

INNOVATION SOURCING DECISIONS OF HI-TECH FIRMS: AN EMBEDDEDNESS PERSPECTIVE

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Abstract

Technological innovations have been increasingly important to a hi-tech firm's success. Firms often have to decide whether to invest in, form a partnership for, or simply purchase such innovations. While extant research has been dominated by economic perspectives, we regard such innovation sourcing decisions as a firm's strategic choices that are constrained by its network relationships. From such an embeddedness perspective, we bridge four main areas of research in technology innovation and probe how a firm's positional and structural embeddedness allows it to have the necessary network capabilities to choose between different innovation sourcing modes. In addition, we argue that this relationship will be further moderated by the firm's relational embeddedness. We believe this research has significant implications for both theory and practice in hi-tech industries.

INTRODUCTION

Technological innovations have become increasingly critical for organizational competitive advantage, especially, in hi-tech firms that face a hyper-competitive environment (D'Aveni, 1995), escalating research and development costs (Contractor, Kim and Beldona, 2002) and a knowledge-based economy (Sorensen and Stuart, 2000). While research generally agrees on the importance of technological innovation, four different innovation sourcing modes that represent distinct perspectives exist regarding how firms should acquire or build this capability. These include corporate venture capital investment, technology alliance, R&D consortia, and acquisition. The perspectives they represent are, however, dominated by the economic rationale and assume firms are atomistic entities (e.g., Hodgson, 1998; Williamson, 1975).

In this paper, we regard innovation sourcing decisions as a firm's strategic choices that can be constrained by their network relationships, since distinct social structural patterns within markets can influence the opportunities and constraints for actors (Gulati, Nohria and Zaheer, 2000). Hence, we introduce a fifth perspective, namely, the embeddedness perspective, which we believe would better help understand organizational innovation sourcing decisions (Mizruchi and Galaskiewicz, 1994) and provide a bridge among existing bodies of work on innovation sourcing.

The embeddedness perspective posits that organizations participate in a variety of interfirm relations and the content and structure of ties among network participants plays an important role in determining firm social and economic behavior (Gulati and Garguilo, 1999). Embedded ties have three unique features, namely, trust, fine-grained information transfer, and joint problem-solving which differentiate them from arm's length relations (Uzzi, 1996). Since our interest is in the innovation sourcing decisions of established firms, the relevant network is defined as formalized collaborative relationships within a hi-tech industry where the nodes represent competing firms that exchange information, assets and other resources. Accordingly, our model

will hold particularly hold in networks where members are separated by social distances and in networks that continue to grow so that firms have varying levels of embeddedness which could impact organizational decision making processes.

Recent academic studies maintain that firm size is a significant predictor of innovation sourcing decisions (Veugelers and Cassiman, 1999). Hence, for parsimonious reasons, this analysis exclusively explores the innovation sourcing decision in large, established firms in the hi-tech industry. The intent of this perspective is to provide an organizing framework that explains how relational assets influence the differential innovation sourcing modes that organizational decision-makers pursue.

Towards this end, this article is organized as follows. The next section examines the innovation sourcing modes of established firms, followed by an investigation of how different forms of organizational embeddedness impinge on this decision. Next, we present our theoretical framework and develop key propositions pertaining to the choice between these different innovation sourcing modes. Finally, after a brief discussion, implications for future theoretical research along with managerial implications are provided.

THEORETICAL BACKGROUND

In the management literature, the term technological sourcing has sometimes been used interchangeably with innovation sourcing (Hagedoorn and Duysters, 2002). Organizational innovation has been viewed to be a result of the combination of existing and new knowledge (Kogut and Zander, 1992). While knowledge recombination underlies the innovation sourcing decision, technology sourcing entails exploration of new knowledge and may not necessarily require re-combination with existing knowledge. Hence, technology sourcing may be viewed as a subset of the innovation sourcing decision.

Organizational theorists have shown great interest in the innovative capabilities of established firms (Cohen and Kleeper, 1996; Sorenson and Stuart, 2000). Established, hi-tech firms increasingly have to make strategic decisions that explore innovation sourcing modes such as in house development, external alliances or acquisitions as they have both the resources and ability to search for choices that could help them maintain their competitive advantage (Ahuja and Lampert, 2001; Barley, Freeman and Hybels, 1992). Identifying the governance mechanism most suitable for innovation sourcing by established hi-tech firms, then, has important implications.

Extant Perspectives

Although corporate venture capital (CVC) investments, co-operative alliances, R&D consortia, and acquisitions are useful modes for innovation sourcing based on four diverse perspectives, literature in each of these streams has emerged parallel to the other.

The first perspective, inspired by the entrepreneurship literature, maintains that corporate venture capital (CVC) investments, which involve equity investments that incumbents make in start-up firms (Gompers and Lerner, 1998), are an effective mode for established firms to learn about emerging technologies (Maula, Keil and Zahra, 2004; Zahra, Ireland and Hitt, 2000). The economic rationale underlying this perspective is that equity forms reduce knowledge integration costs, especially, when partner firms have great dissimilarity in their knowledge bases. However,

for the most part, this stream does not examine the nexus between organizational network structure and innovation sources, which can have rich implications for strategic renewal and business development.

