PRELIMINARY paper prepared for the R&D Management Conference 2002

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This paper explores the relationship between alliance block membership and innovative performance from a longitudinal perspective. After having explored the complex interrelationship between network evolution and block dynamics we will test some basic hypotheses on the effect of block membership on innovative performance under various network evolutionary conditions. Empirical testing is performed on the microelectronics industry.

1. Introduction

Over the past years, several authors have addressed the question of the effectiveness of relational and structural embeddedness on company performance (see, e.g. Rowley, Behrens and Krackhardt, 2000). Many authors have argued that strong ties are particularly effective under conditions of relative stability, whereas weak ties are particularly geared towards dynamic industry environments (refs). Others (e.g. Hagedoorn and Duysters, 2002) have found that under conditions of turbulence a satisficing strategy employing many, seemingly redundant, alliances might be more effective to increase firm performance than an optimisation strategy that is geared towards bridging structural holes.

Although we share the notion of some of these authors that "… the degree of uncertainty and required rate of innovation in the environment influence the appropriate network configurations…"(Rowley et al. 2000), we argue that these findings are, above all, contingent on the stage of a network's evolution. With the latter we refer to the evolution of a network that is either structure-reinforcing or structure-loosening (Madhavan, Koka, Prescott, 1998), caused by incremental technological developments or disruptive technologies, respectively.

The main aim of our paper is to improve our basic understanding of how firms should position themselves under various network conditions, in order to maximize their innovative rents. More in particular, we examine two basic strategies that can be pursuit in terms of either block membership or non-block membership. Using Coleman's (1988) closure arguments and Burt's (1992) structural holes argument we will first address the effect of closure advantages and disadvantages as well as broker advantages and disadvantages on strategic block formation in (international) alliance networks. Then, we will content that these advantages are contingent on the stage of an alliance network's evolution. In particular, we will study the interrelationship between network evolution and block dynamics. In the next part, we will derive some basic hypotheses on the effect of block membership on innovative performance under various network evolutionary conditions. In the empirical part of our paper we will test these hypotheses using alliance data on three major IT sectors, - i.e. computers, telecommunications and microelectronics. The use of a longitudinal dataset allows us to study the full dynamics of these networks from the early 1970s until 2000.

2. Theoretical background

Research on alliances has made significant progress in exploring the question of why and when alliances are formed (Kogut & Zander, 1993; Powell & Brantley, 1992). More recently, research has also made progress in advancing our understanding of "with whom" firms are likely to form alliances (Gulati, 1995). In dealing with the competitive implications of alliances, research has either focused on the performance/financial benefits of alliance formation (Berg, Duncan, & Friedman, 1982; Hagedoorn, 1993) or examined the implications of trust, opportunism, partner rivalry, and sustained cooperation as a means of achieving competitive benefits (Gulati, 1995; Hill, 1990). Adopting a transaction cost perspective or a social network perspective, researchers have attempted to examine the relationship between governance mechanisms and the evolution of trust and its implications for realizing benefits of cooperation (Gulati, 1995). In examining the relationship between competition and cooperation, research (with the exception of the strategic behaviour approach) has largely focused upon the internal characteristics of the alliance. It is argued that it is important to acknowledge the mixed-motive nature (competition plus cooperation) of alliances and its implications for dependence, trust, and mutual benefit (Singh & Mitchell, 1996). Although this approach has served to considerably advance our understanding of the internal process of alliance dynamics, it is lacking in improving our current understanding of the external competitive implications of alliance relationships. In other words, despite its insightful focus on the alliance, this line of research has been primarily introspective and has not yet begun to incorporate in its research domain the external competitive environment in which the alliance competes.

The rapid proliferation of alliances has not only ushered in a new era of cooperation among companies big and small, but it also started a new era of competition between alliances. Cooperative agreements have become an integral part and a cornerstone of competitive strategies. "Competition through cooperation" has become the mainstay of a firm's attempt to gain financial and survival advantages. The virtual explosion of cooperative agreements on a worldwide basis has led to a new form of competition: group versus group rather than company versus company (Gomes-Casseres, 1996).

Research by Gomes-Casseres (1996) and by Doz and Hamel (1998) is among the first to have explored the increasing frequency of collaboration as a reflection of a fundamental shift from the traditional form of competition (firm vs. firm) to a new form (group vs. group). By laying the foundation for this unexplored yet critical field of enquiry, these researchers have provided a basis for investigating the underlying principles of and antecedents to alliance competition.

