

Inter-Organizational Networks and Knowledge Flows: A Dynamic Framework

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Abstract

This paper seeks to tie together the concepts of knowledge spillovers and strategic entrepreneurship by establishing an integrated theoretical framework conceptualizing how inter-organizational knowledge flows create value and improve competitiveness for entrepreneurs and their organizations. It achieves this by considering the three key aspects. First, *the dynamics of inter-organizational knowledge flow* and the extent to which innovation requires knowledge flow and access between firms and other actors. Second, *the dynamics of network resources*, especially the investments required to establish and sustain inter-organizational knowledge networks. The paper draws on the notion of *network resources* to better understand those assets entrepreneurs have at their disposal to facilitate knowledge-based interactions and relationships. Third, *the spatial dynamics of knowledge flow*, focusing on the spatial aspects of knowledge flows. The paper builds on theories of knowledge flow and the extended resource-based view of the firm to present a dynamic framework for understanding the assets entrepreneurs can strategically manage to secure competitive advantage and facilitate innovation through inter-organizational networks. It is argued that entrepreneurs must better distinguish the types of network resources in which their firms invest in order to facilitate a greater understanding of the evolutionary nature of business interactions and their dynamism. Entrepreneurs also need to consider the complexity of interactions, which may possess a mix of formal, informal, personal and organizational characteristics. The network capital approach to external relationship management developed in the paper allows the adoption of strategies which explicitly seek to make the most effective use of ties, relationship and interactions, and ensure these are a firm-level, rather than an individual-level, resource.

1. Introduction

Existing research has made clear the role of entrepreneurship in facilitating knowledge spillovers (Audretsch and Lehmann, 2006; Audretsch et al., 2006). In general, entrepreneurs utilize considerably more knowledge than that which they have themselves created (Storper, 2000). The aim of this paper is to analyze the role of inter-organizational networks in facilitating the dynamic flow of knowledge to and from entrepreneurs and their organizations. There is growing evidence that inter-organizational knowledge network development is related to the growth of firms (Freel, 2000; Davenport, 2005; Knoblen and Oerlemans, 2006). In order to compete successfully, entrepreneurs may need to develop external networks to access resources they do not possess internally (Bennett, 1998; Huggins, 2000; Kingsley and Malecki, 2004). The networks of entrepreneurs are often considered to be particularly reliant on social networks such as connections with friends and family (Aldrich and Zimmer, 1986, Uzzi, 1997; Jack, 2005; Thorpe et al., 2005; Lechner et al., 2006; Bowey and Easton, 2007). Also, entrepreneurial networks are considered to be generally localized in their organizational and spatial context (Huggins, 2000; Lissoni, 2001; Johannisson, et al. 2002).

The focus on the *inter-organizational* networks of entrepreneurs is recognition of the important role of both organizational and cognitive boundaries hold for our understanding strategic management and entrepreneurship, particularly in relation to knowledge flows and networks (Pfeffer and Salancik, 1978; Thompson, 1967; Easterby-Smith et al., 2008). Inter-organizational networks in this context are defined as consisting of the interactions and relationships organizations utilize to access knowledge. These may be in the form of alliances concerning formalized collaboration and joint ventures, and other ‘contracted’ relationships,

or more non-formalized interaction and relationships between organizations. There is also an additional focus on spatial dynamics in recognition of the growing importance of geographic factors in understanding the nature of knowledge flows (Bell and Zaheer, 2007). There is considerable debate regarding the geography of knowledge spillovers. Krugman (1991) doubts the knowledge spillovers are spatially constrained, although empirical evidence point to the opposite (Audretsch and Feldman, 1996; Audretsch and Stephan, 1996).

This paper seeks to tie together the concepts of knowledge spillovers and strategic entrepreneurship by establishing an integrated theoretical framework conceptualizing how inter-organizational knowledge flows create value and improve competitiveness for entrepreneurs and their organizations. It achieves this by considering the three key aspects. First, *the dynamics of inter-organizational knowledge flow* and the extent to which innovation requires knowledge flow and access between firms and other actors. In these instances, the type of knowledge will also influence sourcing patterns, with more tacit forms less likely to be sourced through market-based relations. In this case, networks are key sourcing channels facilitating knowledge flow, through what Romer (1990) describes as effective mechanisms for supporting collective interests and producing new ideas. Innovation is considered to be at the heart of competitive advantage attainment for both firms and locations, and is changing the eco-geographic landscape.

Second, *the dynamics of network resources*, especially the investments required to establish and sustain inter-organizational knowledge networks. The paper draws on the notion of *network resources* to better understand those assets entrepreneurs have at their disposal to facilitate knowledge-based interactions and relationships. In seeking to distinguish different forms of network resource, the paper integrates the concept of *social capital*, which it is argued largely concerns resources related to the social relations and networks held by those individuals within a particular firm. As a means of describing and identifying network resources that are more strategically held by the firm as a whole the paper introduces the concept of *network capital*. It is argued that entrepreneurs require network resources to access appropriate knowledge. The effectiveness of these resources is based on their ability to capture a significant proportion of the value distributed across particular networks compared with amount of investment made in these resources.

Third, *the spatial dynamics of knowledge flow*. The final part of the framework focuses on the spatial aspects of knowledge flows, which has received much attention in recent years (Audretsch and Feldman, 1996; Anselin et al., 1997, 2000; Andersson and Ejeremo, 2005), particularly the extent to which physical proximity influences the nature and types of networks through which knowledge flows. The paper argues that despite the recognized importance of proximity to network development, there is an increasing emphasis on the importance of understanding networks and knowledge flows in an environment that is simultaneously local and global. Many firms do not acquire their knowledge from within geographically proximate areas, particularly those firms based upon innovation-driven growth where knowledge is often sourced internationally. It is suggested that while social

capital may facilitate local knowledge spillovers, other forms of network resource relating inter-organizational networks also facilitate spillovers through the flow of knowledge.

As Maskell and Malmberg (2007) intimate, within an evolutionary context there are significant linkages between the drivers and mechanisms of knowledge-based development at the micro and macro-level. Within this environment, firms are increasingly focusing on their core activities, i.e. those they anticipate will provide them with a competitive edge, and are increasingly searching external knowledge sources as part of their innovation management strategies (Abramovsky et al., 2004; Sako, 2006). Similarly, at a macro-level, regional and national competitiveness is considered to be sustained by facilitating innovation among respective business communities (Porter, 1990; Huggins and Izushi, 2007). This paper contends that the competitiveness of both firms and economies (locations) is increasingly a function of the value created through inter-organizational flows of knowledge. Entrepreneurs and their firms utilize inter-organizational networks to manage flows and access knowledge to enhance expected economic returns, whilst the competitiveness of economies is increasingly related to the rate at which knowledge is able to flow between organizations within these economies. However, there is an inherent tension between entrepreneurs and economy-level decision-makers (i.e. policymakers) as to the optimum nature and structure of the networks through which knowledge flows.

Economic policymakers now commonly intervene to ensure maximum knowledge flow across their areas under their jurisdiction to improve competitiveness. Key examples include policies related to the development of systems of innovation and clusters of related economic activity. Entrepreneurs, on the other hand, are required to take a more strategic approach, ensuring that networks facilitate flows allowing access to the knowledge required by their firms regardless of the physical location of network actors. Also, entrepreneurs must take account of the fact that networks may allow knowledge to flow more freely out of a firm than productively into it. A key example of the way in which entrepreneurs to seek manage knowledge flows through networks are the formation of strategic alliances.

Within the extant literature, policy-related perspectives on knowledge flows are mainly situated within studies emanating from economic geography and spatial (regional) studies, whilst firm-level perspectives are largely located within organizational and management studies. Although there are commonalities across these two paradigms, particularly the emphasis on knowledge flows as a key facilitator innovation, the difference in perspective and focus means that there has been little integrated thinking across disciplines as the alignment of macro and micro-level theories of knowledge flow, particularly with regard to providing firm and economy-level decision-makers with recommendations that are coherent as opposed to antagonistic.

2. Knowledge Spillovers and Entrepreneurship

Knowledge spillovers can be defined as the continuum between pure knowledge spillovers that are uncharged, unintended and not mediated by any market mechanism, and rent spillovers consisting of externalities that are at least partially paid for (Andersson and

Ejeremo, 2005). Therefore, knowledge flows relate to spillovers occurring through the flow of skills, expertise, technology, R&D and the like across inter-organizational networks (Andersson and Karlsson, 2007). The spillover effects of knowledge can take place through time and across space. A key dimension of spillovers is geographic distance, with the general argument is that knowledge spills over more easily locally than at a distance. A study by Jaffe et al. (1993) discovered that citations to domestic patents were more likely to be domestic and more likely to come from the same region and locality as the cited patents. They also found that the localization of patent citations was significant even when the existing concentration of related research activity was taken into account. This suggests that local firms are often embedded in knowledge networks (Breschi and Malerba, 2001).

Also, ready access to local public or private research institutes and universities is another route through which knowledge flows. Such knowledge spillovers are especially important in highly knowledge-intensive industries that deal with knowledge at the frontier of research. A study conducted by Audretsch and Feldman (1996) shows that innovative activity tends to geographically cluster more in knowledge-intensive industries where knowledge spillovers play a decisive role. Although such industries tend to exhibit a geographic concentration of production activity, clustering of their innovation activities tends to be even greater. However, knowledge spillovers also take place internationally, but usually through more selective routes.

Leading-edge technology constantly changes, resulting in new, better products and processes. Unless local networks keep abreast of different technological options emerging outside, they run the risk of becoming rigid and outdated (Camagni, 1991; Izushi, 1997; Bathelt et al., 2004). In particular, the success of entrepreneurial endeavors – those taking the risk of starting up new ventures and tapping into new areas outside established technologies and markets – will depend on the firm's ability to access major markets from other localities and regions (Bresnahan et al., 2001). While firms benefit from local knowledge spillovers as an undirected and spontaneous 'buzz', they may also need to consciously build non-local 'pipelines' to tap into knowledge from outside (Bathelt et al., 2004). Clearly, knowledge spillovers will not be uniform across all firms and places. For instance, smaller firms in a region may benefit from spillovers of university knowledge as they have fewer resources with which to generate their own knowledge (Acs et al., 1994). Also, regional high-technology firms tend to benefit from university knowledge (Audretsch et al., 2005), with there being a significant correlation between the concentration of high-technology industries and university research in high-technology fields within a region (Nagle, 2007).

The study of entrepreneurship has increasingly reflected the general agreement that entrepreneurs and new companies must engage in networks to survive. Also, it is accepted that the socio-economic climate in which entrepreneurs operate will vary their ability 'to capture the benefits of economic efficiency' that networks facilitate (Szarka, 1990; Jack, 2005; Thorpe et al., 2005; Lechner et al., 2006; Bowey and Easton, 2007). Johannisson (1995), for instance, found evidence that entrepreneurs situated in innovative settings are

more successful at building networks that blend business and social concerns through both individual dyadic ties, and larger socio-centric contextual networks at large.