Represented by organizational learning scholars, studies that focus on the second theoretical perspective emphasize technological alliances as an effective means to support learning processes through complementary knowledge bases and absorptive capacity, while holding other factors constant (Hodgson, 1998; Loasby, 1998). Although this perspective highlights the significance of accumulation and expansion of tacit knowledge resources for organizational survival and growth, it insufficiently addresses the ability of external networks to alter the opportunity set perceived by firms.

The third perspective primarily draws on the resource dependence perspective and proffers cooperative R&D endeavors such as R&D consortia as an effective channel for accessing resources that span firm boundaries to enhance innovative productivity (Sakakibara, 2002). Received research in this stream acknowledges that extant network relations restrict partner opportunistic behavior and facilitate knowledge transfer (Olk and Young, 1997). However, this perspective does not offer insights into the reason why some organizations enter into R&D consortia to the exclusion of or in combination with other alternative innovation sourcing modes.

The fourth perspective that builds on the classic transaction cost economics (TCE) perspective conceptualizes this decision as a choice between equity acquisitions and non-equity arrangements (Arrow, 1962; Coase, 1937). The economic rationale underlying acquisitions is the prevention of high monitoring costs due to appropriation concerns (Anand and Khanna, 1997; Mowery and Rosenberg, 1989), which should promote hierarchical administrative forms or acquisitions. Studying governance structures, Gulati and Singh (1998) however, found no significant difference between industry appropriability regimes and the choice of administrative forms. The drawback of the market-hierarchy dichotomy of Williamson's (1975) framework is that it considers organizations as atomistic units and overlooks the impact of a critical factor, i.e., the social structure in which firms are embedded.

Table 1 summarizes the key ideas and presents representative studies within each of the four perspectives described above.

Embeddedness Perspective

Researchers increasingly examine the role of organizational embeddedness, which argues that organizations are embedded in concrete and enduring strategic relationships that impact their actions and outcomes (Baum and Dutton, 1996; Dacin, Ventresca and Beal, 1999). Gulati and Gargiulo (1999) operationalize embeddedness in terms of positional, relational and structural forms. Zukin and DiMaggio (1990) conceptualize embeddedness more broadly to include the impact of cognition, culture, political institutions along with social structure on firm behavior. Since social structure affects many important economic outcomes and insights from prior network research suggest that Gulati and Gargiulo's (1999) embeddedness constructs primarily capture the social structure around organizations, we utilize their classification in this paper. According to them, positional embeddedness focuses on "organizational role" in the network and the ensuing information advantages. For example, the more central an organization's network position, the more likely it is to have better information about a larger pool of potential partners in the network (Sorenson & Stuart, 2001). Relational embeddedness focuses on the quality and

depth of dyadic relations such as cohesiveness. For example, in his ethnographic study of apparel firms, Uzzi (1996) noted that manufacturers sent work to network partners with whom they had intense social interactions to help these organizations survive in the short run even though the same work could be sent to other shops that offered instant volume discounts. Structural embeddedness focuses on indirect relations such as those that result when firms bridge structural hole positions or gaps in the network when all participants are not linked to one another. In networks with fewer gaps high levels of awareness among network members promote reputation concerns and limit opportunistic behavior (Simsek et al., 2003). For example, empirical findings from the chemical industry indicate that fewer gaps in the collaboration network enhance innovation output due to fine-grained information transfer between network members (Ahuja, 2000). We focus on organizational embeddedness for the following three reasons.

Table 1. Prior Literature on Innovation Sourcing Modes

<u>Innovation Sourcing Mode</u>	<u>Theoretical Perspective</u>	<u>Economic Rationale</u>	<u>Knowledge Characteristics</u>	<u>Representative Studies</u>
<i>CVC Investments</i>	Entrepreneurship	Minimizing knowledge integration costs	Extensive differences in knowledge bases	–Winters, 1988; –McNally, 1997; –Gompers & Lerner, 1998; –Maula et al., 2004; –Zahra, 2004; –Zahra, Ireland & Hitt, 2000
<i>Technology Alliances</i>	Organizational learning	Reducing knowledge transfer and coordination costs	Complementary knowledge bases	–Das & Teng 1998; –Larsson et al., 1998; –Hitt et al., 2000; –Olk, 2002; –Inkpen, 2001
<i>R&D Consortia</i>	Resource dependence	Risk-sharing; Enhancing R&D productivity; Changing R&D appropriability conditions	Relatedness of knowledge bases	–Hagedoorn, 1993; –Olk & Young, 1997; –Sakakibara, 1997a; –Doz et al., 2000; –Sakakibara, 2002
<i>Acquisitions</i>	Transaction cost economics	Minimizing contract execution costs; Reducing hold-up costs	Tacit/Complex knowledge bases	–Williamson, 1975; –Walker & Weber, 1984; –Oxley, 1997

First, Stinchcombe (1965) noted that the quality of relationships of established firms with customers, suppliers, and other external entities are likely to be superior to those of new firms. Since relationship factors have been identified as a logical antecedent to knowledge transfer, they could critically influence organizational choice of governance mode and organizational ability to effectively source innovation. This is particularly important in the case of established firms who have nurtured extensive network ties over the course of their life span.