We will address this important issue from a social networks perspective. This perspective explains the actions of actors in terms of their position in networks of relationships. From a social network perspective organizations are embedded in a set of social relations that is often referred to as their social capital. Social capital encompasses many aspects of a social context, such as social ties, trusting relations, and value systems that facilitate actions of individuals located within that context (Tsai, 1998; 2000). These different aspects of social context are labeled the structural, the relational, and the cognitive dimensions of social capital (Nahapiet and Ghoshal, 1998). We will argue that network embeddedness can be seen as an important determinant of the innovative success of companies.

Embeddedness refers to the fact that economic action and outcomes are affected by the partners' relations and by the structure of the overall network of relations (Granovetter, 1992). Granovetter (1985, 1992) distinguishes relational, structural and positional embeddedness. Relational embeddedness focuses on the role of direct links as a mechanism for knowledge acquisition. Structural embeddedness stresses the informational value of the structural position that companies occupy in the network. Positional embeddedness captures the impact of the positions organizations occupy in the overall structure of the alliance network on their decisions about new cooperative ties (the roles in the system). Embeddedness implies that a focal firm's actions are influenced by the behavior and relations of the partner firms in its network. Firms are actually caught in a web of relations that on the one hand puts restraints on their behavior and on the other hand can be used to their advantage. Interconnectedness (structural embeddedness) involves norm creation at the network level; relational embeddedness creates trust at the dyadic level (Rowley, Behrens, Krackhardt, 2000).

3. Block membership

Block membership can be seen as one of the strongest forms of social embeddedness. The effect of block membership on the innovative performance of companies can therefore be seen in the light of the current debate on the advantages and disadvantages of social embeddedness.

The basic arguments that are used in this debate stem from Burt's (1992) structural hole argument and Coleman's (1988) closure argument concerning social capital. Coleman (1988) argues that being part of a dense and redundant network is advantageous since it involves trust and cooperation among its members. Hence, firms engage in local search as a result of their social capital (Burt, 1992) and embeddedness (Granovetter, 1985; Gulati, 1998). Existing inter-firm relationships provide the infrastructure for future alliance formation. In other words, the current relations of a firm are products of its prior relational activities as well as the basis upon which it establishes future social relations. Through these strong ties, strategic blocks or cohesive subgroups of densely connected partners emerge in the strategic alliance network. These blocks or groups are characterized by highly cohesive subsets of similar actors (Knoke and Kuklinsky, 1992). In either case, actors who maintain especially cohesive bonds among themselves are more likely to act similarly, to share information, to develop

similar preferences, or to act in concert (Knoke and Kuklinsky, 1992).

On the contrary, Burt (1992) suggests that firms embedded in sparsely connected networks will enjoy brokerage advantages based on access to non-redundant information (Rowley, Behrens, Krackhardt, 2000). Through 'information access, timing, referrals and control' (Burt, 1992) strategic opportunities are raised as firms form bridges between densely connected and redundant parts of the network and other non-redundant parts through structural holes or disconnects in social structure (Burt, 1992). Such strategies enable those actors to access knowledge or information that has a high yield. In this context, direct as well as indirect contacts are found to be important. In terms of direct contacts, firms engage in local search based on social capital for extending their network. Regarding the indirect contacts firms should look for partners that have direct links to actors with whom oneself does not have strategic links. This enables them to bridge structural holes in the network. Since current alliance networks provide future alliance opportunities (Gulati, 1995; 1998; 1999), early participation may provide firms with potentially valuable possibilities for the future. Thus alliance proactive firms in networks are more likely to possess specialized knowledge associated with identifying and selecting appropriate alliance partners (Sarkar, Echambadi, Harrison, 2001).

In spite of these theoretical contributions, the literature is quite inconclusive about the performance effects of group membership. There is, especially, a strong lack of systematic longitudinal empirical studies that examine these effects. In order to fill this void we will test a number of hypotheses, derived from our understanding of some basic relationships between cohesive group membership and innovative performance.

