourcing Firm JV Network Centrality	0.1992 ***	0.0203	0.1992 ***	0.0203	
Sourcing Firm JV Network Centrality^2	-0.0035 ***	0.0006	-0.0035 ***	0.0006	
Supplying Firm JV Network Centrality	0.1702 **	0.0667	0.1036 **	0.0328	2.92*
Supplying Firm JV Network Centrality^2	-0.0067 **	0.0032	-0.0028 **	0.0012	5.76***
Sourcing Firm JV Network Remoteness	-0.2022 ***	0.0614	-0.2022 ***	0.0614	
Supplying Firm JV Network Remoteness	-0.1342 *	0.0804	-0.1342 *	0.0804	
Sourcing Firm Country Specific JV Experience	0.1831 ***	0.0369	0.0914 *	0.0479	19.9***
Supplying Firm Country Specific JV Experience	0.1698 ***	0.0565	0.1698 ***	0.0565	
Cultural Distance	-0.0919 *	0.0467	-0.0919 *	0.0467	
Sourcing Firm Home Market	0.1562 ***	0.0441	0.1562 ***	0.0441	
Supplying Firm Home Market	-0.0001	0.0383	-0.0001	0.0383	
Sourcing Firm Age	-0.0035	0.0023	-0.0035	0.0023	
Supplying Firm Age	-0.0006	0.0019	-0.0006	0.0019	
Sourcing Firm Size	0.3358 *	0.1936	0.4194 **	0.1391	3.23**
Supplying Firm Size	0.1901	0.1330	0.4942 ***	0.0966	10.98***
Intercept	-15.8350 ***	1.3034	-15.8350 ***	1.3034	
Model fit					
Joint Ventures					635
Observations					976,707
Wald χ^2 (degrees of freedom)					730.76*** (63)
Log Likelihood					-2361.8621

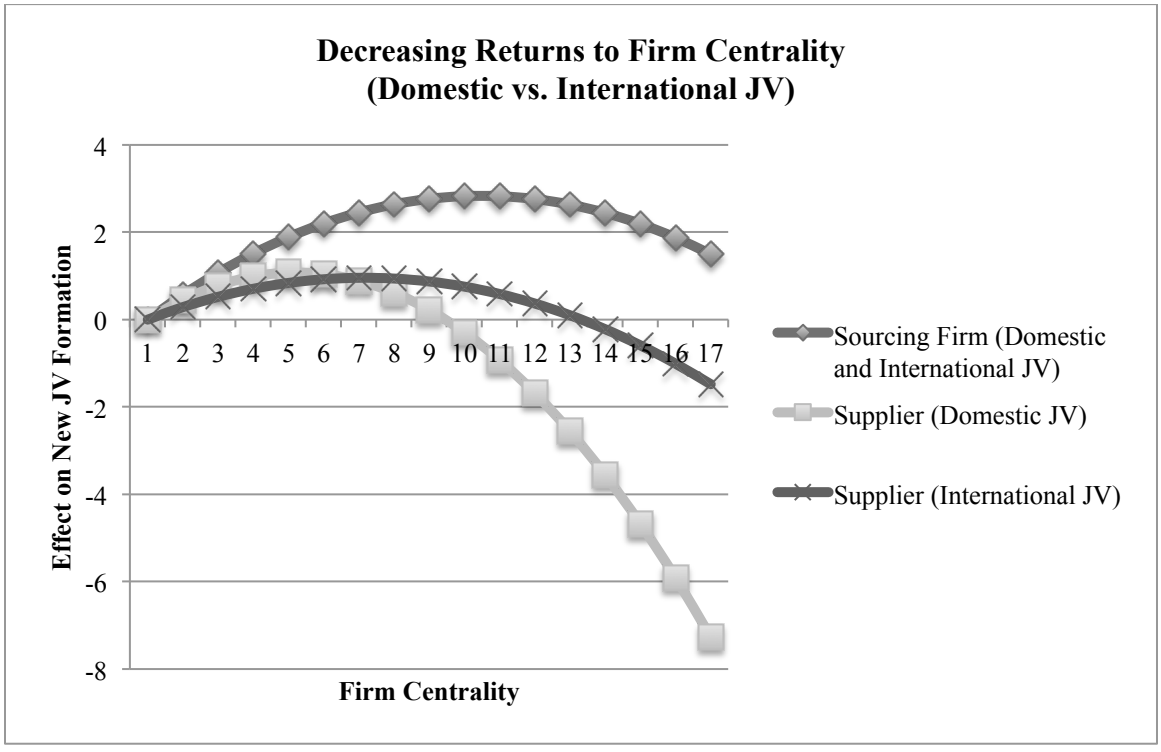
a. The model was estimated using yearly and continental dummy variables but these coefficients were not included in this table due to space considerations.
***p<.001, **p<.05, *p<.1