Second, in his seminal work, Granovetter (1985) underscored the role of networks as a key

source that allows access to external capabilities. Scholars recognize that R&D activities are the most private component of any firm with significant clues for future market performance (Anand and Khanna, 1997). Hence, there is a greater likelihood that mechanisms through which established firms' source knowledge resources will be guided by their embeddedness (Uzzi, 1996). For example, high relational embeddedness typically suggests cohesive ties that not only promote information exchange but also enhance the level of trust and co-operation between independent organizations.

Third, research by Powell, Koput and Smith-Doerr (1996) indicates that in hi-tech industries the network is the locus of innovation. Given that organizational actors at any given time are known to act only on interdependencies and information that they are aware of (MacMillan, 1979), this perspective becomes important. This is because organizational access to relevant information will vary by virtue of their level of embeddedness.

Moreover, beyond economic factors, non-economic factors such as trust, prestige, etc. are given greater priority by actors with limited information processing capabilities (Simon, 1945). This precludes 'rational' choices that are merely driven by forces such as technology, transaction economics and resource dependencies. Organizational embeddedness can differentially affect managerial innovation sourcing decisions. Thus, the use of the embeddedness approach helps advance research in decision-making and addresses prior calls to utilize network theory for investigating issues that are not easily explained by other perspectives (Salancik, 1995). Next, we present our conceptual framework for the innovation sourcing decision.

CONCEPTUAL MODEL AND PROPOSITIONS

In this paper, arguments on the organizational innovation sourcing decision are based on Gulati and Gargiulo's (1999) classification of different types of embeddedness. The logic underlying this examination relates to the multifarious characteristics of network positions (whether the focal organization is centrally or peripheral located in the network), network structure (whether the focal organization's network partners are highly interconnected to each other or whether the focal organization's network partners are not linked to each other), and network ties (whether the focal organization has established strong or weak ties with network partners). More specifically, the ability of positional embeddedness to reveal prestige, the ability of structural embeddedness to unmask access to non-redundant information and relational embeddedness to demonstrate cohesiveness in the network of interest, guide this treatment (see Figure 1).

In particular, this paper extends Stuart's (1998) logic that firms with high positional embeddedness have greater absorptive capacity and are more likely to search beyond their existing technological foci depending on other network embeddedness dimensions. To do this, the framework presented, endeavors to capture the innovation sourcing decision by complementing the positional embeddedness dimension with other dimensions, namely, the firm's network structural and relational embeddedness.

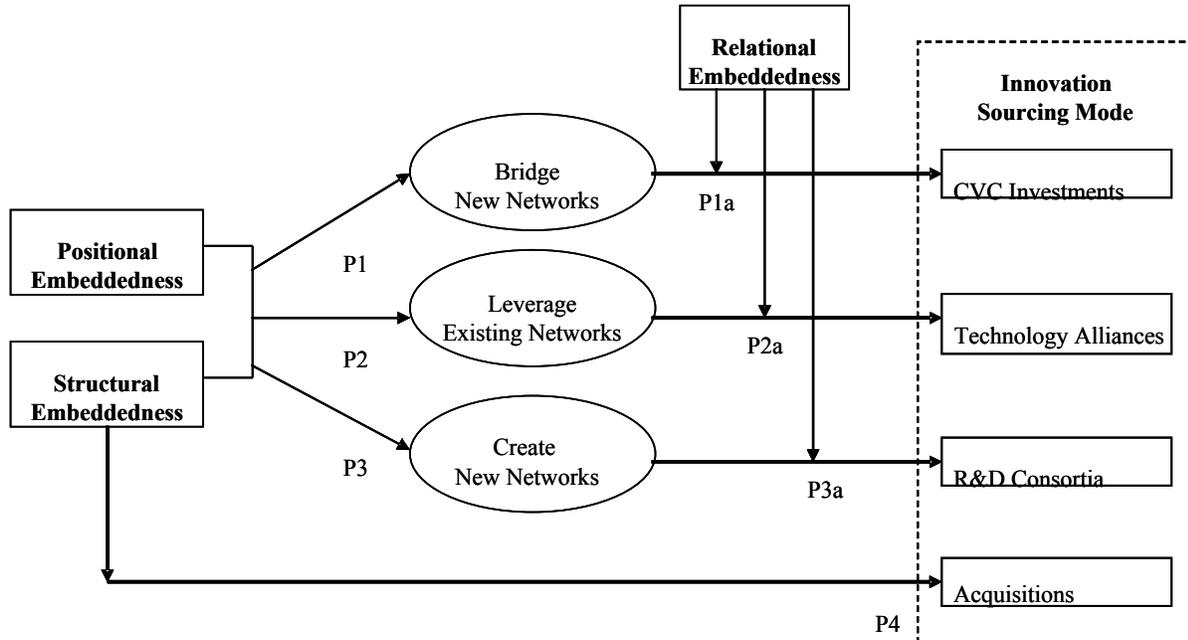


Figure 1. The Embeddedness Perspective on Innovation Sourcing Decisions

Echoing the findings of Gulati (1999) that embeddedness facilitates development of firm’s network-related capabilities, we argue that the confluence of positional embeddedness and structural embeddedness presents organizations with differential capabilities. The focus in this paper is on three such network-related capabilities, namely, the potential to bridge to other networks, to leverage extant networks, and to create new networks. At this point, it is important to clarify that these capabilities are not mutually exclusive. Hence, we maintain that a result of these network resources is that an established firm can have one, all or any combination of the above capabilities. Below, we describe the ways in which organizations attain these disparate networking capabilities and how these, in turn, affect the ensuing innovation sourcing decision as reflected in four main modes.