4. Propositions

Members of cohesive sub-groups develop strong, cohesive ties through frequent interaction. Strong ties (Granovetter, 1973), are generally characterized by a solid, reciprocal and trustworthy relationship. This creates a large basis of trust and intimacy between the partners (Brass, Butterfield, Skaggs, 1998; Granovetter, 1973). Since trust is an important basis for knowledge sharing and joint learning firms are expected to be more productive in joint innovative activities. Furthermore, changing transaction partners in the short run, involves significant switching costs and implies a risk that existing relationships will dissolve. Under these conditions, each partner has to invest a substantial amount of time and energy to establish a long-term relationship (Burt, 1992). As firms engage in local search for partners the basis of partner attractiveness and the ties between firms within blocks will remain or even strengthen (Madhavan, Koka, Prescott, 1998). Thus, when trustworthy partners are already available, searching for or switching to new partners is hard to rationalize in forming strategic alliances. Actors rather replicate their existing ties than search for new ones (Gulati, 1998; Walker, Kogut & Shan, 1997). In the context of strong ties and familiarity, joint innovative activities and the sharing of knowledge are expected to generate higher innovative performance than when firms follow an individual innovation strategy outside cohesive sub-groups. Hence,

Proposition 1: Members of cohesive sub-groups are more innovative than non-member firms.

However, as a result of (over)embeddedness, firms can also be constrained in their partner choice when facing opportunities for linking up with actors of another strategic block. Once firms have established links with firms in a specific strategic block, it can be difficult for them to establish links with firms outside that block, because of the possible conflict of interest among its partners. This implies that some actors in blocks are locked in as a result of initial alliance choices and actors outside the block are locked out in order to prevent knowledge leakage to competing groups. Another reason for locking out actors of other groups is the implicit expectation of loyalty to group members, since many alliances preclude the parties from allying with firms from competing groups (Gulati, Nohria, Zaheer, 2000). As a result, certain partners are not available, because they are already tied to the focal firm's competitors. Actors have limits to the resources they can devote to the search process for new partners. These resource constraints imply that ties formed with one actor place constraints on ties with others. Therefore, some potential partners are simply excluded in the partner selection phase. This phenomenon of strategic gridlock (Gomes-Casseres, 1996) forces firms to engage in local search for partners within its own strategic block.

Thus, in most alliances, partners are chosen on the basis of prior positive experience, where they rely on their embedded relations and social capital. Hence, the decision with whom to partner is influenced by the network of past partnerships, (Gulati, Gargiulo, 1999) and depends on the embedded relations the firm is already engaged in (Granovetter, 1985; Gulati, 1998). As a result of this repeated alliance formation through local search and

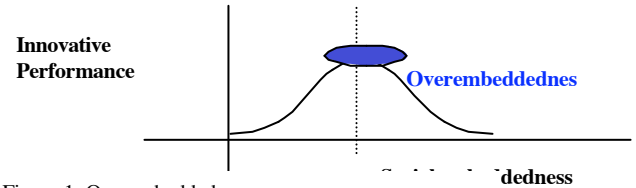

Figure 1. Overembeddedness

frequent interaction, the partners' relationship becomes strong and similar. Similarity facilitates information sharing since the strong relationship constitutes trust. Since there is frequent interaction and high commitment in the relationship, a strong basis of trust and intimacy between the partners (Brass et al., 1998; Granovetter, 1973a) is created. This is also referred to as the "familiarity breeds trust" phenomenon (Gulati, 1995). Similarity can be a stimulus for interaction, or can be the cause of attraction. Scholars often refer to "similarity

breeds attraction" (Brass et al., 1998) which increases the firms' tendency to replicate their existing ties. In terms of learning we expect that, over time, overembeddedness and similarity lead to decreasing opportunities for learning and innovation, see Figure 1. Thus,

Proposition 2: There is a curvilinear (inversed-U shaped) relationship between cohesive group membership and innovative performance.

5. Technology life cycles and strategic block formation

In contrast to the general conception of new life cycles born out of market needs (Sherwin and Isenson, 1967; Utterback, 1974) high technology industries are typical examples of markets created by radical technological innovations (Mueller and Tilton, 1969; Tushman and Anderson, 1986). At these early stages, there is often substantial uncertainty about the technological feasibility of an innovation and its potential market size.

Ultimately, those technologies which are most successful in both technological terms and in meeting customer demands will accumulate a critical mass and may set a technological regime and basic design. The emergence of a basic design leads to a substitution of radical technological development by more focused incremental cumulative improvements along a specific technological path or trajectory (Duysters, 1995). Incremental technological improvements are structure reinforcing since they enhance and extend the underlying sustaining technology, and thus reinforce the existing status quo (Bower, Christensen, Clayton, 1995) and bases of competition. Such technologies are also accumulative and competence enhancing (Tushman, Anderson, 1986) and support the way the industry is functioning.