In particular, research on the networking behaviour of entrepreneurs has tended to focus on personal-social and professional networks as contributing to the success potential of a venture (Birley, 1985; Aldrich and Zimmer, 1986; Huggins, 2000). Entrepreneurship models of networking have mainly incorporated social network and resource-dependence theories, as well as a resource-based view of the entrepreneur (Ostgaard and Birley, 1996). Network perspectives are seen as contributing to explaining patterns of entrepreneurship, by which it is the social role and embedded social context that facilitate or inhibit the activities of entrepreneurs (Aldrich and Zimmer 1986; Huggins, 2000). Networks matter to entrepreneurs because they create efficiencies in assembling the resources necessary in the entrepreneurial process (Thorpe et al., 2005).

3. The Dynamics of Inter-Organizational Knowledge Flow

In general, knowledge is now recognized as a key ingredient underlying the competitiveness of regions, nations, sectors and firms (Romer, 1986; 1990; Lucas, 1988; Nonaka and Takeuchi, 1995; Grant, 1996). Cost-based competition results in the competitiveness of firms and their locations becoming unaligned, e.g. high market share for firms but low wages for workers (the race to the bottom). Knowledge-based competition, on the other hand, provides a greater opportunity for aligning the competitiveness of firms and locations (the race to the top) (Huggins and Izushi, 2007). The competitiveness of firms and locations is increasingly a function of their capability to access appropriate knowledge that can be utilized to innovate. At its most fundamental level, the knowledge base of an economy can be defined as the capacity and capability to create and innovate new ideas, thoughts, processes and products and to translate these into economic development, i.e. increasing the value of a regional economy and the associated generation of wealth (Huggins and Izushi, 2007). The knowledge development capabilities of economies are increasingly associated with their systems of innovation, both national and regional, with universities, R&D laboratories and training agencies, etc. considered a part of these systems alongside firms. (Freeman, 1987, Freeman, 1994; Nelson and Rosenberg, 1993; Cooke et al., 2004; Lawton Smith and Bagchi-Sen, 2006).

Knowledge can be defined as information that changes something or somebody, either by becoming grounds for action or by making an individual or an institution capable of different or more effective action (Drucker, 1989). Unlike simple information, knowledge concerns action and is function of a particular stance (Nonaka and Takeuchi, 1995). Of course, knowledge takes many different forms, with one of the most familiar typologies suggesting that knowledge is either explicit/codified or tacit. In general, explicit knowledge refers to information that can be easily communicated among individuals, whereas tacit knowledge—such as skills, competence, and talents—is more difficult to directly communicate to someone else in a verbal or other symbolic form (Huggins and Izushi, 2007; Nonaka and Takeuchi, 1995). Codified knowledge is usually considered to be relatively less sensitive to space than tacit knowledge, with tacit knowledge flow bounded within specific spatial contexts (Bathelt

et al., 2004). Moreover, reductions in transport costs and improvements in communications have increased access to codified knowledge rendering it less important as a source of competitive advantage. Tacit knowledge, on the other hand, is considered not to travel well, making it a key source of 'the geography of innovation' (Asheim and Gertler, 2005). Problems in accessing knowledge also highlight its intangible, non-standardized, and inseparable nature.

Knowledge can be considered as an institutional asset represented by both the social knowledge of co-ordination and learning -tacit - and explicit knowledge - codifiable and 'knowing about' (Blackler, 1993; Grant, 1996; Kogut and Zander, 1996; Mowery et al. 1996). The importance of knowledge access and management indicates that as an identifiable resource it is appreciated by as being fundamental to making competitive improvements (Grant, 1996; Oliver, 1997). Knowledge is often described as a public good, where use by one actor does not preclude its use by others. However, as Oliver (1997) argues, in reality it is no longer possible to think of knowledge as a truly public good that can be easily reproduced and diffused, but at best a quasi-public good where reproduction and diffusion cannot be taken for granted. Seely Brown and Duguid (2001) distinguish between 'sticky' and 'leaky' knowledge, with sticky knowledge being that which is difficult to move, while leaky knowledge refers to the undesirable flow of knowledge to external sources.

With this risk in mind, the question can be legitimately asked – why would firms engage in inter-organizational knowledge networks. i.e. non-market collaborative and co-operative interactions, rather than control their knowledge flows through the marketplace. Fundamentally, the answer is that knowledge markets are rare. They are difficult to create due to inherent asymmetry in the existing knowledge base of buyers and sellers. The buyer is often unable to convey specifically to the seller the knowledge they are seeking, and vice-versa. If the seller is able to effectively convey the knowledge they are selling, the buyer will in effect have acquired it for free (Arrow, 1971; Maskell, 2000). Most markets of this type are actually for information rather than knowledge; for example, books, newspapers, and other 'fact-supplying' media. This means that knowledge must often be sought through other means, and while firms may seek to internalise knowledge sources to overcome market failure, networks are now widely accepted as being key vehicles by which firms obtain access to knowledge.

Inter-organizational networks, therefore, are potentially an important aspect of the innovation process. Accessing knowledge through inter-organizational networks depends not solely on the availability of external knowledge and sources but also on factors internal to firms. The most frequently discussed of such internal factors is the capability to assess and absorb knowledge. Cohen and Levinthal (1990) argue that the ability of a firm to recognize the value of new, external knowledge, assimilate it, and apply it to commercial ends is critical to its innovation capabilities. This 'absorptive capacity', is history-dependent and reflects how much a firm has invested in the area of expertise it specializes in. Absorptive capacity largely depends upon a firm's investment in innovation efforts (Cohen and Levinthal, 1990).

Although the competitive advantage of firms can arise from size and position within their industry, alongside their physical assets (Porter, 1980), the pattern of competition in advanced economies has increasingly come to favor those firms that can mobilize knowledge and technological skills to create novelty in their products (Prahalad and Hamel, 1990). Along with this, the mode by which knowledge is produced has shifted from traditional linear processes of innovation to more complex incremental and iterative chain-link models based on the interactions between knowledge actors (Kline and Rosenberg, 1986; Rothwell, 1994). The characteristics associated with the new models of knowledge production include the following: the number and types of sites where innovation occurs is rising rapidly; the stock of knowledge is in part an outcome of the intensity of interaction between knowledge actors; the pattern and dynamics of these interactions are constantly shifting, reflecting ever-changing contexts of knowledge requirements; and the density of interactions is increasing rapidly, as is the number of knowledge actors (Chesbrough, 2003; Florida, 2002). The links between knowledge creation and diffusion processes, through individuals, organizations, and systems of institutions and organizations, are clearly required to be understood as fully as possible as knowledge becomes the key value creator in modern economies (Huggins and Izushi, forthcoming).

At a more macro-level, endogenous growth theory has placed knowledge at the centre of economic development (Romer, 1986; Romer, 1990; Lucas, 1988). Knowledge is viewed not only as the key to the competitiveness of a production unit, i.e. a firm (Nonaka and Takeuchi, 1995), but also territories, i.e. regions, which are increasingly treated as an economic entity with knowledge viewed as the major element in achieving regional competitiveness (Huggins and Izushi, 2007). While such views on the prominence of knowledge for regional economic development remain contested (Lagendijk and Cornford, 2000; MacKinnon, et al., 2002), one of the outcomes of both theoretical and policy developments in this area is that knowledge-based organizations have come to be regarded as key sources of knowledge utilizable in the pursuit of economic growth, with knowledge and knowledge access a more important role within, for example, universities (Feldman and Desrochers, 2003).

As the knowledge base of industries becomes increasingly expansive and dispersed, the locus of innovation - which in this case can be said to be the capacity to access knowledge that can be applied to make competitive change - will be found in 'networks of learning', rather than in individual firms, whereby learning occurs within the context of membership of a 'community' (Powell et al., 1996). The growing importance of the economics of knowledge and learning has been further recognized by a school of evolutionary economists, who focus their attentions on the necessity for firms to undertake technical and organizational innovation in order to overcome uncertainty and instability, within Schumpeter's (1934) framework of the evolutionary nature of capitalism arising from within economic life (Nelson and Winter, 1982; Dosi, 1988; Dosi et al., 1988; Freeman, 1994). Evolutionary economists, or neo-Schumpeterians as they are often referred to, conceptualize the firm in a similar manner to the resource-based view, in this case as differentiated organizations that use differentiated inputs for production (Dosi, 1988; Cooke, 2004).

Evolutionary thinking has essentially emerged as a critique of the neo-classical perspective, by placing considerable emphasis on the 'social institutions' into which firms are integrated, giving particular emphasis to history, routines and their influence on the evolution of firms and the trajectory of their development (Morgan, 1997). As Cooke (2004) indicates, within evolutionary economics it is knowledge that plays one of the fundamental institutional roles, with the knowledge possessed by the entrepreneur acting as the key creation catalyst. This knowledge is seen as being best developed through learning processes which are mediated through heterarchical, or network, relationships based on social institutions concerning trust, reputation, custom, reciprocity, etc (Cooke, 2004). In other words, innovation is facilitated by the pursuit of knowledge and its application, which is itself conditioned by the ability to 'learn-by-interacting'. Therefore, despite the traditional dominance of neo-classical perspectives, the spread of interest in the network metaphor has been most rapid in those fields where evidence about the interdependence of firms and an acknowledgement of the existence of imperfect operating conditions is strong (Antonelli, 1996).

Because of the path-dependent nature of their capabilities, firms, often find it hard to respond quickly to radical technological and knowledge changes. Clearly, a solution to this challenge is to extend the boundary of external knowledge sourcing and form networks and alliances with partners in the areas into which they are seeking to move. An important and under-emphasized component of the dynamics of technological change is that the search for new knowledge is community-based (Huggins and Izushi, 2007). Firms and individuals in an industry search for new knowledge as members of a 'population' based on shared disciplines (Stuart and Podolny, 1996; Dixon, 2000; Wenger, 1998) Such communities enhance productivity through sharing of knowledge. However, they may also constrain the directions of progress and sometimes blind their members to developments taking place outside their knowledge community. The maturation of an industry represents a case of this. After an industry undergoes early phases of the creation, replication, and the selection of varieties in products and firms, it comes to consist of firms and individuals with similar mindsets (Huggins and Izushi, 2007).

The sharing of knowledge can occur across place across knowledge communities, as well as within them. However, such cross-community knowledge sharing takes place mostly at a relatively elementary or intermediate level of knowledge. Given the need for individuals to devote their limited resources to efforts to stay at the respective knowledge frontier, most knowledge workers understand state-of-the-art knowledge and contribute to its advancement only within their own community. Variations in the number of knowledge communities within an industry are primarily influenced by two forces. One is the level of technical progress in each knowledge community. As technology and knowledge advances in its sophistication and complexity, a greater amount of knowledge will accumulate along with the demand for individuals to learn more, resulting in more communities (Huggins and Izushi, 2007).

As knowledge communities grow in number, it becomes more important to integrate diverse streams of the state-of-the-art knowledge residing within them. For individual firms, this means management's ability to combine knowledge of individual technologies and

consolidate corporate-wide technologies and skills within their organizations (Prahalad and Hamel, 1990). It is clear there are a range of different modes through which entrepreneurs and firms are able to access knowledge. For instance, one-way flows (knowledge transfer) and two-way flows (knowledge sharing/exchange) can be complemented by the ideas of combining knowledge through miscible flows (i.e. the extent to which different types and forms of knowledge can be combined and mixed to create value), similar to Romer's (1996) of creating new recipes from existing knowledge.