In hypothesis 11a and b, I suggested that the country specific JV experience of a sourcing firm and a supplier firm respectively, the greater the likelihood of a JV being formed between the sourcing (supplying) firm and a supplying (sourcing) firm from that country. When looking at the Country specific JV experience it can be seen that there is a positive effect for both sourcing and supplying firms, and the effect is statistically significant ($p < .001$). This result provides strong support for Hypotheses 9a and b.

Cultural distance was also suggested to play a significant role in the JV formation process. In looking at the variable for cultural distance it can bee seen that it has a negative and statistically marginally significant ($p < .1$) effect on new JV formation, providing limited support for Hypothesis 10.

When the constraint on the linear term of JV network centrality for the supplying and sourcing organization was released, only the supplying firm network centrality's effects showed a statistically significant difference. The χ^2 difference statistic on the linear effect of firm centrality was marginally statistically significant at .1 confidence level whereas the χ^2 difference statistic of the quadratic effect of firm centrality was statistically significant at .001 confidence level. While the coefficients' significance and signs remained stable, there is only limited support for Hypotheses 11.

Figure 7: Diminishing Returns to JV Network Centrality (International vs. Domestic)



In hypothesis 14 I suggested that the effect of potential partner network remoteness on new manufacturing JV formations differs among potential partners that have different home countries. Looking at the coefficients on JV network remoteness, this difference is not statistically significant, failing to provide support for Hypothesis 12.

Finally, when the constraint on the quadratic term for JV network centrality both the sourcing and supplying organization was released only the in the case of the supplying JV network centrality was the χ^2 difference statistic of the quadratic effect of firm centrality was statistically significant at .001 confidence level. Thus, there is limited support for Hypothesis 13.

Table 11: Summary of Hypotheses & Results

Hypothesis #	Hypothesis	Result	Significance
H1a	The ego network size of a focal OEM in the manufacturing JV network has a positive effect on the likelihood of a new manufacturing JV being initiated by that focal OEM.	Supported	p<.001
H1b	The ego network size of a potential partner in the manufacturing JV network has a positive effect on the likelihood of a new manufacturing JV being initiated with that potential partner.	Supported	p<.001
H2a	The ego network density of a focal OEM in the manufacturing JV network has a negative effect on the likelihood of a new manufacturing JV being initiated by that focal OEM.	Limited	Mixed

Table 11: Summary of Hypotheses & Results			
Hypothesis #	**Hypothesis**	**Result**	**Significance**
H2b	The ego network density of a potential partner in the manufacturing JV network has a negative effect on the likelihood of a new manufacturing JV being initiated with that potential partner.	Not Supported	p >.1
H3a	The betweenness centrality of the focal OEM in the manufacturing JV network has a positive effect on the likelihood of a new manufacturing JV being initiated by the focal OEM.	Supported	p<.05
H3b	The betweenness centrality of a potential partner in the manufacturing JV network has a positive effect on the likelihood of the focal OEM to initiate a new manufacturing JV with that partner.	Not Supported	p >.1
H4a	In the manufacturing JV network, there is a diminishing return to ego betweenness centrality of the focal OEM in manufacturing JV formations.	Supported	p<.001
H4b	In the manufacturing JV network, there is a diminishing return to ego betweenness centrality of the potential partner in manufacturing JV formations.	Not Supported	p >.1
H5a	The network centrality of the focal OEM in the manufacturing JV network has a positive effect on the likelihood of a new manufacturing JV being initiated by the same OEM.	Supported	p<.001
H5b	The network centrality of a potential partner has a positive effect on the likelihood of the focal OEM to initiate a new manufacturing JV with that partner.	Supported	p<.001
H6a	There is a diminishing return to the network centrality of the focal OEM in manufacturing JV formations.	Supported	p<.001