The establishment of a technological regime does not only lower technological uncertainty. Due to the adaptation of the basic design as the market standard uncertainty is also considerably reduced. From that point onward, cumulative improvements in technology are becoming more important than radical innovation. Since the industry is characterized by accumulative technological improvements, which are structure reinforcing, incremental innovation occurs through the interaction of many firms (Tushman, Anderson, 1986). This might lead to a situation in which cohesive sub-groups thrive whereas firms that are particularly effective in bridging structural holes (Burt, 1992) are less effective. Under these conditions, when innovation depends on a series of interdependent innovations, independent companies will have a hard time coordinating and knitting these innovations together (Chesbrough, Teece, 1996). Hence, we expect firms to integrate these innovations by engaging in strategic block formation. Through strategic block formation, the firms within the blocks can enhance and extend the underlying sustaining technology (Bower, Christensen, Clayton, 1995). In this way block members exploit their existing capabilities by linking up with firms in their own technology cluster to improve their innovative performance. Hence:

Proposition 3: In a situation of structure reinforcing cumulative technological change, cohesive sub-group members are more innovative than their non-group counterparts.

After a period of technological progress and considerable market growth, most industries undergo a phase of more moderate technological and market development. Saturation of demand is leveling sales growth towards zero, whereas technological progress seems to approach its natural limits. Faced with problems of advancing current technologies, firms need to invest an increasing amount of resources in R&D to make significant new progress. In order to speed up stagnating technological progress, firms should broaden their focus in search for alternative technologies. These search processes may eventually lead to new technological regimes or to the establishment of a new technological paradigm. Substitute technologies may offer better perspectives and may be able to trigger off new technological paths. These radical and disruptive technological innovations often drastically alter the price/performance ratio of high technology products and often act as forces of creative destruction, which threaten incumbent industry leaders and open up opportunities for new firms. Under these structure-loosening conditions it might be sensible for any organization to shift its attention towards the new technological paradigm. This "competence destroying discontinuity" (Tushman and Anderson, 1986) alters the way the industry functions and can radically change the bases of competition in an industry. The shift in regime also reshuffles both the current bases of attractiveness and the existing ties of firms in blocks and may thus result in an out-block orientation in partner selection.

However, because technological change is radical, the impetus for cohesive group members to move into this technology is not very high. Then, the reputation effects within the group are not offset by the potential rewards that can be found in engaging into these new innovations. Furthermore, most cohesive sub-group members are characterized by strong inertial forces, which prevent them from engaging in more innovative relationships. Group think pressures might even lead to situations in which incumbents even tend to increase investments in the old technology rather than to switch to the new technological regime (Foster, 1986). The inability of these cohesive sub-group members to explore new technologies paves the way for non-cohesive subgroup firms to take advantage of the new technologies. Non-cohesive group members however may have created a radar function of alliances in order to scan the most promising technologies. They can expect high rewards for bringing a technological dominant product to the market. Thus,

Proposition 4. Under conditions of structure-loosening disruptive technological change, non-subgroup members have a higher innovation rate than their cohesive sub-group counterparts.

6. Concluding remarks

So far we have seen that a firm's innovative performance is contingent on *both* its position in various network settings, i.e. block-membership or non-block membership and is shaped by the nature of technological change and innovation, that is cumulative and incremental vs. disruptive and radical.

As we have described in our first hypothesis we expect that block-members are more innovative than non-members. However, as firms become overembedded, we expect in hypothesis 2 that block-members become less innovative. In a situation of cumulative change, as stated in hypothesis 3, cohesive group-members are more innovative than non-block members. In this case the state of overembeddedness will be reached at a later point in time, because innovativeness is just supported by the virtues of closure and block membership. Then, through the strong ties, that represent trustworthy and reciprocal relationships, firms involved take advantage of the network externalities in their block. This makes them more productive in their joint innovative efforts, since these solid relationships are a means to transfer tacit knowledge in an exploitative learning environment. This state of overembeddness will be reached earlier in case of structure-loosening events, because they demand investments in new technologies instead of investing in the former technological regime. Therefore, we state in hypothesis 4 that under conditions of frequent and radical technological change, firms that are not restricted by block membership might be more effective in exploiting new technologies. Then these firms have the opportunity to link up with firms that have the most innovative technologies, without having to fear reputation effects that block-members have to face.

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