As Storper and Scott (2009) argue "knowledge has a tendency to grow indefinitely, for it can be endlessly re-used, is extremely leaky (and hence its circle of users continually expands), and can be combined and recombined in virtually unlimited ways." (p. 148). In this sense, value is created when there is a 'collision' of knowledge. Network actors receive a greater proportion of the value created the 'nearer' - in a cognitive sense (Boschma, 2005) - they are to the collision. At a locational level, localized flows of knowledge result in a higher proportion of the value distributed across networks being captured and retained within a location, i.e. by local firms and organizations. Limitations in the appropriateness of knowledge accessible through localized pools means that access to appropriate knowledge is often inversely related to the geographical proximity of appropriate knowledge sources. The competitiveness of locations is positively associated with the inflow of appropriate knowledge, providing the value created through these flows is captured locally, i.e. high levels of knowledge miscibility - large collisions - equates to high levels of growth.

4. The Dynamics of Network Resources

The resource-based view of the firm recognizes that a firm's resources, including their application and transferability, are critical factors in creating and sustaining competitive advantage (Wernerfelt, 1984; Barney, 1991; Rangone, 1999). Such resources include the tangible and intangible assets owned or controlled by firms, and are a source of the value creation. These resources are often considered concomitant with both the size of firms and their capacity to undertake innovation (Wiklund and Shepherd, 2003; Thorpe et al., 2005). However, as Zaheer and Bell (2005) note, scholars with a resource-based view of the firm tend to focus only on the internal capabilities of firms. Also, although Williamson (1991) recognizes inter-firm networks as hybrid organizational forms within his framework of transaction-cost economics, the role of these networks as resources beyond contractual arrangements remains less recognized. As a means of addressing this gap, recent research has proposed an extension of the resource-based view of the firm to account for external network capabilities in addition to internal capabilities (Lavie 2006). Gulati (1999; 2007, Gulati and Gargiulo, 1999, Gulati, Nohria and Zaheer, 2000) introduces the concept of *network resources* to understand the advantages bestowed by such networks in allowing firms to leverage valuable information and/or resources possessed by their inter-organizational network partners.

These networks concern the interactions, relationships, and ties existing between firms and may arise through the need to access knowledge in the form of new technology, skills and to keep pace with competitors (Ahuja, 2000). In general, network scholars stress that

innovation, be it undertaken internally or externally, is a complex process which may require knowledge flow between firms and other actors. (Meagher and Rogers, 2004, Lichtenthaler, 2005). Increasingly, this process is viewed as a systemic undertaking, i.e. firms no longer innovate in isolation but through a complex set of interactions with external actors (Chesbrough, 2003). Therefore, external networks are potentially an important aspect of the innovation process and are often manifested in the form of strategic alliances between firms in the form of collaboration and other relationships resulting in frequent and repeated interaction (Stuart, 2000; Ireland *et al.*, 2002; Grant and Baden-Fuller, 2004).

It possible to distinguish two types of network resource underlying the governance dynamics of inter-organizational networks. First, *social capital* in the form of social networks established across firms or other organizations through which knowledge may flow. Coleman (1988) defines social capital as consisting of obligations and expectations, which are dependent on: the trustworthiness of the social environment; the information flow capabilities of social structure; and norms accompanied by sanctions. Coleman (1988) argues that social capital is defined by its function and, as with the cases he highlights, this common function is the creation of localized trust. Second, *network capital*, in the form of more calculative and strategic networks designed specifically to facilitate knowledge flow and accrue advantage for firms (Gulati, 2007). We introduce the network capital concept as a response to the increased recognition that the leveraging of inter-firm and other external networks can be considered a strategic resource that can potentially be shaped by managerial action (Mowery *et al.*, 1996; Dyer and Singh, 1998; Madhavan *et al.*, 1998; Lorenzoni and Lipparini, 1999; Kogut, 2000; Gulati 2007).

Social capital has proved a popular and powerful mechanism for analyzing how knowledge, particularly in its tacit form, can be accessed both within and across organizations (Nahapiet and Ghoshal, 1998; Tsai and Ghoshal, 1998; Gargiulo and Benassi, 2000; Tsai, 2000; Kostova and Roth, 2003; Oh *et al.*, 2004; Inkpen and Tsang, 2005; Walter *et al.*, 2007). One of the most important contributions linking social capital to knowledge networks is that of Nahapiet and Ghoshal (1998), which focuses on the importance of social capital within the firm, and the organizational advantages and intellectual capital creation it facilitates through personal relationships fulfilling social motives such as sociability (Portes 1998), approval and prestige. Nahapiet and Ghoshal (1998) point to social capital as consisting of friendships and obligations at an intra-organizational level than cannot be easily pass from one person to another. Nahapiet and Ghoshal's (1998) work is particularly useful not only because it makes the link between intra-organizational networks, knowledge and social capital, but its focus on the combination and exchange of knowledge in relation to factors such as access, motivation, capability and the anticipation of value. However, it has not gone without criticism. For instance, Locke (1999) argues that there is a potential loss of objectivity in linking business and social relationships, since objective communication means giving information to those who need it, without regard to whether or not they are your friends.

Most commonly, social capital consists of the perceived value inherent in networks and relationships generated through socialization and sociability as a form of social support

(Borgatti and Foster, 2003). In recent years, however, the social capital literature has come to define a resource where the motivations for investment are largely based on self-interest (Monge and Contractor, 2003). This has strayed a long way from Coleman's (1988) assertion that 'social capital is the norm that one should forgo self-interest and act in the interests of the collectivity' (p.S104). It is difficult to reconcile self-interest with social capital's culture of obligation, norms, and trustworthiness. Furthermore, the conundrum Putnam's (2000) thesis leaves us with is that although communities, especially business communities, are now more networked than ever, they actually possess less social capital, and 'in some ways social capital may be economically counterproductive' (Putnam 2000, 322).

As Dasgupta (2005) argues, the literature following Coleman has gone far beyond their modest claims on the role of interpersonal social networks. Social capital's power is its ability to understand how individuals are able to mobilize their network to enhance personal returns usually within place-bound environments. As Lin (2001) argues, social capital is an 'investment in social relations by individuals through which they gain access to embedded resources to enhance expected returns' (p. 17-18). In other words, social capital is a *social* and *individually* held capital. This leaves us with the question of how to understand and analyze the networks held by firms and other organizations, rather than those of individuals.

In this instance, our focus is on the role of knowledge and differentiating social capital, in the form of investments in social networks at an interpersonal level to secure individual advantage, from the advantage firms gain from investments in inter-firm and other external networks. As Westlund and Nilsson (2005) argue, 'when these investments are made in social networks, it is logical to say that they amass a form of 'social capital'' (p. 1081). If firms deliberately invest in networks, these networks are likely to concern the development of relationships which Williamson (1993) refers as 'calculative', since they consist of actions motivated by expected economic benefits (Hite and Hesterly, 2001). We define these inter-firm assets more specifically as *network capital* consisting of investments in calculative relations by firms through which they gain access to knowledge to enhance expected economic returns. This definition makes a clear distinction between the two types of network resource: network capital and social capital, and addresses an explanation as to why social capital may be declining and becoming eroded, even though firms and other organizations are increasing the investment they commit to network development (Coleman, 1990; Putnam, 2000).

Table 1 highlights the key characteristics differentiating network capital from social capital. The criteria underlying the choice of these characteristics are based on four critical factors of capital creation: (1) the source of the capital; (2) the mechanisms through which the capital is created; (3) the objects of the capital; and (4) the impact of the capital. A key difference between these two forms of network resource concerns the rationality of the actors, and whether or not actions are motivated by behaviour seeking to directly accumulate either economic or social returns. Oliver (1997) suggests that two types of rationality are at play within firm resource selection processes: economic rationality based on systematic and deliberate decision processes oriented towards economic goals; and normative/social

rationality based on habitual and unreflective decision processes embedded in norms and traditions (Oliver, 1997).

The source of network capital is rooted in an economic rationality, whereby firms invest in establishing calculative networks to access the knowledge they require. The source of social capital is based on a social rationality, whereby individuals invest in social networks to access embedded resources relating to sociability and social expectations. The key difference between these two forms of rationality is whether or not actions are motivated by behaviour that seeks directly to accumulate either economic or social returns. Oliver (1997) suggests that two types of rationality are at play within firm resource selection processes: (1) economic rationality based on systematic and deliberate decision processes oriented towards economic goals; and (2) normative rationality based on habitual and unreflective decision processes embedded in norms and traditions (Oliver 1997). A key difference between network capital and social capital is the rationality and motivation for network participation. This differentiation is consistent with Bourdieu's (1986) view that social capital is not conceived as a calculated pursuit of gain, but in terms of the 'logic of emotional investment'.

In contrast to the implicit social and emotional logic underlying the creation of social capital, the mechanisms through which network capital are established are rooted in a business and economic logic, whereby access to knowledge is sought as means of increasing economic returns. This is again consistent with the view that 'profits' from social capital are not usually 'consciously pursued' by the actors within a network (Bourdieu, 1986). The distinction between different forms of network behavior is not new, and has a long history in sociological studies. Max Weber, for instance, distinguished 'communal' (*Vergemeinschaftung*) relationships, based on subjective feelings, from 'associative' (*Vergesellschaftung*) relationships, based on rational judgments and expectations, as well as action predicated on 'custom' (*Sitte*) or a purely rational orientation (*zweckrational*) (Weber 1968).

In contrast to social networks, calculative networks provide greater resource availability (Hite and Hesterly 2001). Therefore, network capital is likely to be highly significant to firms as they seek to access and exploit knowledge. Although the social capital concept has been applied in a way that has added to our understanding of knowledge transfer and flows through networks, the need for transfer mechanisms to operate without compromising the competitive advantage of firms has been less debated. In particular, a greater understanding of the role of 'trade-offs' relating to the perceived value of the inward and outward flow of knowledge through networks is required (Brass et al. 2004). These trade-offs highlight the multidirectional flow of knowledge through inter-firm networks. For instance, a firm may allow another firm access to its research or technology as a means of securing access to knowledge related to the commercialization and innovation of this research or technology (Fosfuri, 2006; Lichtenthaler, 2005). One of the potential downsides of inter-organizational networks is that, without effective management, knowledge may flow more freely out of a firm than productively into it (Teece, 1998).

In practice, the inward and outward accessing of knowledge through networks will often take place in tandem, with there being a trade-off between accessing required knowledge and the leaking of knowledge assets that a firm would ideally rather protect. In scenarios where the value of leaked knowledge outweighs that received, the impact of networks may be the improved competitiveness of other network members at the expense of the focus firm. Effective network management, through strategic and intentional investment in relationships with other firms, is a mechanism for ensuring that value is captured rather than lost through inter-firm networks (Lichtenthaler, 2005; Teece, 1998). A network capital perspective provides a means of mediating external knowledge exploitation activity. Distinguishing between the network capital and social capital located in networks is a means of understanding the trade-offs, characteristics, function and potential for managing knowledge flows. Such a distinction is consistent with the knowledge-based view of the firm (Grant 1996), knowledge management theory (Nonaka and Takeuchi, 1995) and theories of intellectual capital (Stewart, 1997).

Williamson (1993) has usefully distinguished between the personal trust of individuals, which is akin to blind trust, and which when abused results in betrayal, and the network trust of organizations, which equates more with reflective forms based upon the institutional environment within which these organizations operate. Rather than the blind trust of social obligation associated with social capital, network capital is based on a weaker form of trust related to meeting the calculated interests of firms within the network. Therefore, unlike social capital, network relationships will continue to develop only if access to relevant knowledge remains forthcoming. This highlights the potential superiority of social capital in establishing networks with durability. However, as the effects of networks endowed with social capital may not necessarily match their intended function, this makes their management inherently difficult.

