The Gloomy Side of Embeddedness:

The Effects of Overembeddedness on Inter-firm Partnership Formation

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Abstract

We discuss the 'gloomy' side of firms' embeddedness in networks of inter-firm partnerships. We propose a nested understanding of the effects of three levels of overembeddedness—environmental, inter-organizational and dyadic overembeddedness—on subsequent inter-firm partnership formation and argue for a joint examination of these three levels and their interactions over time. As a whole, increases in firms' embeddedness will generate decreasing returns to the firms involved, prompting (i) the search for and attachment to novel partners and (ii) the dissolution of extant partnerships. On the flipside, overembeddedness thus sparks network evolution—by cueing firms to look beyond their embedded partnerships. (100 words)

INTRODUCTION

The past few decades have witnessed an unprecedented growth in the formation of inter-firm partnerships in a wide variety of fields (Hagedoorn 2002; Powell and Grodal 2005). Increasingly, scholars have come to view the formation of such inter-firm partnerships as socially embedded events (e.g., Gulati 1999; Hagedoorn 2006; Walker *et al* 1997). That is, the literature increasingly shows appreciation of existing social structures that surround potential partner firms, and the history of prior ties between them, which has significantly furthered our understanding of inter-firm partnership formation. For example, Gulati (1995a) demonstrates that past partnerships between two firms cue the formation of subsequent ones, Garcia-Pont and Nohria (2002) find that the density of ties in the group of firms surrounding two potential partners affects the likelihood of tie formation between them, and Hagedoorn (1993) shows that firms' sectoral embeddedness significantly influences their propensity to engage in new partnerships. The key message of contributions like these is that inter-firm partnership formation does not find place in isolation, but rather does so in an embedded manner (Granovetter 1985; Gulati and Gargiulo 1999).

Many contributions demonstrate that social embeddedness positively affects inter-firm partnership formation because it provides firms with e.g. information on available partners, their capabilities, and credibility. However, a small number of contributions also suggest that the effect of embeddedness on new partnership formation is not necessarily positive. Under conditions of increasing social embeddedness, firms could face decreasing opportunities for the formation of valuable new partnerships with others embedded in the same partnership network (e.g., Burt 1992; Duysters *et al* 2003; Hagedoorn *et al* 2007; Uzzi 1997). In other words, there may be a 'gloomy' side to firms' embeddedness in their partnership network due to the over-entrenched nature of well-embedded inter-firm ties. In this chapter, we propose that this over-entrenchment

cues firms to establish partnerships with un-embedded others, and gradually dissolve those with extant ones. Together, these spark a network's evolution.

We explore the gloomy side of embeddedness by distinguishing several distinct yet interrelated levels of overembeddedness and their separate and joint effects on inter-firm partnership formation. In so doing, we follow up on extant work by e.g. Dacin *et al* (1999), Gnyawali and Madhavan (2001), Hagedoorn (2006) and Simsek *et al* (2003), who each propose interactive, multi-level conceptions of embeddedness that might provide us with a more in-depth understanding of the relationship between social embeddedness and inter-firm partnership formation. We illustrate that we can further our understanding of inter-firm partnership formation and, more specifically, firms' choice of partners, through a multi-level, longitudinal analysis of the increasing embeddedness and eventual overembeddedness of firms in their networks of external partnerships.

Our contribution is broadly twofold. First, we contribute a number of explanations of changes in the patterns of inter-firm network ties that stress their highly endogenous nature (cf. Gulati and Gargiulo 1999; Madhavan *et al* 2008). In a large number of settings, network patterns are path-dependent. We show how an understanding of the mechanisms that underpin such path-dependencies is important for explaining the dissolution of extant ties and the formation of novel ones. Second, we argue that the effects of embeddedness on a network's evolution are complex because of their multi-level nature. One cannot study the effects at one level without properly accounting for variance at, and interactions with and between, other levels. Thinking about the evolution of networks in a multi-level fashion brings to the fore the complex dynamics at and between the individual embeddedness levels (cf. Hagedoorn 2006).

In this chapter, we proceed as follows. First, we present an outline of our understanding of several levels of social embeddedness, the interactions between these different levels, and their

individual and combined effects on inter-firm partnership formation. Second, we subsequently discuss individual levels of overembeddedness, their possible effects on future inter-firm partnership formation, and the consequences of the interaction effects between different levels of overembeddedness. Lastly, we formulate some propositions that serve to guide theoretical and empirical development.