Organizational Embeddedness and Innovation sourcing decisions

To gain insight into the choice of the organizational form, some scholars have examined alliances in general, while others have investigated alliances with technological components in particular (Gulati, 1999; Vanhaverbeke, Duysters and Noorderhaven, 2002). Majority of these studies have dealt with each of these forms isolated from the other (Hagedoorn and Sadowski, 1999; Hoffmann and Schaper-Rinkel, 2001).

Few empirical studies have looked into the choice between alternative mechanisms. Not only is firm choice of different modes of knowledge acquisition an understudied area, but also the managerial literature has been inspired by numerous perspectives in examining these alternatives. Although TCE is by far the most popular (Hennart and Reddy, 1997; Vanhaverbeke et al., 2002), other scholars have employed the competence perspective (Colombo, 2003), the resource dependence perspective (Tallman and Shenkar, 1994) and the real options perspective

(Bowman and Hurry, 1993) to explore the choice between alternative external technology sourcing modes.

The decision-making literature asserts that under uncertainty, organizations undertake extensive information gathering and processing. The network literature details the information-gathering (Freeman, 1991) and information screening (Leonard-Barton, 1992) capabilities of networks in which organizations are embedded. Because innovation is an information intensive activity (Ahuja, 2000), it is pertinent to consider opportunities presented by organizational embeddedness to better understand the choice between equity-based and partnership-based modes of innovation sourcing. Taking a different approach from prior scholars, next, we investigate the role of positional and structural embeddedness in providing firms with unique network-related capabilities that influence their innovation sourcing decision.

Table 2 summarizes our key propositions describing the role of different types of embeddedness on established firm's ability to develop network related capabilities that influence their innovation sourcing decisions.

Table 2. Key Propositions on Innovation Sourcing Modes

<u>Proposition</u>	<u>Description</u>	<u>Moderating Effect</u>	<u>Network Capability</u>	<u>Innovation Sourcing Mode</u>
<i>P1</i>	High Positional embeddedness Low Structural embeddedness		Bridge to new and unfamiliar networks	
<i>P1a</i>	Established firms with the capability of bridging to new and unfamiliar networks	Low Relational Embeddedness in new networks		<i>CVC Investments</i>
<i>P2</i>	High Positional embeddedness High Structural embeddedness		Leverage existing networks	
<i>P2a</i>	Established firms with the capability to leverage existing networks	High Relational Embeddedness in existing networks		<i>Technology Alliances</i>
<i>P3</i>	High Structural equivalence High Structural embeddedness		Create new networks	
<i>P3a</i>	Established firms with the capability to create new networks	High Relational Embeddedness in existing networks		<i>R&D Consortia</i>
<i>P4</i>	Low Positional embeddedness High Structural embeddedness			<i>Acquisitions</i>

Corporate Venture Capital Investments

First, we explore the role that positional embeddedness plays in developing an established firm's capability to acquire pioneering technologies or radical innovations. Brown (1991) contends that experimentation with these innovations is one mechanism for incumbents to circumvent common learning traps. The positional approach is rooted in network models of equivalence and centrality that capture the position an organization occupies in the emerging network (Borgatti and Everett, 1992). For purposes of this innovation sourcing decision, we restrict our investigation to the role of centrality in acquisition of this new knowledge.

Central organizations have a larger "intelligence web" through which they have access to fine-grained information about other organizations (Gulati and Gargiulo, 1999). In addition, central organizations have greater access to external assets as they are considered to be prestigious actors (Brass and Burkhardt, 1992). Information advantages complemented by the higher visibility of central organizations enhance their attractiveness to potential partners. Especially, under conditions of high uncertainty, the signaling property of network positions introduces reputation differences which suggest that central organizations have greater experience and technological capabilities.

Taking the positional embeddedness approach, prior empirical studies show that firms with higher visibility are pursued by other organizations to enter alliances to a greater extent compared with other potential partners (Stuart, 1998). However, the positional approach provides an incomplete picture when this inquiry moves beyond an isolated decision and considers the choice between several alternative modes. Consequently, for a better understanding of this decision, we simultaneously probe the structural embeddedness of these firms. Structural embeddedness shifts the focus of analysis to the directness of communication between actors. Organizations that occupy structural hole positions (positions that link unconnected network members) enhance information benefits as the diversity of their contacts across unconnected groups leads to less redundancy and higher quality of information (Burt, 1998).