In terms of the object of the capital, a key distinction is that network capital is a firm-level resource, whilst social capital concerns the relationship resources of individuals. Of course, the social capital of individuals may be mobilized as a means of securing returns for the firm, but this is most likely to be of proportionally higher importance in small firms. In these firms, the social capital of the entrepreneur may be more highly developed than the network capital of firm. In relation to impact, the effect of network capital primarily relates to economic returns secured through access to knowledge, and social capital to social returns, although in both cases other returns may emerge as a by-product, such as the unintended access to useful knowledge often facilitated through social networks.

Network capital's emphasis on the business and professional aspects of networks echoes Granovetter's (1973) notion of 'work-related ties'. However, while Granovetter (1973) aligns work-related relationships with his concept of weak ties, based on relatively infrequent contact (as opposed to strong ties based on frequent contact often amongst friends), the network capital-social capital approach is not cast in terms of distinguishing the amount of time network actors spend with each other. Rather, it is primarily concerned with

distinguishing the reasoning network actors interact, which as Granovetter (1973) indicates is related to network content.

Table 1: Network Capital and Social Capital Characteristics of Inter-Organizational Networks

Dimensions	Characteristics	Network Capital	Social Capital
Source	Rationality	Economic	Social/Normative
	Network	Calculative networks, although social networks emerge as a by-product	Social networks, although calculative networks may emerge as a by-product
	Investment	Relationship investments by firms	Relationship investments by individuals
Mechanisms	Interaction	Based on a logic of business and professional expectations	Based on a logic of sociability and social expectations
	Stability	Mix of dynamic and stable networks	Mainly stable networks
	Trust	Reflective	Blind
	Management	Can be strategically managed by firms	Difficult for firms to strategically manage
	Spatial Proximity	Network actors not necessarily spatially proximate	Higher propensity of spatial proximity to other network actors
Object	Key Object	Firms	Individuals
	Firm Size	Large and growing firms	Small and new firms
Impact	Network Returns	Principally economic, although social returns may emerge as a by-product	Principally social, although economic returns may emerge as a by-product

Firms may shed the use of existing social ties and switch their network management to a network capital logic as the social networks that were paramount during the start-up phase of a firm become limited in their ability to impact positively on subsequent development (Lechner and Dowling, 2003). Entrepreneurs and small business owner-managers build personal networks where individual ties combine calculative and social aspects (Anderson et al., 2007; Johannisson et al., 2002). This to be expected, since in small and new firms the network requirements of both the firm and the firm's operator (i.e. the entrepreneur) are likely to coincide, and encompass both his/her social and economic needs and objectives (Jack, 2005). Hite and Hesterly (2001) refer to the different functions and objectives of a network as its 'compositional quality'. This compositional quality changes in much the same way the resources required by firms change as they evolve, with networks becoming more

calculative and less social in terms of expected economic costs and benefits, and more intentionally managed (Hite and Hesterly, 2001).

In general, new and small firms are more likely to be dependent on social capital, with inter-firm networks consisting of the social networks of the entrepreneurs or owners of the firm (e.g. the relatives and friends of the owners). As firms grow, their dependence will typically shift towards network capital, as networks become more calculative (e.g. suppliers, customers, collaborators and partners become more important) and less reliant on the social networks of the owners (Almeida et al. 2003; Thorpe et al. 2005). However, the nature of the networks will also be dependent upon the size and vintage of network partners. As Lechner and Dowling (2003) find, small firms are often ‘forced to share their initial technology base with other and more powerful firms’ (21), which implies relationships based on network, as opposed to social, capital.

From the perspective of entrepreneurs, this network capital may manifest itself through improved performance resulting from the credibility of having prominent strategic alliance partners (Stuart et al. 1999). In other words, small firms use these networks to develop their reputation as a means of overcoming imperfections in the markets for knowledge (Lichtenthaler and Ernst, 2007). Yli-Renko et al. (2001) find that knowledge exploitation for young knowledge-based firms depends on repeated intense inter-action, as well as the willingness of firms to share information. The configuration of networks at start-up stage will influence firm performance, which will be enhanced by developing networks that provide access to diverse information and capabilities with minimum costs of redundancy, conflict and complexity (Baum et al., 2000).

As firms evolve, it can be anticipated that their networks will evolve from more path-dependent social networks – which in the first instance will be highly reliant on the preexisting social networks of the entrepreneur(s) – to more intentionally managed networks based on reputation and access to relevant resources and partners (Hite and Hesterly, 2001). In larger firms, network capital becomes more evident through the formation of strategic alliances based on formalized collaboration and joint ventures, and other ‘contracted’ relationships involving equity and R&D agreements (Goerzen, 2005; Goerzen and Beamish, 2005; Grant, 1996; Grant and Baden-Fuller, 2004; Ireland et al., 2002; Stuart 2000). Within the strategic management literature, studies on the utilization of strategic alliances often highlight the networks developed by multinational corporations through contractual relationships with an objective of improving resource and knowledge access (Hagedoorn, 2002; Hagedoorn and Schakenraad, 1994; Kim et al., 2006). As the cost of searching and maintaining network partners may be proportionately higher for small firms, investments in network capital will tend to account for a greater proportion of total investment in small as opposed to large firms (Almeida et al., 2003).

As Gulati (1999) argues, networks are dynamic and change over time, which suggests that networks require diversity in the types of investments made. Unless diversity is sustained, in the long-run networks may reduce firm heterogeneity through the articulation of shared

norms, standards, and rules of conduct among firms (Oliver, 1997; Monge and Contractor, 2003). In an entrepreneurial setting, Westlund and Bolton (2003) present a persuasive case concerning some of the negative aspects of social capital among firms, arguing that the strong trust embedded in interpersonal relations can inhibit firm-level development. Network capital is more attuned to capturing the role of networks as evolutionary systems with trajectories which change along with the resources they accrue (Glückler, 2007; Kilduff and Tsai, 2003; Monge and Contractor, 2003). Although stable networks reduce the transaction costs of knowledge transfer, it is likely that such knowledge will become increasingly homogeneous and less useful across network actors (Maurer and Ebers, 2006). The preponderance of static strong ties may result in the operation of inefficient networks (Lechner and Dowling, 2003).

In general, network capital investments may become ineffective if there is knowledge equivalence between firms due to similarities in knowledge profiles, which results in network redundancy (Cowan et al. 2004). As firms become increasingly familiar with each other's knowledge, negative network effects may emerge, locking firms into the network and stifling the creation of new knowledge and innovation (Adler and Kwon, 2002; Arthur, 1989; Labianca and Brass, 2006). For example, in a study of new biotechnology firms, Maurer and Ebers (2006) found that social capital can impede, as well as enable, organizational adaptation, owing to the inertial forces rooted in what they term as relational lock-in and cognitive lock-in. Among less successful firms, these inertial forces result in social capital becoming a liability, as it impacts negatively on the ability of firms to adapt the configuration of their external relationships according to changing information and resource requirements (Maurer and Ebers, 2006). These inertial network forces highlight the issue of over-embeddedness, whereby the actors a firm is best connected to may not be best placed to provide solutions to current problems (Krackhardt, 1994; Monge and Contractor 2003). In Maurer and Ebers's (2006) study, the more successful firms showed a higher propensity to develop new ties to match their evolving requirements. To maintain effective networks, firms should monitor the emergence of lock-in and over-embeddedness and take appropriate action by reconstituting their network capital investments.

5. The Spatial Dynamics of Knowledge Flow

In general, the development of leading advanced regional economies is considered to involve the flow of knowledge through a highly networked regional business culture rich in spillovers through 'untraded interdependencies' (Castells and Hall, 1994, Storper, 1995; Saxenian, 1994; Porter, 1998; Cooke *et al.*, 2004; Rutten and Boekema, 2007). It is argued that networks within these leading regional economies are able to mobilise and fully develop the human capital residing within knowledge-based firms through external networks providing feedback loops, ensuring the continuation of high levels of innovation (Garnsey and Lawton Smith, 1998; Goman, 2000; Bresnahan and Gambardella, 2004; Crescenzi, 2005). Fundamentally, simply being in the same locality is often of little benefit for diffusing knowledge within a region, with there being a need for networked interaction between actors (Singh, 2005).

As part of these developments, regional analysis has given increased attention to the existence of external institutions that are involved in the innovation process (Keeble *et al.*, 1999; Cooke *et al.*, 2004; Huggins and Izushi, 2007). Increasing the innovativeness of firms, and promoting the development and enhancement of knowledge networks and regional innovation systems, has been described as the high road of regional competition (Malecki 2004). The important role of external knowledge has led to the innovation process at regional level being conceived as systemic, resulting from both formal and informal networking with other knowledge actors such as universities, R&D labs and other firms (Seely Brown and Duguid, 2001; Chesbrough, 2003; Cooke *et al.*, 2004). Cooke (2004) suggests that regional innovation systems consist of interacting knowledge generation and exploitation sub-systems linked to global, national and other regional systems, which stresses the importance of both regionally internal and external linkages. This discourse is largely reliant on empirical work from exemplar regions and firms, i.e. those regions which are among the most competitive in the world in terms of economic growth rates and workforce qualifications and the number of large, international firms based in 'new' or 'high technology' sectors (Saxenian, 1994; Owen-Smith and Powell, 2004; Gertler and Wolfe, 2004; Lawton Smith, 2003; Garnsey and Heffernan, 2005).

Alongside regional systems of innovation, clusters have rapidly become a key focus of regional economic theory and policy, with the underlying tenet being that competitiveness is determined by the strength of key concentrations of specific industries (Porter, 1998). Porter (1998) defines clusters as geographically proximate groups of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities. Clusters are considered to be founded on a network culture based on the strong ties consistent with the transfer of complex knowledge through the type of face-to-face interaction facilitated by the geographic proximity of firms and other actors (Bathelt *et al.*, 2004; Sorenson *et al.*, 2006; Steiner and Ploder, 2008).

The role of space and place are recognized as increasingly important features of inter-organizational networks (Davenport 2005; Iyer *et al.* 2005; Pittaway *et al.* 2004). Generally, it is argued that strong ties promote the transfer of complex knowledge, while weak ties promote the transfer of simple knowledge, with strong ties requiring the type of face-to-face interaction facilitated by the geographic proximity of network actors (Bathelt *et al.*, 2004; Sorenson *et al.*, 2006; Uzzi, 1997). The existence of established spatially proximate knowledge networks is one of the key reasons why a number of the most successful localities and regions throughout the world have become or remained more industrially competitive than those that have not adopted a networked approach (Bathelt *et al.*, 2004; Huggins, 2000; Knoben and Oerlemans, 2006). Also, older industrial regions may suffer from lock-in or path dependency, i.e., a level of inertia among firms within the region that prevents changes in practices from occurring (Boschma and Frenken, 2006; Grabher, 1993; Martin and Sunley, 2006). The inability of firms to alter their practices may act as a barrier to seeking and absorbing new knowledge created outside the boundaries of their firm, and becoming locked in to an existing low-growth regime preventing the development of new knowledge networks (Asheim and Isaksen, 2003; Cohen and Levinthal, 1990; Malecki 2007). Increasingly,

scholars identify the basic elements of a regional innovation system in a wide number of regions than merely the most competitive globally (Cooke, Heidenreich, and Braczyk 2004; Freel 2002).