Although this chapter is conceptual and theoretical in nature, we provide illustrative evidence to exemplify our main line of reasoning. In particular, we present illustrations of the effects of overembeddedness in the context of R&D partnership networks in the information technology industry during the 1990s. Our specific focus is on IBM, one of the major players in the industry. We took the information for these examples from the MERIT-CATI database on cooperative R&D agreements (see Hagedoorn 2002).

EMBEDDEDNESS AND INTER-FIRM PARTNERSHIP FORMATION

A vast body of previous work has introduced a differentiation of several levels of social embeddedness that affect the formation of relatively new forms of economic organization such as inter-firm partnerships (Dacin *et al* 1999; Granovetter 1992; Gulati and Gargiulo 1999; Hagedoorn 2006; Hite 2003; Lam 1997; Simsek *et al* 2003; Uzzi 1997). Most of the extant work has, in broad terms, distinguished between structural embeddedness and relational embeddedness (Gulati 1998). Structural embeddedness refers to the broader environmental setting of the social relationships in which economic organizations find themselves. Relational embeddedness refers to the specific dyadic relationships in pairs of related economic organizations.

In line with Hagedoorn (2006), we take this differentiation one step further by making a distinction into three separate levels of embeddedness of economic organizations, i.e. their environmental embeddedness, their inter-organizational embeddedness and their dyadic

embeddedness. One of the main advantages of such a differentiated understanding of the concept of embeddedness is that it allows for empirical tests that peal apart the micro-, meso-, and macro-level dimensions of embeddedness. Our particular differentiation of embeddedness resonates the recommendations by, among others, Dacin *et al* (1999), Gnyawali and Madhavan (2001), Gulati and Gargiulo (1999) and Smelser and Swedberg (1994) to further specify the concept of embeddedness in such a way that it can be applied in a specific and empirically relevant context.

Environmental Embeddedness and Inter-firm Partnership Formation

At the most wide-ranging level of social embeddedness that affects inter-firm partnership formation, i.e. environmental embeddedness, we think of the sectoral, industry-specific propensity to build inter-firm partnerships.[1] The larger the environmental embeddedness, the more firms are tied together beyond their immediate circle of partnerships into an overarching industry network.

A considerable body of work has established that sectors of industry differ widely with respect to the degree to which firms engage in partnerships (Contractor and Lorange 2002; Hagedoorn 2002; Oster 1999; Yu and Tang 1992). In general, firms in high-tech industries engage in partnerships more frequently than those in medium- and low-tech industries. This has led to a lop-sided distribution of inter-firm partnerships across industries. Powell and DiMaggio (1983) explain that it is through a process of informed imitation, or 'mimetic isomorphism', that firms cope with uncertainty and ambiguity. By modeling their actions on successful others, firms

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[1] We define inter-firm partnerships as all forms of cooperation between firms that share knowledge and resources through formal agreements that can be governed through either equity-based joint ventures or a range of non-equity, contractual agreements.

avoid unnecessary investments in searching for and weighing the alternative avenues to economic success. Abrahamson and Rosenkopf (1993) also argue that such modeling, or the existence of so-called bandwagons, can occur in a vast array of situations in which ambiguity with respect to economic returns is the common denominator. Moreover, in such ambiguous and uncertain environments, inter-firm partnerships may serve to obtain legitimacy in the market (Dacin *et al* 2007). This may be one of the possible explanations for the omnipresence of inter-firm partnerships in high-tech industries, which are typically characterized by higher levels of uncertainty, ambiguity and change than medium- and low-tech industries.

As an example, in the beginning of the eighties the call for compatibility between different parts of information systems prompted many incumbents to join their efforts in co-owned ventures (Harrigan 1985). The consecutive examples set by firms like IBM and Hitachi in terms of engaging in these inter-firm partnerships were soon amplified at the industry level (see e.g., Hagedoorn 2002). Gulati (1995a) found results that are consistent with this line of reasoning as he determined that, in three different industries, aggregate alliance formation at the industry level significantly influenced dyadic alliance formation between 1980 and 1989.

The existing partnership distribution for industries does not necessarily imply that the sectoral opportunity to engage in partnerships is given and stable over time. The research mentioned in the above merely indicates that in many high-tech industries and dynamic sectors inter-firm partnerships currently are a more familiar phenomenon than in other industries. Such familiarity is relevant as it indicates the degree to which firms find themselves in larger industrial settings where many other firms are also engaged in inter-firm partnerships.