On the one hand, high positional embeddedness of established firms makes it possible for them to form linkages beyond their current technological foci (Stuart, 1998). At the same time, low structural embeddedness (networks rich in structural holes) further catalyzes linkages that span the network divide. Since these organizations have greater indirect ties which act as information processing device, they allow relevant developments in other networks to be brought to the attention of the focal firm (Gulati, 1995a). Both the ability of established firms with high positional embeddedness to transfer their prestige to other networks along with their low structural embeddedness provides them the capability of bridging networks. We contend that this network-related capability should further mobilize an established firm's rise to a central location in these new, unfamiliar networks.

Established firms that have indirect ties that allow them access to new networks and a central location in these networks improves the accuracy of the information available to them in these new networks (Coleman, 1988). High centrality of established firms in existing networks that occupy structural hole positions should consequently increase the probability of access to radical innovations (innovations that provide ground breaking solutions) (Maula et al., 2004). In a sense, we argue that greater firm-level resources that impact an organizations positional embeddedness in combination with novel network-level informational resources contribute to established firms capability to bridge to new, unfamiliar networks.

Beyond positional embeddedness, incorporation of structural embeddedness is critical to gain better insights into the innovation sourcing decision. Accordingly, our theoretical argument for the innovation sourcing decision of established firms proposes that high-prestige firms with indirect ties that span unconnected networks will ease assimilation of radical innovations. Thus:

***PI:** High positional and low structural embeddedness positively enhance the network-related capability of established firms to bridge to new and unfamiliar networks.*

Our main argument illustrates that beyond positional attributes, the extent of structural embeddedness can alter the nature of organizational innovation sourcing. This view describes how firms learn about opportunities. Although network-related capabilities play a critical role in the choice of mode for innovation sourcing, we also investigate the moderating role of relational embeddedness on this relationship.

Research by Gulati (1995b) recognizes the role of relational embeddedness or inter-firm ties and illustrates that the intensity of network relationships can influence the opportunity set of viable alternatives. This is because the quality and depth of dyadic relations is important in promoting trust. Other research by Shapiro, Sheppard and Cheraskin (1992) supports the idea that high relational embeddedness plays a pivotal role in the development of knowledge-based trust and serves as the basis for deterrence-based trust (Walker, Kogut and Shan, 1997).

While, high centrality in the networks that established firms have recently entered into (due to their capability to bridge to other networks) should minimize the information asymmetry problem (Gulati, 1998), we contend that the comparatively low relational embeddedness between actors in these new networks should promote equity-based modes of innovation sourcing.

Entrepreneurship scholars have recently begun to explore the vital role that corporate venture capital (CVC) investments play for incumbent firms in allowing for an early recognition of technological discontinuities. The governance modality in CVC investments primarily involves hierarchical control. Gompers and Lerner (1998) define CVC investments as funding that established firms provide small and medium sized start-ups in return for equity positions. This innovation sourcing mode entails a certain amount of control on the start-up firm besides mutual commitment between partner firms.

A great majority of research into CVC investments recognizes its potential benefits for established firms (Kann, 2000; Maula and Murray, 2002; Rind, 1981, Sykes, 1990). There is also some research that documents its benefits for new ventures or start-ups (Lee, Lee and Pennings, 2001; Zahra, 2004). Most of these studies adopt either an organizational learning or a competitive dynamics perspective. CVC investments are risky since firms attempt to jump a technology trajectory that is markedly distinct from current trajectories that entail incremental improvements. However, CVC investments can be viewed to have option-like characteristics that allow established firms to expand their investment with gains or divest their investment in the case of a negative turn of events.

These investments have the advantage that in the case of failure, limited damage is inflicted on the primary operations of established firms. Moreover, only established firms with high positional embeddedness that have the capital and clout to overcome investment choices that turn

bad will opt for this mode to source innovations. Hence, it is contended that established firms with the network-related capability of bridging to other networks along with low relational embeddedness in those networks drives their innovation sourcing mode choice.

Moreover, the need to reaffirm their clout should promote utilization of this mode to source radical innovations. In sum:

P1a: *Low relational embeddedness of established firms with the capability of bridging to new and unfamiliar networks will positively influence CVC investments as the preferred mode for sourcing radical innovations.*

Technology Alliances

Academic research in decision-making indicates that prior and extant networks play a key role in the innovation sourcing decision (Gulati, 1999). Drawing on this argument, it follows that under conditions of uncertainty firms with high structural embeddedness will be more likely to make satisficing rather than optimizing innovation sourcing decisions (Tallman and Shenkar, 1994). Hence, these firms are less likely to scan the full range of potential opportunities for access to knowledge.

Stuart (1998) maintains that firms with high positional embeddedness are likely to attract the interest of organizations outside their area of concentration. The reputation effect of these firms provides them access to knowledge beyond areas of their existing technological foci. Exploring novel technologies is especially beneficial for established firms as it challenges their existing cognitive structures (Lei, Hitt and Bettis, 1996). However, high structural embeddedness (lack of structural holes or gaps in the network) along with high positional embeddedness should predispose established firms to pursue innovation sourcing linkages with partners in the proximate technological vicinity. This tendency should provide established firms the network-related capability of leveraging existing networks.