In general, spatially proximate knowledge networks are considered a key factor underlying the success of the most advanced and successful regional economies (Malmberg and Maskell, 2006). As means of understanding these spatially defined networks, scholars have identified social capital, in the form of social norms and customs, as the network resource that lubricates the transfer and connection of knowledge (Capello and Faggian, 2005; Tura and Harmaakorpi, 2005). These social norms and customs are embedded in the social environment, and the trustworthiness of any environment is often tacit and specific to each community (Iyer et al., 2005; Lorenzen, 2007). The more trustworthy a community is, the likelier it may be to facilitate the transfer and connection of knowledge, in turn reinforcing the cycle of knowledge creation (Iyer et al. 2005). Social capital is essentially a place-based social network phenomenon (Capello and Faggian 2005; Westlund and Bolton 2003) rooted in theories of physical proximity (Monge and Contractor 2003), dense matrices of social relations (Lorenzen, 2007), and local knowledge (Ostrom, 2000). Network capital is less spatially bounded in its dimensions, encompassing to a greater extent the value of networks formed in a global environment, whereby interactions are increasingly flexible, dynamic and ephemeral (Monge and Contractor, 2003). Interestingly, Bell and Zaheer (2007) find a significant positive effect of friendship and distance on knowledge flow. i.e. more knowledge flows between friends when they are geographically distant from one another than when they are proximate to each other.

Globalization is resulting in the disembedding of traditional networks and re-embedding of new ties at a distance (Monge and Contractor, 2003). This emphasizes the importance of understanding networks and knowledge flows in an environment which is simultaneously global and local. For example, many firms, do not acquire their knowledge from within regionally proximate areas, particularly those firms based upon innovation-driven growth where knowledge is primarily sourced internationally (Davenport, 2005). If applicable knowledge is available locally, firms will attempt to access it; if not, they will look elsewhere (Drejer and Lund Vinding, 2007). Only those firms and organizations located in a contextual geographic environment rich in relevant knowledge sources can take competitive advantage of the co-location of other knowledge actors. By necessity, leading firms in regionally sparse knowledge environments may be required to make a number of non-local linkages (Malecki and Hospers, 2007). Also, while firms with low levels of absorptive capacity (Cohen and Levinthal, 1990) tend to network locally, those with higher absorptive capacity are often more connected to global networks (Drejer and Lund Vinding, 2007). This is perhaps to be expected, and illustrates the importance of internal knowledge absorption capacity on external knowledge network development.

Even in those locations possessing a knowledge rich environment there is evidence of a greater role being played by non-localised networks (Athreye, 2004; Bathelt *et al.*, 2004; Doloreux, 2004; Garnsey and Heffernan, 2005; Saxenian, 2005). There is evidence of a

greater role being played by non-localized networks (Huggins and Izushi, 2007). For example, in the high-technology setting of Cambridge in the UK many actors report global networks to be of greater significance to their operations (Athreye, 2004; Garnsey and Heffernan, 2005). Also, in Canada's high-technology city of Ottawa, sometimes referred to as Silicon Valley North, it is found that while local networks continue to provide mechanisms for transferring knowledge and stimulating innovation within the cluster, for Ottawa's high-tech community global knowledge networks are the most important sources of knowledge and innovation (Doloreux, 2004). In California's Silicon Valley, Saxenian (2005) describes how Asian engineers and entrepreneurs are creating and building networks between the region and regions in China and India and transferring knowledge from the west to the east. The key aspect of these developments is that the knowledge base of the world's most advanced local and regional economies is no longer necessarily local, but positioned within global knowledge networks, connecting actors (Wolfe and Gertler, 2004; Huggins and Izushi, 2007).

There is a growing school of thought that non-proximate actors are often equally, if not better, able to transfer complex knowledge across such spatial boundaries, providing a high performing network structure is in place (McEvily and Zaheer, 1999; Dunning, 2000; Lissoni, 2001; Davenport, 2005; Zaheer and Bell, 2005; Palazzo, 2005; Boschma, 2005). Network capital will increase in importance as the constraining effect of distance on knowledge flow and transfer gradually diminishes (Tracey and Clark 2003; Johnson et al. 2006). This knowledge is often necessarily superior to that available locally, resulting in improved innovation performance. The extent to which, for example, university knowledge is spatially constrained is related to the extent to which this knowledge matches the knowledge sought by firms in a respective university's region.

A firm's geographic proximity to a relevant knowledge source would therefore appear to be important (Davenport, 2005), although other types of proximity (e.g. relational, organizational and social) may also have an effect on the ability to source and absorb external knowledge (Boschma, 2005). As Tallman et al. (2004) suggest, these arguments indicate that the concept of 'closeness' between firms is shifting from physical space and geography to one based on the organization of their networks within virtual spaces. The rise, for instance, of transnational academic-industry partnerships also demonstrates that knowledge spillovers are not necessarily spatially constrained (Huggins et al, 2008). The internationalization of knowledge sourcing is reflected by the growing number of firms that choose to work with foreign universities in order to take advantage of low-cost high-talent pools, favorable foreign intellectual property rules and government incentives for joint industry-university research (Polenske, 2007).

In his seminal 1955 article, Perroux (1955) argued that in the end "scale" and "innovation" are the predictors of success, whereas Hirschman (1958) recognized the role of interdependence and linkages across related sectors in achieving economic growth. The process of inter-organizational network development across space is a manifestation that these principles are re-emerging as key tenets of change in today's global economy. In

particular, some of the world's most visible knowledge-based locations are operating networks that are more open, as they seek new knowledge and the means to more efficiently exploit their existing knowledge base (Britton, 2004). In Silicon Valley, cluster actors utilize the benefits of proximity to build and manage global-scale production networks (Sturgeon, 2003). In the United Kingdom, national and international networks are just as significant as their local counterparts for fostering innovation (Simmie, 2004). This suggests the propinquity is not enough, with recent empirical evidence finding that high innovation and growing firms: source knowledge more frequently, especially overseas locations; are more likely to act as a source of knowledge for overseas companies; and access strategic partners more frequently (Huggins et al., 2009). In general, high innovation firms more frequently access new technology, skills and expertise from a greater range of sources at different locations (Huggins et al., 2009). National innovation systems are becoming more "leaky" over time, whereby "the role of tacit knowledge and the spatial limits on knowledge spillovers have caused firms to locate R&D facilities where new knowledge is being created" (Carlsson, 2006, p. 65).

In general, the complex local and global environment within which firms operate has led to two broad schools of thought emerging regarding spatial proximity and inter-organizational networks. The first school argues that proximity is a significant mechanism for generating collaborative innovation. The second suggests that connectivity through global spaces is a more important stimulant of technological advancement. These two poles introduce an unnecessary divide of global and local forces when the reality suggests that they are operating in an overlapping manner. Successful connectivity in global spaces is often the outcome of an initial system of localized interaction, whereby it is the knowledge crossing hallways and streets that initially catalyzes intellectual exchange and knowledge transfer across oceans and continents (Glaeser, Kallal, Scheinkman, and Shleifer, 1992). Similarly, international market-based interactions are leading to more localized network-based exchanges, such as those occurring when firms establish operations in locations to deepen relationships with key customers (Miles, 2005).

Technological progress has also impacted significantly on the development of knowledge networks, with improvements in ICT facilitating new modes of knowledge exchange and again heightening the propensity to penetrate international markets. New patterns of knowledge sourcing and the emergence of new emergence serve to illustrate the notion of an economic geography that is as spiky as it is flat (Florida, 2005; Huggins, 2008). This spikiness is typified by the existence of key and leading concentrations of knowledge-based economic activity around the world. These concentrations maintain knowledge bases within a limited number of key regional locations which are the primary spatial architecture underlying systems of innovation. These regions, however, are increasingly connected through the knowledge networks resulting from the internationalization of markets and the broadened scope of knowledge sourcing activities. Contrary to Porter (1990), if the local market does not have the most sophisticated customers, firms are required to look for them elsewhere. Von Hippel (2005) highlights how markets and user-led innovation in a number of markets, such as design, are becoming increasingly international in scope. Furthermore, the

pace of technological change and the insatiable appetite for innovation is such that both product and economic lifecycles are shortening.

Conclusion

This paper builds on theories of knowledge flow and the extended resource-based view of the firm to present a dynamic framework for understanding the assets entrepreneurs can strategically manage to secure competitive advantage and facilitate innovation through inter-organizational networks. This framework is based on three related factors: the nature of knowledge and its flow; the nature of the resources available through inter-organizational networks; and the nature of the geography of these networks. It is suggested that knowledge spillovers through the inward and outward accessing of knowledge through networks will often take place in tandem, with there being a tradeoff between accessing required knowledge and the leaking of knowledge assets that a firm would ideally rather protect. In scenarios where the value of leaked knowledge outweighs that received, the impact of networks may be the improved competitiveness of other network members at the expense of the focus firm. Effective network management, through strategic and intentional investment in relationships with other firms, is a mechanism for ensuring that entrepreneurs capture value rather than lost through inter-organizational networks.

The growth of new knowledge formation across the globe suggests an enhanced requirement to manage network capital, since it is becoming increasingly difficult to establish relationships with appropriate knowledge sources. In general, as firms grow they are more likely to be linked to the global pipelines through which knowledge flows into a region (Bathelt, et al. 2004), with their reliance on social networks as sources of knowledge weakening (Bowey and Easton 2007). The complementary evolution of firms and their external knowledge networks underlines the need for models of these networks to be dynamic across space and time (Hite and Hesterly 2001). More generally, it also highlights the requirement for existing theories of the firm, such as the resource-based view (Barney 1991), to more rigorously account for the changing nature of firms and their network resource requirements.

Entrepreneurs must better distinguish the types of network resources in which their firms invest in order to facilitate a greater understanding of the evolutionary nature of business interactions and their dynamism. Entrepreneurs also need to consider the complexity of interactions, which may possess a mix of formal, informal, personal and organizational characteristics. While network capital should benefit firms, there are potential downsides for firms highly reliant on social capital. Firms may create or deplete network capital as its interests and requirements change. The stickiness of social capital means that speedy creation may not be possible. A network capital approach to external relationship management allows the adoption of strategies which explicitly seek to make the most effective use of ties, relationship and interactions, and ensure these are a firm-level, rather than an individual-level, resource.

This may take the form of developing systems to understand a firm's network capital in terms of: motivation – why particular interactions and relationships are initiated; function – what role they serve for the firm; processes – how and when do the interactions occur; structure – which individuals and organizations are involved; outputs – what outputs are gained for the firm as a direct consequence of network development or as additional by-products; sovereignty – to what extent would/could interactions continue without those individuals currently involved; and evolution – how are the above changing over time. Such a framework has the potential to assess those networks an entrepreneur can or cannot manage or invest in to meet its requirements. The push toward the strategic management of networks, and the potential financial rewards associated with effective management, almost paradoxically suggests the establishment of markets for network capital. This strategic view may further infer the outright commodification of networks whereby contacts with firms of perceived value may be stored, exchanged or even stolen (Grabher and Ibert, 2006).