Inter-organizational Embeddedness and Inter-firm Partnership Formation

The inter-organizational embeddedness of inter-firm partnerships is the next level of embeddedness where inter-firm networks are created by groups of firms or strategic blocks. These groups or strategic blocks refer to "...a set of firms that are connected more densely to each other than to other firms in the industry…" (Nohria and Garcia-Pont 1991: 106). Early work by Harrigan (1985) already indicated the relevance of understanding the role of these groups, which she described as constellations of interacting firms (see also Gomes-Casseres 1996; Granovetter 1994). In such groups, firms are tied together by a network of relatively strong ties where firms maintain and replicate multiple ties within their group (Gimeno 2004; Nohria and Garcia-Pont 1991; Vanhaverbeke and Noorderhaven 2001). This understanding of embeddedness in terms of groups relates to the concept of small worlds where inter-firm networks are clique-like settings of firms. The density and tie strength within these groups is typically high, whereas the strength of ties connecting different groups remains low (Schilling and Phelps 2007; Watts 1999).

Most studies on groups of firms largely echo the seminal contribution by Coleman (1988), which argues that being part of a dense group of network actors is advantageous since it fosters trust development and cooperation among group members. The dense structure gives rise to obligations and sanctioning behavior conducive to the functioning of the group. In addition, it contributes to increased exchange efficiencies among group members (Soda *et al* 2008). The inter-organizational embeddedness of inter-firm partnerships leads to a form of generalized exchange, which we understand to represent an intricate web of dependencies and informational spillovers that reaches beyond mere dyadic reciprocity (Levine and Kurzban 2006; Takahashi 2000).

Research by, among others, Anand and Khanna (2000), Dyer and Singh (1998), and Gulati (1998) indeed indicates that both the familiarity of firms with partnering and their interactions within groups of relatively densely connected firms increase the likelihood that firms

will engage in new partnerships. Both firms' familiarity and their interactions establish embeddedness mechanisms that prompt the endogenous evolution of inter-organizational network ties (cf. Gulati and Gargiulo 1999). More generally, based on insights from social network theory, we note that firms that become well-embedded in these networks accumulate informational advantages that increase their propensity to engage in new partnerships (Freeman 1979; Gulati 1999; Wasserman and Faust 1994).

Dyadic Embeddedness and Inter-firm Partnership Formation

At the third level of embeddedness we find dyadic embeddedness, which can be understood in the context of repeated ties within pairs of firms (Gulati 1995b; Gulati and Gargiulo 1999). Dyer and Singh (1998) and Gulati (1995a) explain that firms will most probably enter into partnerships with firms with which they have collaborated before. This repeated tie effect likely creates strong cohesive ties between firms through frequent interactions. These strong ties are solid and reciprocal relationships that create a basis for trust and closeness between partners. Trust and closeness are believed to lead to dyadic reciprocation over time, which entails the "...extension of benefits to transacting partners…" and vice versa "…when a new situation arises…" (Uzzi 1996b: 678). Unlike the abovementioned generalized exchange inherent in inter-organizational embeddedness, the notion of dyadic embeddedness thus entails a more restricted form of exchange in which the two actors in a tie reciprocate to each other only (Takahashi 2000; Uzzi 1996b).

Apart from the repeated nature of partnerships, dyadic embeddedness also refers to the simultaneous operation of multiple partnerships between two parties, or a combination of elements comprising, what Gimeno and Woo (1996) label 'economic multiplexity' (for a discussion of the evolution of dyadic ties, see Hite 2008). In a partnership that is multiplex,

several partnerships in a dyad may exist that serve to regulate symbiotic, competitive, and commensalistic interdependencies (Pfeffer and Nowak 1976). Evolving routines in e.g. the commensalistic 'dimension' of a multiplex partnership may aid in straightening out possible complications in e.g. the competitive dimension. As such, multiplexity adds to the dyadic reciprocation over time by enabling the contemporaneous conservation and continuation of simultaneous ties.