The absence of weak ties is equated with low access to non-redundant information (Granovetter, 1973). Since weak ties are conceptualized as the wherewithal with which organizations bridge to unfamiliar networks, a lack of these ties can significantly thwart organizational ability to span the network divide. Furthermore, high structural embeddedness is likely to promote linkages within the existing network for several reasons. First, these linkages are an efficient means to eliminate duplicative efforts. Second, since these firms work in similar resource niches they share organizational routines that increase their absorptive capacity and ease knowledge transfer (Stuart, 1998).

A combination of insignificant indirect ties to other networks, high positional embeddedness and prior linkages within the existing network should all increase organizational proclivity to leverage existing networks for innovation sourcing. Leveraging existing networks to explore innovations new to the firm by established firms with high positional embeddedness should contribute to a greater heterogeneity in problem-solving. Failure to explore new innovations could have detrimental effects as it increases the likelihood that these firms fall into common learning traps. Therefore, it is proposed that:

P2: *High positional and high structural embeddedness positively enhance the network-related capability of established firms to leverage existing networks.*

While, networks with the above characteristics provide established firms with the capability of leveraging existing networks, we contend that it is the extent of relational embeddedness which determines whether or not these firms choose a particular mode for sourcing innovations.

Alliances involve a cooperative agreement between at least two firms (Olk, 2002). Inkpen (2001) identifies alliances to include a broad range of organizational forms such as equity joint ventures, licensing agreements, minority equity relationships, etc. For simplicity, in this section we focus on technology-based alliances that involve limited duration partnerships between firms. Since value creation is one of the primary rationales for alliance formation, selecting the appropriate partner is an important decision (Hitt, Dacin, Levitas, Arregle and Borza, 2000).

Veugelers and Cassiman (1999) contend that the public good nature of technology heightens the risk of technology leakage and opportunistic behavior in these alliances. Due to this potential for partner opportunism, Das and Teng (1998) contend that there must be a minimum level of confidence between partners prior to alliance formation. Greater relational embeddedness should provide an effective deterrence mechanism and shield partner firms from opportunism.

High cohesiveness of ties is also associated with ease of knowledge transfer that should spur utilization of non-equity-based forms for acquiring knowledge held by partner firms. Firms that leverage existing networks are more likely to utilize these partnership-based modes of innovation sourcing due to lower information search costs and higher levels of trust (Powell et al., 1996). Established firms also are more likely to have the requisite management skills to effectively cope with this innovation sourcing vehicle due to their prior linkages (Dyer and Singh, 1998).

Furthermore, since new innovations may have been in existence but are new to the firm, relational embeddedness should provide established firms with the ability to leverage their network to assimilate this technology from other organizations due to their high prestige. In hi-tech industries where speed is critical, Teece (1992) contends that alliances provide firms with an attractive option over internal development or acquisitions. Other research also contends that alliances reduce the transaction and coordination costs of arms-length market transactions (Dunning, 1995). Since competition is greatest in networks with high structural embeddedness, we argue that in such networks central, established firms with high levels of relational embeddedness predominantly utilize technology alliances. Hence:

***P2a:** High relational embeddedness of established firms with the capability to leverage existing networks will positively influence technology alliances as the preferred mode for sourcing new innovations.*

R&D Consortia

Academic research by Doz, Olk and Ring (2000) was among the first to explore R&D consortia formation processes. Their research underscores the catalytic role of environmental pressures such as changes in environmental threats and firm-level effects such as shared interests among member organizations on network emergence. Doz et al. (2000) define R&D consortia as arrangements where two or more companies that pool resources and share decision-making

create a legal entity to conduct co-operative R&D activities. Sakakibara (1997a) identified two main motives for organizational participation in R&D consortia: cost-sharing and skill-sharing. His findings also suggest that these two motives are not necessarily mutually exclusive.

In light of Shirai and Kodama's (1989) findings that R&D consortia participants tend to be large listed firms and Sakakibara's (1997b) findings that outlays on R&D consortia are only a small share of any firm's total R&D investment, it is more plausible that skill-sharing or risk-sharing rather than the cost-sharing motive dominates the R&D consortia formation decision of established hi-tech corporations. Scholars in the organizational literature contend that R&D consortia are an excellent means to internalize and combine knowledge that enhances innovative productivity (Teece, 1992). In addition, firms in industries with high spillovers increase their preference for R&D consortia to internalize these spillovers (Sakakibara, 2002).

Although Sakakibara (2002) investigated industry and firm-level conditions that drive R&D consortia formation, a better understanding of the innovation sourcing decision necessitates investigation of this decision from a network embeddedness lens. In this analysis, we examine another positional embeddedness construct, structural equivalence which is a pair-level measure of the similarity of firms/actors network patterns. The greater the similarity of firm networks, the greater the structural equivalence of these firms (Valente, 1995). Since, structural equivalent firms have similar resource profiles (Gnyawali and Madhavan, 2001) and these firms are likely to avoid direct conflict (Smith, Grimm, Young and Wally, 1997), we argue that hi-tech industries with high concentration are likely to have established firms that are structural equivalents.