In a complementary sense to the strategic decisions of entrepreneurs, the role of policymakers is to ensure that firms are supported in capturing this value. Policymakers often appear to expect that economic benefits will spillover from these networks as a by-product of the development of socialized interaction rather than intentional investments (Casson and Della Giusta, 2007; Huggins 2000; Pittaway et al., 2004). Policymaking should further take into account the need for knowledge sourcing and networking to be equally set in both a regional and global dimension and context. For entrepreneurs, the core of such developments is two-fold. First, to increase the involvement of entrepreneurs in the type of enduring knowledge networks required for effective collaborative innovation to be achieved; and second, to enable entrepreneurs to source the most relevant and up-to-date knowledge by ensuring that their networks contain the requisite level of dynamism. The 'pre-packaged' knowledge available from knowledge providers such as consultants is often of less use to entrepreneurs. In general, the requirement for entrepreneurs is access to 'non-standardized' and highly specific forms of knowledge. The role of public policy is to establish such dynamism through the promoting and facilitating global searches for appropriate knowledge sources.

References

- Abramovsky, L., Griffith, R., and Sako, M. (2004). *Offshoring of Business Services and its Impact on the UK Economy*. Advanced Institute of Management: London.
- Acs, Z., Auderetsch, D. B. and Feldman, M. P. (1994) R&D spillovers and recipient firm size. *Review of Economics and Statistics*, 76: 336–340.
- Adler, P.S. & Kwon, S.W. (2002). Social capital: Prospects for a new concept. *Academy of Management Review*, 27, 17-40.
- Ahuja, G. (2000). The duality of collaboration: Inducements and opportunities in the formation of interfirm linkages. *Strategic Management Journal*, 21, 317–343.

Aldrich, H. and Zimmer, C. 1986 Entrepreneurship through social networks, in Sexton, D. and Smilor, R. (eds.) *The Art and Science of Entrepreneurship* (Cambridge, MA: Ballinger) pp. 3-24.

Almeida, P., Dokko, G. and Rosenkopf, L. (2003). Startup size and the mechanisms of external learning: increasing opportunity and decreasing ability? *Research Policy*, **32**, 301-315.

Anderson, A., Park, J. and Jack, S. 2007 Entrepreneurial social capital: Conceptualizing social capital in new high-tech firms, *International Small Business Journal*, **25**: 245-272.

Andersson, M. and Ejermo, O. (2005) How does accessibility to knowledge sources affect the innovativeness of corporations? Evidence from Sweden, *Annals of Regional Science*, **39**:741–765.

Andersson, M. and Karlsson, C. 2007 Knowledge in regional economic growth: The role of knowledge accessibility, *Industry and Innovation*, **14**: 129-149.

Anselin L, Acs Z, Varga A (1997) Local geographical spillovers between university research and high technology innovations. *Journal of Urban Economics*, **42**:422–448.

Anselin L, Acs Z, Varga A (2000) Geographic spillovers and university research: a spatial econometric approach. *Growth and Change* **31**:501–515

Antonelli, C. (1996) Localized knowledge percolation processes and information networks, *Journal of Evolutionary Economics*, **6**, 281-295.

Arrow, K.J. (1971). *Essays in the Theory of Risk-Bearing*. Amsterdam: North-Holland.

Arthur, B. (1989). Competing technologies and lock-in by historical events: the dynamics of allocation under increasing returns. *Economic Journal*, **99**, 116-131.

Asheim, B. and Gertler, M. (2005) The geography of innovation: Regional innovation systems, in Fagerberg, J., Mowery, D.C. and Nelson, R.R. (Eds) *The Oxford Handbook of Innovation*. Oxford: Oxford University Press.

Asheim, B. and Isaksen, A. 2003 SMEs and the regional dimension of innovation. in Asheim, B., Isaksen, A., Nauwelaers, C. and Tödtling, F. (Eds) *Regional innovation policy for small-medium enterprises* (London: Edward Elgar) pp. 21-48.

Athreye, S. (2004). Agglomeration and growth: a study of the Cambridge hi-tech cluster; in Bresnahan, T. and A. Gambardella (eds.) *Building High-Tech Clusters Silicon Valley and Beyond*, Cambridge and New York: Cambridge University Press.

Audretsch, D. B. and M. P. Feldman (1996) R&D spillovers and the geography of innovation and production', *American Economic Review* **86**(3), 630–40.

Audretsch, D.B. and Lehmann, E.E. (2006) Does the Knowledge Spillover Theory of Entrepreneurship hold for regions? *Research Policy*, **34**, 1191–1202

- Audretsch, D.B., Stephan, P.E., 1996. Company-scientist locational links: the case of biotechnology. *American Economic Review* 86(3), 641–652.
- Audretsch, D. B., Lehmann, E. E. and Warning, S. (2005) University spillovers and new firm location. *Research Policy*, 34: 1113–1122
- Audretsch, D.B., Keilbach, M., Lehmann, E.E., 2006. *Entrepreneurship and Growth*. Oxford University Press
- Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, **17**, 99-120.
- Bathelt, H., Malmberg, A. & Maskell, P. (2004), Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, **28**, 31-56.
- Baum, J., Calabrese, T. & Silverman, B.S. (2000). Don't go it alone: Alliance network composition and startups' performance in Canadian biotechnology. *Strategic Management Journal*, **21**, 267–294.
- Bell, G.G. and Zaheer, A. (2007) Geography, Networks, and Knowledge Flow, *Organization Science*, 18, 955–972
- Bennett, R.J. 1998 Business associations and their potential contribution to the competitiveness of SMEs, *Entrepreneurship and Regional Development*, 10: 243-260.
- Birley, S. 1985 The role of networks in the entrepreneurial process. *Journal of Business Venturing*, 1: 107-118
- Blackler, F. 1993 Knowledge and the theory of organizations: organizations as activity systems and the reframing of management. *Journal of Management Studies*, 30: 863-884.
- Borgatti, S.P. & Foster, P.C. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management*, **29**, 991-1013.
- Boschma, R. A. 2005 Proximity and innovation: A critical assessment, *Regional Studies*, 39: 61-74.
- Boschma, R., and K. Frenken. 2006. Why is economic geography not an evolutionary science? Towards an evolutionary economic geography. *Journal of Economic Geography* 6(3): 273–302.
- Bourdieu, P. (1986). The forms of capital, in Richardson J.G. (ed.) *Handbook of Theory and Research for the Sociology of Education*, New York: Greenwood.
- Bowey and Easton 2007 Bowey, J.L. and Easton, G. (2007). Entrepreneurial social capital unplugged: An activity-based analysis, *International Small Business Journal*, **25**, 273–306.
- Brass, D.J., Galaskiewicz, J., Greve H.R. & Tsai W.P. (2004). Taking stock of networks and organizations: A multilevel perspective. *Academy of Management Journal*, **47**, 795-817.

- Breschi, S. and F. Malerba (2001) 'The geography of innovation and economic clustering: some introductory notes', *Industrial and Corporate Change* 10(4), 817–34.
- Bresnahan, T. and Gambardella, A. (2004) *Building High-Tech Clusters: Silicon Valley and Beyond*. Cambridge: Cambridge University Press.
- Bresnahan, T., A. Gambardella, and A. Saxenian (2001) "'Old economy" inputs for "new economy" outcomes: cluster formation in the New Silicon Valleys', *Industrial and Corporate Change* 10(4), 835–60.
- Britton, J. N. H (2004) 'High technology localization and extra-regional networks', *Entrepreneurship and Regional Development* 16(5), 369–90
- Camagni, R. (1991) 'Local "milieu", uncertainty and innovation networks: towards a new dynamic theory of economic space', in R. Camagni (ed.) *Innovation Networks: Spatial Perspectives*, London: Belhaven Press, 121–44.
- Capello, R. and Faggian, A. (2005). Collective learning and relational capital in local innovation processes. *Regional Studies*, 39, 75-87
- Carlsson, B. (2006). Internationalization of innovation systems: A survey of the literature. *Research Policy*, 35, 56-67.
- Casson, M. & Della Giusta, M. (2007). Entrepreneurship and social capital: Analysing the impact of social networks on entrepreneurial activity from a rational action perspective. *International Small Business Journal*, 25, 220–244.
- Castells, M. and Hall, P. (1994) *Technopoles of the world: the making of the twenty-first century industrial complexes*. London: Routledge.
- Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press: Boston, MA.
- Cohen, W. M. and Levinthal, D. A. (1990) Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 35: 128–152.
- Coleman, J.S. (1988). Social capital in the creation of human capital. *American Journal of Sociology*, 94, 95-120 Supplement.
- Coleman, J.S. (1990). *Foundations of Social Theory*. Cambridge, MA. and London, UK: Belknap.
- Cooke, P. (2004) Regional innovation systems: an evolutionary approach. In: Cooke P, Heidenreich M, Braczyk H (eds), *Regional Innovation Systems: The Role of Governance in a Globalized World*. London: Routledge.
- Cooke, P., Heidenreich, M. and Braczyk, H. Eds. 2004 *Regional Innovation Systems: The Role of Governance in a Globalised World* (London: Routledge).

Cowan, R., Jonard, N. and J-B Zimmerman. (2004). *Networks as emergent structures from bilateral collaboration*. Maastricht: Maastricht Economic Research Institute on Innovation and Technology.

Crescenzi, R. 2005. Innovation and regional growth in the enlarged Europe: The role of local innovative capabilities, peripherality, and education. *Growth and Change* 36(4): 471–507.

Dasgupta, P. (2005). The economics of social capital. *The Economic Record*, **81**, S2-S21.

Davenport, S. (2005). Exploring the role of proximity in SME knowledge-acquisition. *Research Policy*, **34**, 683-701.

Dixon, N. M. (2000) *Common Knowledge: How Companies Thrive by Sharing What They Know*, Boston, MA: Harvard Business School Press.

Doloreux, D. (2004). Regional innovation systems in Canada: A comparative study. *Regional Studies*, **38**, 479-492.

Dosi, G., (1988) ‘Sources, procedures and microeconomic effects of innovation’, *Journal of Economic Literature* 26(3), 1126–71.

Dosi, G., Freeman, C, Nelson, R., Silverberg, G. and Soete, L. (eds) 1988 *Technical Change and Economic Theory* (London: Pinter).

Drejer, I., & Lund Vinding, A. (2007). Searching near and far: Determinants of innovative firms’ propensity to collaborate across geographical distance. *Industry and Innovation*, **14**, 259-275.

Drucker, P.F. 1989 *The New Realities: In Government and Politics/In Economics and Business/In Society and World View* (New York: Harper & Row).

Dunning, J.H. (2000). Regions, globalization, and the knowledge economy: The issues stated, in J.H. Dunning (ed.) *Regions, Globalization, and the Knowledge-Based Economy*. Oxford: Oxford University Press.

Dyer, J.H. & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review*, **23**, 660-679.

Easterby-Smith, M., Lyles, M.A. and Tsang, E.W.K. (2008) Inter-Organizational Knowledge Transfer: Current Themes and Future Prospects, *Journal of Management Studies*, **45**, 677-690.

Feldman, M. P. and Desrochers, P. (2003) Research universities and local economic development: lessons from the history of the John Hopkins University. *Industry and Innovation*, **10**: 5–24.

Florida, R. (2002). *The rise of the creative class: And how it’s transforming work, leisure, community and everyday life*. New York, NY: Basic Books.