Possible reasons for a sustained preference for repeated or simultaneous dyadic partnerships are, among others, the costly and time-consuming nature of both the search for trustworthy and valuable partners and the final selection process of those partners. In addition, changing partners increases the risk that other relationships with existing partners will be dissolved. As relational trust becomes embedded in repeated ties between firms, it positively affects the prolongation and stability of their relationship (Gulati 1995b; Nooteboom *et al* 1997). Zollo *et al* (2002) argue that the development of inter-organizational routines is both an antecedent to and consequence of the occurrence of dyadic embeddedness: routines develop through repeated interactions with the same partner and serve to smoothen the interactions in subsequent partnerships. Hence, such routines serve as an endogenous partnership development mechanism. Consequently, firms prefer to engage in local search and replicate their existing ties rather than search for novel ones.

Interactions among Levels of Embeddedness

Recent contributions (Dacin *et al* 1999; Dansereau *et al* 1999; Hagedoorn 2006; Hite 2003) stress that individual levels of embeddedness are indeed important for understanding the effect of social embeddedness on inter-firm partnering. However, we can gain a more intricate understanding of the complex nature of this relationship in the analysis of the nested interaction

of multiple levels of embeddedness (Dacin *et al* 1999; Gnyawali and Madhavan 2001). The core argument for such a nested perspective is that the combined environmental, inter-organizational and dyadic embeddedness of partnering firms exercise a multiplicative, interacting effect on future joint partnering (Hagedoorn 2006). This implies that patterns of sectoral inter-firm partnership formation, as well as the specifics of groups of partnering firms and the history of pairs of firms, jointly affect future partnership formation.

Inter-firm partnership formation is rooted in the dyadic embeddedness between partnering firms, which itself is affected by inter-organizational embeddedness in terms of the broader experience of firms with partnering and their surrounding networks. This combination of different levels of embeddedness is overarched and reinforced further by an environmental embeddedness that is characterized by a set of industry-based forces that additionally shape the nature of firms' partnering activities (Hagedoorn 2006). However, these effects should be seen in a dialectic context, where it is not only the effect of the higher levels of embeddedness on embeddedness at lower levels, the process also works in the opposite direction. The more firms engage in repeated ties, increasing dyadic embeddedness, the more this affects inter-organizational embeddedness as the density of in-group ties between firms increases (Hite, 2008). This, in turn, has an effect on the environmental embeddedness of inter-firm partnerships, as partnership formation in an industry increases.

OVEREMBEDDEDNESS AND INTER-FIRM PARTNERSHIP FORMATION

Many contributions—whether considering individual-level embeddedness effects or the interaction of multiple levels—stress the positive effects of social embeddedness on partnership formation. Note that this is exactly what we have done to this point. At some point in time, however, increased partnership formation might create overembeddedness (Uzzi 1997) in which

case firms face fewer opportunities for entering into valuable new partnerships. As explained by e.g. Burt (1992) and Gargiulo and Benassi (2000), a concrete effect of overembeddedness would eventually be the declining propensity of network players to form, what could be considered as, redundant partnerships. An over-dependence on a particular group of partners and diminishing information gains through additional partnerships within the same group of firms are known to play a role in this overembeddedness effect (Chung *et al* 2000; Duysters *et al* 2003; Gulati 1995b; Saxton 1997; Uzzi 1996b). This effect is most apparent at the level of pairs of firms, i.e. the level of dyadic embeddedness (Chung *et al* 2000; Gulati 1995b), but depending on the number of (potential) partners in networks and industries, the effect of overembeddedness can take place at each level of embeddedness.

Our understanding of overembeddedness is that, up to a certain threshold, the embeddedness of inter-firm partnerships parallels a growth of new partnerships that generates useful new information (see Figure 1). Beyond a certain point, where social embeddedness reaches its maximum in terms of valuable new partnerships—the grey area in Figure 1—there is an increasing decline of new information gains (Hagedoorn *et al* 2007). Additional partnerships then lead to decreasing marginal returns to the firms involved. Consequently, the potential for useful new partnerships with existing partners, within existing groups of interconnected firms, and within the industry declines (Duysters *et al* 2003; Kenis and Knoke 2002; Uzzi 1996b, 1997). In short, the three embeddedness mechanisms introduced in the above gradually alter the opportunity structure faced by the firms in the partnership network. Here, we propose that a direct consequence of this process is the shift in a firm's partner choice (cf. Hagedoorn *et al* 2007), which will coincide with the dissolution of overembedded partnerships.