Scholars note that high density has a dampening effect on competitive dynamics in structural equivalent firms due to the increase in the number of structural equivalent pairs (Gnyawali and Madhavan, 2001). Based on this research, it is likely that in networks with low levels of structural holes or high structural embeddedness, these firms underscore skill-sharing to ensure competitiveness. Hence, we propose that this network structure should provide structurally equivalent, established firms with a unique network-related capability, the ability to create new networks.

Further, we argue that established firms with the capability of creating new networks will aid assimilation of emerging innovations. This is because the similar asset, information and status flows of structurally equivalent firms increases the likelihood that these firms have similar R&D investment outlays which contributes to the high domain similarity (Cohen and Levinthal, 1989) among R&D consortia participants. On the one hand, established firms with the capability of creating new networks assure leverage of existing technological competencies to create next-generation/emerging innovations. At the same time, high levels of absorptive capacity of structural equivalent firms should enhance skill-sharing in R&D consortia. Based on the above reasoning, it is suggested that:

***P3:** High structural embeddedness positively enhances the network-related capability of structurally equivalent established firms to create new networks.*

While, networks with high structural embeddedness (networks that lack structural holes or those with low levels of interconnectedness among network partners) provide established firms with the capability of creating new networks, we argue that it is the extent of relational embeddedness which determines whether or not these firms choose R&D consortia as a mode for

innovation sourcing. Olk and Young (1997) indicate that R&D consortia are designed to facilitate development of technological innovations. Given that the goal of the framework presented in this paper is to understand the innovation sourcing decision, it is important to include R&D consortia among the alternatives that firms consider in making this decision.

Sakakibara (2002) found that firm age and high cash flow were positively related to the propensity to participate in R&D consortia. The logic underlying these findings is that with time firms have a greater chance to develop formal and informal networks with other firms. In addition, greater cash flow increases the willingness of firms to invest in consortia that have the potential to bring new opportunities to firms in the future. Doz et al. (2000) likewise view R&D consortia as an option that firms can exercise. Employing this reasoning, since established firms have been in existence for a longer duration and generally have a high level of cash flow, their positional and structural embeddedness should influence their innovation sourcing decision.

Extending the previous argument, it is proposed that high relational embeddedness will moderate the relationship between the network-related capabilities of structurally equivalent, established firms in networks with high structural embeddedness and promote their decision to form R&D consortia. These cooperative ventures primarily aid the development and assimilation of emerging or new innovations. This is because R&D consortia are more likely to result in incremental rather than ground breaking innovations due to high levels of relatedness of partner knowledge bases that might hinder development of completely new solutions. In addition, this experimentation also allows established firms to circumvent common types of learning traps. Thus:

***P3a:** High relational embeddedness of established firms with the capability to create new networks will positively influence R&D consortia as the preferred mode for sourcing emerging innovations.*

Acquisitions

Vanhaverberke et al. (2002) define acquisitions as inter-firm linkages that lead to integration of two entities. This definition includes merging of two equal companies or when one company acquires a majority ownership over another (Hagedoorn and Duysters, 2002). Recent scholarly inquiry stresses the growing importance of innovation sourcing as a critical rationale underlying the acquisition decision (Hennart, 1991).

There exist several contradictory rationales in the literature relating to the acquisition decision. While Hoffman and Schaper-Rinkel (2001) contend that acquisitions are preferred in environments where flexibility is less urgently needed, Vermeulen and Barkema (2001) contend that acquisitions become increasingly important for revitalization of the parent firms knowledge base as environmental threats increase.

A positional embeddedness approach suggests that established firms which primarily rely on acquisitions for access to innovations will have low centrality from a network embeddedness perspective although they might have a prominent reputation (For example, Cisco Systems). Given that managers are subject to bounded rationality and affected by their own past experiences (Tallman and Shenkar, 1994), established firms that frequently acquire innovation may have routinized the process of acquiring it. Hence, prior experience will promote choice of this innovation sourcing mode.

Since information asymmetry costs are the primary prohibiting factor in the decision to acquire firms (Balakrishnan and Koza, 1993), existing network ties of these firms should reduce both the information search and asymmetry costs (Vanhaverbeke et al., 2002). Low positional embeddedness, due to their low in-house capabilities coupled with limited prior linkages contributes to low relational embeddedness. Hence, these firms are unlikely to have either the capability of creating new networks or leveraging existing networks.

Although, low structural embeddedness or firms with considerable indirect ties might allow them the ability to bridge to other networks, relatively low alliance management capabilities (Kale, Singh and Perlmutter, 2000) will prevent partnership-based governance modes. On the other hand, high structural embeddedness of established firms increases information redundancies. Access to technologies that are new to these firms but have been in existence i.e. novel technologies is made possible by firms that utilize acquisitions.