Florida, R. (2005). The world is spiky. *Atlantic Monthly*, October Issue, 48-51.

- Fosfuri, A. (2006). The licensing dilemma: Understanding the determinants of the rate of technology licensing. *Strategic Management Journal*, **27**, 1141-1158.
- Freel, M.S. 2000 Do small innovating firms outperform non-innovators? *Small Business Economics*, 14: 195-210.
- Freel, M. (2002) On regional systems of innovation: illustrations from the West Midlands. *Environment and Planning C: Government and Policy*, 20: 633-654.
- Freeman, C. (1987). *Technology, policy, and economic performance: Lessons from Japan*, London: Pinter Publishers.
- Freeman, C. 1994 *Critical survey: the economics of technical change*, Cambridge Journal of Economics, 18: 463-512.
- Gargiulo, M. & Benassi, M. (2000). Trapped in your own net? Network cohesion structural holes, and the adaptation of social capital. *Organization Science*, **11**, 183-196.
- Garnsey, E. & Heffernan, P. (2005). High-technology clustering through spin-out and attraction: The Cambridge case. *Regional Studies*, **39**, 1127–1144.
- Garnsey, E. and Lawton Smith, H. (1998) Proximity and complexity in the emergence of high technology industry: the oxbridge comparison. *Geoforum*, 29: 433–450.
- Gertler, M.S. & Wolfe, D. (2004). Ontario's regional innovation system. in Cooke, P., Heidenreich, M. and Braczyk, H. (eds.) *Regional Innovation Systems: The Role of Governance in a Globalised World*, London: Routledge.
- Glaeser, E. L., Kallal, H. D., Scheinkman, J. A., & Shleifer, A. (1992). Growth in cities. *Journal of Political Economy*, 100(6), 1126-1152.
- Glückler, J. (2007). Economic geography and the evolution of networks. *Journal of Economic Geography*, **7**, 619–634.
- Goerzen, A. (2005). Managing alliance networks: Emerging practices of multinational corporations. *Academy of Management Executive*, **19**, 94 – 107.
- Goerzen, A. & Beamish, P.W. (2005). The effect of alliance network diversity on multinational enterprise performance. *Strategic Management Journal*, **26**, 333 – 354.
- Goman, C. K., *The Human Side of High-Tech: Lessons from the Technology Frontier*, New York: John Wiley & Sons, 2000.
- Grabher, G. (1993) Rediscovering the social in the economics of the interfirm relations, in Grabher, G. (Ed.) *The Embedded Firm: On the Socio-Economics of Industrial Networks*, London: Routledge.
- Grabher, G. & Ibert, O. (2006). Bad company? The ambiguity of personal knowledge networks. *Journal of Economic Geography*, **6**, 251–271.

- Granovetter, M. (1973). The strength of weak ties. *American Journal of Sociology*, **78**, 1360-1380.
- Grant, R. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, **17**, 109-122.
- Grant, R. & Baden-Fuller, C. (2004). A knowledge accessing theory of strategic alliances. *Journal of Management Studies*, **41**, 61-84.
- Gulati, R. (1999). Network location and learning: the influence of network resources and firm capabilities on alliance formation. *Strategic Management Journal*, **20**, 397-420.
- Gulati, R. (2007). *Managing Network Resources: Alliances, Affiliations, and other Relational Assets*, Oxford: Oxford University Press.
- Gulati, R. & Gargiulo, M. (1999). Where do interorganizational networks come from? *American Journal of Sociology*, **104**, 1439-1493.
- Gulati, R., Nohria, N. & Zaheer, A. (2000). Strategic networks. *Strategic Management Journal*, **21**, 203-215.
- Hagedoorn, J. (2002). Inter-firm R&D partnerships: An overview of major trends and patterns since 1960. *Research Policy*, **31**, 477-492.
- Hagedoorn, J. and Schakenraad, J. (1994). The effect of strategic technology alliances on company performance. *Strategic Management Journal*, **15**, 291-311.
- Hirschman, A. O. (1958). *Strategy of economic development*. New Haven, CT: Yale University Press.
- Hite, J. & Hesterly, W.S. (2001). The evolution of firm network: from emergence to early growth of the firm. *Strategic Management Journal*, **22**, 275-286.
- Huggins, R. (2000) The success and failure of policy-implemented inter-firm network initiatives: Motivations, processes and structure. *Entrepreneurship and Regional Development* 12(1): 111-135.
- Huggins, R. (2008). The evolution of knowledge clusters: Progress and policy. *Economic Development Quarterly*, **22**, 277-289.
- Huggins, R. & Izushi, H. (2007). *Competing for Knowledge: Creating, Connecting, and Growing*, London: Routledge.
- Huggins, R. and Izushi, H. (forthcoming) Regional Benchmarking in a Global Context: Knowledge, Competitiveness, and Economic Development, *Economic Development Quarterly*.
- Huggins, R., Johnston, A. and Steffenson, R. 2008 Universities, knowledge networks and regional policy, *Cambridge Journal of Regions, Economy and Society*, 1: 321-340.

- Huggins, R., Izushi, I., Clifton, N., Jenkins, S., Prokop, D., and Whitfield, C. (2009) *Sourcing Knowledge for Innovation: The Internationalisation of Flows – Synthesised Report*, London: NESTA.
- Inkpen, A.C. & Tsang, E.W.K. (2005). Social capital, networks, and knowledge transfer. *Academy of Management Review*, **30**, 146-165.
- Ireland, R.D., Hitt, M.A. & Vaidyanath, D. (2002). Alliance management as a source of competitive advantage. *Journal of Management*, **28**, 413-446.
- Izushi, H. (1997) 'Conflict between two industrial networks: technological adaptation and interfirm relationships in the ceramics industry in Seto, Japan', *Regional Studies* 31(2), 117–129.
- Jack, S.L. (2005). The role, use and activation of strong and weak network ties: A qualitative analysis. *Journal of Management Studies*, 42, 1233-1259.
- Jaffe, A. B., M. Trajtenberg, and R. Henderson (1993) 'Geographic localization of knowledge spillovers as evidenced by patent citations', *Quarterly Journal of Economics* 108(3), 577–98.
- Johannisson, B. 1995. Paradigms and entrepreneurial networks—Some methodological challenges. *Entrepreneurship and Regional Development* 7(3): 215–232.
- Johannisson, B., Ramírez-Pasillas, M. & Karlsson, G. (2002). The institutional emeddedness of local inter-firm networks: A leverage for business creation. *Entrepreneurship and Regional Development*, 14, 297-315.
- Johnson, D.K.N., Siripong, A & Brown, A.S. (2006). The demise of distance? The declining role of physical proximity for knowledge transmission. *Growth and Change*, **37**, 19–33.
- Keeble, D., Lawson, C., Moore, B. and Wilkinson, F. 1999 Collective learning processes, networking and 'institutional thickness' in the Cambridge region, *Regional Studies*, 33: 319-332.
- Kilduff, M. & Tsai, W. (2003). *Social Networks and Organizations*. London: Sage
- Kim, T-Y., Oh, H. & Swaminathan, A. (2006). Framing interorganizational network change: A network inertia perspective, *Academy of Management Review*, **31**, 704-720.
- Kingsley, G. and Malecki, E.J. 2004 Networking for competitiveness, *Small Business Economics*, 23: 71-84.
- Kline, S. J. & Rosenberg, N. (1986). An overview of innovation. In R. Landau & N. Rosenberg (Eds.) *The positive sum strategy: Harnessing technology for economic growth* (pp. 275–305). Washington, DC: National Academy Press.
- Knoben, J. & Oerlemans, L.A.G. (2006). Proximity and inter-organizational collaboration. *International Journal of Management Reviews*, **8**, 71-89.

- Kogut, B. (2000). The network as knowledge: Generative rules and the emergence of structure. *Strategic Management Journal*, **21**, 405-425.
- Kogut, B. and Zander, U. 1996 What firms do? Coordination, identity, and learning. *Organization Science*, *7*: 502-519.
- Kostova, T & Roth, K. (2003). Social capital in multinational corporations and a micro-macro model of its formation. *Academy of Management Review*, **28**, 297-317.
- Krackhardt, D. (1994). Constraints on the interactive organization as an ideal type, in Heckscher C. & Donnellon, A. (Eds.) *The Post-Bureaucratic Organization: New Perspectives on Organizational Change*, Thousand Oaks, CA: Sage.
- Krugman, P (1991) *Geography and Trade*, Cambridge, Mass: MIT Press
- Labianca, G. & Brass, D.J. (2006). Exploring the social ledger: negative relationships and negative asymmetry in social networks in organizations. *Academy of Management Review*, **31**, 596 – 614.
- Lagendijk, A. and Cornford, J. (2000) Regional institutions and knowledge: tracking new forms of regional development policy. *Geoforum*, *21*: 209–218.
- Lavie, D. (2006). The competitive advantage of interconnected firm: An expansion of the resource-based view. *Academy of Management Review*, **31**, 638 – 658
- Lawton Smith, H. 2003. Knowledge organizations and local economic development: The cases of Oxford and Grenoble. *Regional Studies* *37*(9): 899–919.
- Lawton Smith, H. and Bagchi-Sen, S. 2006 University-industry interactions: The case of the UK biotech industry, *Industry and Innovation*, *13*: 371–392.
- Lechner, C. & Dowling, M. (2003). Firm networks: external relationships as sources for the growth and competitiveness of entrepreneurial firms. *Entrepreneurship & Regional Development*, **15**, 1- 26.
- Lechner, C., Dowling, M., and Welpe, I. 2006 Firm networks and firm development: The role of the relational mix, *Journal of Business Venturing*, *21*: 514-540.
- Lichtenthaler, U. (2005). External commercialization of knowledge: Review and research agenda. *International Journal of Management Reviews*, **7**, 231-255.
- Lichtenthaler, U. and Ernst, H. (2007). Developing reputation to overcome the imperfections in the markets for knowledge. *Research Policy*, **36**, 37-55.
- Lissoni, F. (2001). Knowledge codification and the geography of innovation: The case of Brescia mechanical cluster. *Research Policy*, **30**, 1479-1500.
- Locke, E.A. (1999). Some reservations about social capital. *Academy of Management Review*, **24**, 8-9.