Table 11: Summary of Hypotheses & Results			
Hypothesis #	**Hypothesis**	**Result**	**Significance**
H6b	The total number of manufacturing JVs of a potential partner has a diminishing effect on the likelihood of a new manufacturing JV being initiated with that partner.	Supported	p<.001
H7a	The network remoteness of a focal OEM has a negative effect on the likelihood of a new manufacturing JV being initiated by the same OEM.	Supported	p<.001
H7b	The network remoteness of a potential partner has a negative effect on the likelihood of the focal OEM to initiate a new manufacturing JV with that partner.	Supported	p<.001
H8a	The effect of potential partner's network centrality on new manufacturing JV formations differs among potential partners that are OEMs and those that are suppliers.	Supported	p<.001
H8b	The effect of potential partner network remoteness on new manufacturing JV formations differs among potential partners that are OEMs and those that are suppliers.	Not Supported	p >.1
H9a	The greater the country specific JV experience of a sourcing firm, the greater the likelihood of a JV being formed between the sourcing firm and a supplier from that country.	Supported	p<.1
H9b	The greater the country specific JV experience of a supplying firm, the greater the likelihood of a JV being formed between the supplying firm and a sourcing firm from that country.	Supported	p<.001
H10	The higher the cultural distance between the sourcing and supplying firms, the lower the likelihood of the sourcing firm to initiate a new manufacturing JV with that supplier.	Limited	Mixed
H11	The effect of potential partner's network centrality on new JV formations differs among potential partners that have different home	Limited	Mixed

Table 11: Summary of Hypotheses & Results			
Hypothesis #	**Hypothesis**	**Result**	**Significance**
	countries.		
H12	The effect of potential partner network remoteness on new manufacturing JV formations differs among potential partners that have different home countries.	Not Supported	p >.1
H13	The non-monotonic effect the total sourcing ties has on the likelihood of a new JV formation differs between firms with different home countries.	Limited	Mixed

Robustness

In all cases, to evaluate the robustness of the above results, additional estimations were performed where the standard errors were clustered by each focal OEM. Such an estimation accounts for factors that may vary across firms that are not included in the model specifications. The overall fit of the models, as well as the valence, magnitude, and statistical significance of the coefficients remained virtually unchanged, indicating that the findings are robust to alternate model specifications and estimation methods.

CHAPTER 5: DISCUSSION AND IMPLICATIONS

The results show significant contribution to the supply chain management literature. First, examining Ego Network Variables this thesis finds that as a firm engages in manufacturing JVs and its ego network increases in size, it is more likely to further engage in additional manufacturing JVs. This suggests the presence of strong experiential and legitimacy effects in new manufacturing JV formations. This finding is

in line with previous literature that indicates the existence of these effects in the context of strategic alliances (Yeniyurt et al., 2009; Zaheer et al., 2010). The findings indicate that for a potential partner, a larger ego network facilitates the partner's selection for future manufacturing JVs. This finding is in line with previous research (e.g. Beckman et al., 2004).

The results regarding the effect of ego network density on new manufacturing JV formation are mixed. There is partial support for a negative effect of high ego network density on the focal OEM's involvement in new JVs. This could be interpreted as high levels of ego network density engendering structural homophily, and limiting access to a diverse set of potential partners and resources. Ego betweenness centrality plays a significant role in the process of new manufacturing JV formation for an OEM. For lower levels of network centrality, the effect is positive, facilitating the OEM's engagement in new manufacturing JVs. Yet, as ego betweenness centrality increases, its positive effect on new JV formations diminishes, and for great levels of ego betweenness centrality the effect turns negative. This inverted U shaped curvilinear relation between the focal OEM's ego betweenness centrality and new manufacturing JV formation indicates that at low levels centrality is beneficial while at high levels centrality is detrimental.

Moving to the overall network variables, the results reveal the significance of network constructs of centrality and remoteness for partnership formation. The results show that as a firm engages in manufacturing JVs, its network centrality increases, and it is more likely to further engage in additional manufacturing JVs. Further, this thesis identified a diminishing return to increased focal OEM centrality in terms of the

likelihood of new JV initiation. As it can be seen in Figure 6, although the effect remains positive, after a certain point, each additional JV partnership diminishes the role of focal OEM centrality in new JV formation.