While the empirical findings of Vanhaverbeke et al (2002) demonstrate that at the dyadic level, central firms acquire firms with whom they have previously engaged in alliance relationships, we focus on the acquisition decision of firms with low positional embeddedness. Other research contends that while acquisitions fill existing gaps in the incumbents' knowledge bases by internalizing proven novel technologies, they are not useful for spotting innovations in their formative stages (Maula et al., 2004) such as pioneering and emerging technologies. This becomes even more critical in networks with high structural embeddedness. Hence, it is proposed that:

P4: High structural embeddedness and low positional embeddedness of established firms positively influence acquisitions as the preferred mode for sourcing innovations.

DISCUSSION

Existing scholarly inquiries highlight the complexity inherent in innovation sourcing decisions (Veugelers and Cassiman, 1999). Bridging prior diverse research in the field, this paper takes an embeddedness perspective and focuses on the role of organizational network attributes to present a different picture of how established firms in hi-tech industries may accomplish their innovation goals through four main modes of innovation sourcing.

With regard to corporate venture capital investments, the capability to bridge to new networks provides established firms an opportunity to hedge future technological threats by investing in radical innovations. Moreover, CVC investments allow for information sharing and involve loose coupling between firms. They ease the incumbent firm's ability to overcome obsolescence created by radical technological breakthroughs (Hill and Rothaermal, 2003). For example, due to its high positional embeddedness and low structural embeddedness in a network of 923 partners, Mitsubishi Corporation has taken up equity positions in several organizations to invest in radical innovations (Goerzen, 2005). In essence, established firms such as Mitsubishi that have fostered the capability to bridge to unfamiliar networks are better able to overcome three common learning traps, namely, maturity, familiarity and propinquity elaborated by Ahuja and Lampert (2001).

On the other hand, central, established firms that are strongly enmeshed in their network catalyze the leverage of existing networks that ensnares them into these three learning traps that can seriously influence their survival during periods of technological discontinuities. For example, high positional embeddedness of Sun Microsystems allowed it to leverage its alliance network to support the promotion of its Reduced Instruction set computing technology (Goerzen, 2005). It is contended that organizations with the capability of leveraging their networks to acquire emerging innovations can avoid these learning traps. Meanwhile, organizational ability to create new networks by formation of R&D consortia allows established firms to take on the role of creating technological discontinuity themselves. For example, the quest to develop next generation DVD technology has led structural equivalent “Blu-ray” developers such as Sony, Pioneer, Panasonic and Hewlett-Packard to come together (Goerzen, 2005). R&D consortia which successfully meet their objective of developing new technological standards contribute to the bargaining power of partner firms that can ultimately prevent a performance slump in incumbent firms. In a sense, involvement in emerging innovations helps these firms overcome learning traps.

Finally, acquisitions are an effective innovation sourcing mode for internalizing proven new innovations. Also, this mode is most suitable for overcoming learning traps that established firms are likely to fall into.

Decision cycles theory (Connolly and Wagner, 1988) may also be utilized to explain some of the innovation sourcing decisions as it conceptualizes decisions through interweaving of action, reflection, and feedback. Connolly and Koput (2002) drew parallels between social network theory and decision cycles theory wherein they pointed out that the impact of heterogeneity in learning trajectories is mirrored as distinctive firm behavior. The thesis elaborated in the paper, more specifically, suggests that the confluence of network positional and structural embeddedness provides established firms with differential capabilities. A limitation of this paper is that it does not delve into the possibility that organizational network embeddedness is continually reshaped and restructured as innovation sourcing decisions are implemented. That is, this decision will change the extent of the positional, structural and relational embeddedness of established firms. Hence, future research can examine the metamorphosis in the network position and network ties of organizational actors as a result of this decision.

This paper contributes to the literature by developing a framework that provides a more integrated view of the literature in four parallel but related streams. More importantly, the arguments depict ways in which organizational network-related capabilities impinge on innovation sourcing decisions. This has important implications for the sometimes incoherent arguments in the literature related to the innovation potential of established firms.

Clearly, the arguments presented in this paper have not focused on other governance modes for external innovation sourcing such as licensing, equity joint ventures, outsourcing, etc. However, since this analysis is framed to understand how established firms tap breakthrough inventions for commercialization, it has implications for organizational renewal and survival and the alternatives emphasized are congruent with this objective. In addition, it would be more fruitful to investigate why established firms with all three above-mentioned networking capacities, over or under emphasize one over the other innovation sourcing modes.

Given that our intention is to provide an alternative perspective with regard to innovation sourcing, we have ignored or assumed constant some of the factors in innovation sourcing. It will

be useful for future research to contrast the embeddedness perspective with other perspectives, therefore revealing the boundary conditions under which other perspectives may be most relevant.

In conclusion, this paper seeks to establish a basis for future empirical research. This paper extends prior research by taking the firm as the unit of the analysis that has been widely advocated by scholars exploring the external technology sourcing decision in firms (Vanhaverbeke et al., 2002). This paper contributes to the literature on entrepreneurship in large corporations by identifying innovations sourcing modes that allow established firms to circumvent common learning traps. In addition, by drawing attention to organizational network-related capabilities, this paper also makes a contribution to managerial practice. By highlighting the role of network embeddedness, this paper underscores the need for managers to identify techniques that allow effective exploitation of these network resources to enable them to reinvent themselves.

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