- Lorenzen, M. (2007). Social capital and localised learning: Proximity and place in technological and institutional dynamics, *Urban Studies*, **44**, 799-817.
- Lorenzoni, G. & Lipparini, A. (1999). The leverage of interfirm relationships as a distinctive organizational capability: A longitudinal study. *Strategic Management Journal*, **20**, 317-338.
- Lucas, R. E. (1988) On the Mechanics of Economic Development. *Journal of Monetary Economics*, **22**: 3-32
- MacKinnon, D., Cumbers, A. and Chapman, K. (2002) Learning, innovation and regional development: a critical appraisal of recent debates. *Progress in Human Geography*, **26**: 293-311.
- Madhavan, R., Koka, B. and Prescott, J.E. 1998 Networks in transition: How industry events (re)shape interfirm relationships, *Strategic Management Journal*, **19**: 439-459.
- Malecki, E. J. (2004). Jockeying for position: What it means and why it matters to regional development policy when places compete. *Regional Studies*, **38**, 1101-1120.
- Malecki, E. J. (2007). Cities and regions competing in the global economy: Knowledge and local development policies. *Environment and Planning C: Government and Policy*, **25**, 638-654.
- Malecki, E. J. and G.-J. Hospers 2007 Knowledge and the competitiveness of places. *The Learning Region: Foundations, State of the Art, Future*. R. Rutten and F. Boekema (Eds) (Cheltenham: Edward Elgar) pp.143-159.
- Malmberg, A., and P. Maskell. 2006. Localized learning revisited. *Growth and Change* **37**(1): 1-18.
- Martin, R. and Sunley, P. 2006 Path dependence and regional economic evolution, *Journal of Economic Geography*, **6**: 395-437.
- Maskell, P. 2000 Social capital, innovation and competitiveness. In *Social capital: Critical perspectives*. S. Baron, J. Field and T. Schuller (Eds.) (Oxford: Oxford University Press) pp. 111-123.
- Maskell, P. and Malmberg, A. (2007). Myopia, knowledge development and cluster evolution. *Journal of Economic Geography*, **5**, 603-618.
- Maurer, I. & Ebers, M. (2006). Dynamics of social capital and their performance implications: Lessons from biotechnology start-ups. *Administrative Science Quarterly*, **51**, 262-292.
- McEvily, B. & Zaheer, A. (1999), Bridging ties: A source of firm heterogeneity in competitive capabilities. *Strategic Management Journal*, **20**, 1133-1156.
- Meagher, K. and Rogers, M. 2004 Network density and R&D spillovers, *Journal of Economic Behavior and Organization*, **53**: 237-260.

- Miles, I. (2005). Knowledge intensive business services: Prospects and policies. *Foresight*, 7, 39-63.
- Monge, P.M. & Contractor, N.S. (2003). *Theories of communication networks*. New York: Oxford University Press.
- Morgan, K. (1997). The learning region: Institutions, innovation and regional renewal. *Regional Studies*, 31, 491–503.
- Mowery, D., Oxley, J. & Silverman, B. (1996). Strategic alliances and interfirm knowledge transfer, *Strategic Management Journal*, 17, 77-91.
- Nagle, M. (2007) Canonical analysis of university presence and industrial comparative advantage. *Economic Development Quarterly*, 21: 325–338.
- Nahapiet, J. & Ghoshal S. (1998). Social capital, intellectual capital, and the organizational advantage, *Academy of Management Review*, 23, 242-266.
- Nelson, R. and Rosenberg, N. (1993) Technical innovation and national systems. , In: Nelson R. (eds). *National innovation systems: A comparative analysis*, Oxford, Oxford University Press.
- Nelson, R. R. and S. G. Winter (1982) *An Evolutionary Theory of Economic Change*, Cambridge, MA: Belknap Press.
- Nonaka, I. & Takeuchi, H. (1995). *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. New York: Oxford University Press.
- Oh, H.S., Chung, M.H. & Labianca, G. (2004). Group social capital and group effectiveness: The role of informal socializing ties. *Academy of Management Journal*, 47, 860-875.
- Oliver, C. (1997). Sustainable competitive advantage: Combining institutional and resource-based views. *Strategic Management Journal*, 18, 697-713.
- Ostgaard, T. and Birley, S. 1996 New venture growth and personal networks, *Journal of Business Research*, 36: 37-50.
- Ostrom, E. (2000). Social capital: a fad or a fundamental concept?, in Dasgupta P. and Serageldin, I. (eds.) *Social Capital: A Multifaceted Perspective*, Washington, DC: World Bank.
- Owen-Smith, J. & Powell, W.W. (2004). Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community. *Organization Science*, 15, 5-21.
- Palazzo, G. 2005 Postnational constellations of innovativeness: A cosmopolitan approach, *Technology Analysis & Strategic Management*, 17: 55–72.
- Perroux, F. (1955). Note sur la notion de pôle de croissance [Note on the concept of growth poles]. *Economic Appliquée*, 8, 307-320.

- Pfeffer, J. and Salancik, G. (1978). *The External Control of Organizations: A Resource Dependence Perspective*. New York: Harper & Row.
- Pittaway, L., Roberston, M., Munir, K., Denyer, D. & Neely, A. (2004). Networking and innovation: a systematic review of the evidence. *International Journal of Management Reviews*, 5-6, 137-168.
- Polenske, K. (2007) *The Economic Geography of Innovation*. Cambridge: Cambridge University Press.
- Porter, M. E. (1980). *Competitive strategy: Techniques for analyzing industries and competitors*, New York: Free Press.
- Porter, M. E. (1990). *The Competitive Advantage of Nations*. New York: Free Press.
- Porter, M. E. (1998). *On Competition*. Boston, MA: Harvard Business School Press.
- Portes A. (1998). Social capital: Its origins and application in modern sociology. *Annual Review of Sociology*, 24, 1-24.
- Powell, W.W., Koput, K.W. and Smith-Doerr, L. 1996 Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology, *Administrative Science Quarterly*, 41: 116-145.
- Prahalad, C. K. & Hamel, G. (1990). *The core competence of the corporation*. Harvard Business Review, 68(3), 79–91.
- Putnam, R.D. (2000). *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon & Schuster.
- Rangone, A. 1999 A resource-based approach to strategy analysis in small-medium sized enterprises, *Small Business Economics*, 12: 233-248.
- Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94(5), 1002–1037.
- Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5), S71–S102.
- Romer, P. M (1996) Why, Indeed, in America? Theory, History. and the Origins of Modern Economic Growth, *American Economic Review*, 86; 202-206.
- Rothwell, R. (1994). Towards the fifth-generation innovation process. *International Marketing Review*, 11(1), 7–31.
- Rutten, R. & Boekema, F. (Eds.) (2007). *The learning region: Foundations, state of the art, future*. Cheltenham, UK: Edward Elgar.

Sako, M. (2006). Outsourcing and Offshoring: Implications for Productivity of Business Services. *Oxford Review of Economic Policy*, 22, 499-512.

Saxenian, 1994 Saxenian, A. (1994) *Regional advantage: culture and competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.

Saxenian, A. (2005). From brain drain to brain circulation: Transnational communities and regional upgrading in India and China. *Studies in Comparative International Development*, 40, 35-61.

Schumpeter, J. A. (1934) *The Theory of Economic Development*, Cambridge, Mass., Harvard University Press.

Seely Brown, J. and Duguid, P. 2001 Knowledge and organization: A social-practice perspective, *Organization Science*, 12: 198-213

Singh, J. (2005) Collaborative networks as determinants of knowledge diffusion patterns. *Management Science*, 51: 756–770.

Sorenson, O., Rivkin, J.W. & Fleming, L. (2006). Complexity, networks and knowledge flow. *Research Policy*, 35, 994-1017.

Steiner, M. and Ploder, M. (2008). Structure and Strategy within Heterogeneity: Multiple Dimensions of Regional Networking. *Regional Studies, Regional Studies*, 42, 793-815.

Stewart, T. A. (1997). *Intellectual capital: The New Wealth of Organizations*. (New York: Doubleday-Currency).

Storper, M. (2000) Globalisation and knowledge flows: An industrial geographer's perspective, in J.H. Dunning (ed.) *Regions, Globalization, and the Knowledge-Based Economy*. Oxford: Oxford University Press.

Storper, M. and Scott, A.J. (2009) Rethinking human capital, creativity and urban growth, *Journal of Economic Geography*, 9,147–167.

Storper, M. 1995 The resurgence of regional economies, ten years later, *European Urban and Regional Studies*, 2: 191-221.

Stuart, T.E. (2000). Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. *Strategic Management Journal*, 21, 791–811.

Stuart, T. E. and J. M. Podolny (1996) 'Local search and the evolution of technological capabilities', *Strategic Management Journal* 17(Summer Special Issue), 21–38.

Stuart, T.E., Hoang, H. & Hybels, R.C. (1999). Interorganizational endorsements and the performance of entrepreneurial ventures. *Administrative Science Quarterly*, 44, 315-349.

Sturgeon, T. J. (2003). What really goes on in Silicon Valley? Spatial clustering and dispersal in modular production networks. *Journal of Economic Geography*, 3(2), 199-225.

- Szarka, J. 1990 Networking and small firms, *International Small Business Journal*, 8: 10-22.
- Tallman, S., Jenkins, M., Henry, N. & Pinch, S. (2004). Knowledge, clusters, and competitive advantage. *Academy of Management Review*, **29**, 258-271.
- Teece, D.J. (1998). Capturing value from knowledge assets: The new economy, markets for know-how, and intangible assets. *California Management Review*, **40**, 55-79.
- Thompson, J. D. (1967). *Organizations in Action*. New York: McGraw Hill.
- Thorpe R., Holt, R., Macpherson, A. & Pittaway, L. (2005). Using knowledge within small and medium-sized firms: A systematic review of the evidence. *International Journal of Management Reviews*, **7**, 257–281.
- Tracey, P. and Clark, G.L. (2003). Alliances, networks and competitive strategy: Rethinking clusters of innovation. *Growth and Change*, **34**, 1-16.
- Tsai, W.P. (2000). Social capital, strategic relatedness and the formation of intraorganizational linkages. *Strategic Management Journal*, **21**, 925-939.
- Tsai, W.P. & Ghoshal, S. (1998). Social capital and value Creation: The role of intrafirm networks. *Academy of Management Journal*, **41**, 464-476.
- Tura, T. & Harmaakorpi, V. (2005). Social capital in building regional innovation capability. *Regional Studies*, **39**, 1111-1125.
- Uzzi, B. (1997). Social structure and competition in interfirm networks: The paradox of embeddedness. *Administrative Science Quarterly*, **42**, 35-67.
- von Hippel, E. (2005) *Democratizing Innovation*, Cambridge, MA: MIT Press.
- Walter, J., Lechner, C. & Kellermanns, F.W. (2007). Knowledge transfer between and within alliance partners: Private versus collective benefits of social capital. *Journal of Business Research*, **60**, 698-710.
- Weber, M. (1968). *On Charisma and Institution Building*. Chicago: University of Chicago Press.
- Wenger, E. (1998) *Communities of Practice: Learning, Meaning, and Identity*, Cambridge: Cambridge University Press.
- Wernerfelt, B. 1984 A resource-based view of the firm, *Strategic Management Journal*, **5**, 171-180.
- Westlund, H. & Bolton, R. (2003). Local social capital and entrepreneurship. *Small Business Economics*, **21**, 77-113.
- Westlund, H. & Nilsson, E. (2005). Measuring enterprises' investments in social capital: A pilot study'. *Regional Studies*, **39**, 1079-1094.

Wiklund, J. & Shepherd, D. (2003). Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses. *Strategic Management Journal*, **24**, 1307–1314

Williamson, O.E. (1991). Comparative economic organization: The analysis of discrete structural alternative. *Administrative Science Quarterly*, **36**, 269-296.

Williamson, O.E. (1993). Calculativeness, trust, and economic organization. *Journal of Law and Economics*, **36**, 453-486.

Wolfe, D. & Gertler, M. (2004). Clusters from the inside and out: Local dynamics and global linkages. *Urban Studies*, **41**, 1071–1093.

Yli-Renko, H., Autio, E. and Sapienza, H.J. (2001). Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms. *Strategic Management Journal*, **22**, 587–613.

Zaheer, A. and Bell, G. (2005). Benefiting from network position: Firm capabilities, structural holes, and performance. *Strategic Management Journal*, **26**, 809–825.