It was noted that there are inherent uncertainties involved in the partner selection process. This uncertainty propagates itself principally around the lack of information that firms face when entering into a new partnership. The findings provide support to the idea that network centrality acts as a proxy for credibility and mitigates this uncertainty. This finding is in line with previous research (e.g. Beckman et al., 2004). Yet, the results show that the effect of centrality on new JV formation differs significantly between potential partners that are competing OEMs and potential partners that are component suppliers. While the competitor OEMs benefit significantly from an increase in their network centrality, suppliers do not.

Further, even for the OEMs competing with the focal OEM that is considering the formation of a new manufacturing JV with the purpose of sourcing components for its production process, the effect of centrality turns negative at very high levels of centrality. This suggests that very high levels of centrality can be interpreted as an increase in the likelihood of opportunistic behavior. The threat of opportunism is even higher for component suppliers, for whom an increase in the number of manufacturing JV partnerships has a detrimental effect on the likelihood of being selected for a JV by the focal OEM. These differences can be seen in the non-linear effects of centrality by company type shown in Figure 6.

On the other hand, the results show no difference in the effect of network remoteness between potential partners that are OEMs and those that are component suppliers. It can be inferred that a remote network member, with limited connections to the rest of the network, has a lower chance of being part of a new manufacturing JV. This is valid for both sides of the dyad, as a focal OEM with high network remoteness is also less likely to form a new manufacturing JV. These findings are in line with the extant network literature that has posited that networks remoteness is a significant barrier to the transfer of information among network members (Beauchamp, 1965). These findings have significant managerial implications as companies that operate in today's complex sourcing networks are in constant search of means of decreasing the uncertainty of their business environment. Managers should be conscious that network centrality and remoteness are key factors that impact other companies' perceptions of credibility and opportunistic behavior. Network connections are an important element of supply chains and they should be treated and managed as such.

These results are in line with previous studies that have suggested that a firm's position in the network can be used to gauge its credibility (Zaheer et al., 2010). Yet, the effect of centrality on global JV formation is non-monotonic, having a positive effect early on, but turning negative at greater network centrality levels. Further, the findings indicate that the effect of network centrality differs for international and domestic JVs. A visual representation of the effect of network centrality on new JV formation can be seen in Figure 7. For sourcing organizations, the returns on centrality peak at approximately eleven JVs for both domestic and international partnerships. This suggests that the benefits and coordination costs of network centrality are the same of domestic

partnerships or global partnerships. On the other hand, for suppliers, the effect of centrality peaks around five JVs for domestic partnerships and seven JVs for international partnerships. These results suggest that centrality has greater returns for the sourcing organization than for the supplying firm. Also, large numbers of JV network connections are more detrimental to a new domestic JV partnership than a new international JV partnership of a supplier.

JV network remoteness has strong negative effects on the likelihood of a new JV being formed, and this effect is even stronger for the sourcing firm. The implication is that remote firms have great difficulty in establishing global manufacturing JVs, regardless of JV's location. The results also suggest that firms seek to hedge international uncertainty (Inkpen & Beamish, 1997) and the negative effects of cultural distance by gaining and utilizing country specific experience. Country specific JV experience is plays a positive role in forming new JVs for both sourcing and supplying firms. While JV experience has a stronger effect for sourcing firms than suppliers in domestic JVs, supplying firm's country specific experience plays a more important role than sourcing firm's experience in the case of international JVs.

CHAPTER 6: LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

While this thesis makes significant inroads into the furthering the understanding of supply chain management and the collaborative venture formation patterns therein, several avenues for future research remain. This study utilizes data from the automotive industry, yet manufacturing JVs are a common phenomenon in all manufacturing industries. The external validity of these hypotheses should be further confirmed by an empirical test in alternate industries. Furthermore, while this thesis focused on manufacturing JVs, future research should explore the implications of network structure in other types of collaborative partnerships. The decision making process by which firms choose to progressively engage in collaborative ventures (i.e. non-equity based alliances to equity-based JVs) is one that the tenets of network theory can further the understanding of.

Additionally, partnership performance is not encompassed within the scope of this research. Future studies are needed to identify the effects of network structure on partnership and individual firm performance. In addition, future studies should examine the potential interaction effects between the various network constructs articulated herein. For example, the interaction between ego network size, density and betweenness is also of interest. Future research should also consider the implications of network theory for information sharing. Social network analysis provides a clear way to assess credibility using information sharing in the supply chain. It can be expected that the network

structure of a global value chain has important implications for the diffusion of information, technological developments, and new practices.

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