[FIGURE 1 ABOUT HERE]

As continued local cooperation with existing partners, within existing groups of interconnected firms, and within the industry's web of partnerships, becomes less fruitful, firms will increasingly detach from such existing, 'local' partners and select 'nonlocal' ones, i.e. those in different groups and/or industries. The process of embedding thus eventually leads to overembeddedness, which sparks the dissolution of extant ties and the concurrent formation of novel ones. This cues a new cycle of embedding, overembeddedness, dissolution of extant ties, and the simultaneous search for and formation of novel ones.

That the search for novel partners most likely coincides with a decline in the number of extant, embedded partnerships has several reasons, three of which we mention here. First, a firm's capacity to maintain external partnerships is limited. Therefore, investing time and effort in certain partnerships necessarily bounds investments in others.[2] Assuming that firms ultimately prefer to enter the most productive partnerships, they thus face the trade-off of maintaining less productive partnerships versus engaging in more productive others. Second, closely related to the previous reason, unlike many interpersonal relationships, inter-firm partnerships ultimately serve economic purposes to the firms involved. Although these economic purposes need not be reflected in immediate or direct returns—e.g., status consequences of affiliation with certain (groups of) firms may take time to surface—it is fair to assume that trust and shared norms are of little use in the absence of (longer-term) economic benefits. Third, the endogenous mechanisms driving firms' embeddedness in their partnership networks cause local informational, cognitive

[2] This does not necessarily mean that a firm's capacity to manage partnerships is constant over time. It may increase as cooperative experience feeds into its ability to evaluate and absorb external information, see e.g. Gulati (1999), Powell *et al* (1996), and Powell and Grodal (2005).

and normative convergence within such networks (cf. Baum and Ingram, 2002). The flow of novel information and the concurrent emergence of new mental images of the cooperative landscape that result from a firm's involvement with nonlocal firms are, more likely than not, in dispute with extant local representations of this landscape.

Dyadic Overembeddedness and Inter-firm Partnership Formation

At the level of possible dyadic overembeddedness, empirical work by e.g. Gulati (1995a) and Rosenkopf *et al* (2001) indicates an inverted U-shaped, curvilinear, relationship between the number of previous partnerships between two firms and the likelihood of valuable new partnership formation between them. Fear of over-dependence on specific partners, declining useful information exchanges and decreasing opportunities for learning from these partners appear to be main indicators of possible overembeddedness of partnerships and their sponsoring firms.

Continuous partnership formation and the concomitant information exchanges between two firms might eventually create certain similarities between these partners (cf. Gomes-Casseres *et al* 2006; Mowery *et al* 1996). At some point in time, this will have a negative effect on the potential value of an ever-increasing partnership formation process between the firms (Mowery *et al* 1996; Saxton 1997; Uzzi 1996b). Consequently, in terms of the aforementioned possibly multiplex nature of dyadic embeddedness, firms may at a certain point in time decide to 'de-multiplexify' their simultaneous partnerships in a dyad as to maintain a certain degree of flexibility for future tie formation (Uzzi 1996a). Although multiplexity adds to appropriate governance of interdependencies between firms, it may also saturate the dyad and lead to the loss of its momentum.

Rosenkopf *et al* (2001) provide a detailed understanding of the dyadic embeddedness of

partnership formation by relating both joint technical committee activity and previous dyadic partnerships to new partnership formation between two firms. Their data show that both joint technical committee activity and previous dyadic alliances individually have an inverted U-shaped relationship to new partnership formation. Moreover, the interaction of these two phenomena also negatively influences dyad formation—suggesting that, beyond a certain threshold, the interplay between various elements of dyadic embeddedness apparently leads to over-entrenchment of the dyad, decreasing informational returns, and to consecutive decreases in the formation of valuable new partnerships. A direct consequence, we believe, will be that the firms involved start searching for novel partners and gradually dissolve extant patnerships.

The formation of partnerships by IBM in the information technology industry provides an interesting illustration of this potential dyadic overembeddedness effect. Figures 2 and 3 present IBM's ego network based on newly formed R&D partnerships for the periods 1990-94 and 1995-99, respectively.[3] Dotted lines represent 1 - 3 R&D partnerships between firms, whereas solid lines indicate 4 - 9 partnerships and thick lines represent 10 or more R&D partnerships. One of the main observations in these network plots is that during the first half of the 1990s, IBM appeared to be well embedded in close-knit R&D cooperation through a series of multiple dyadic alliances with four firms: Apple, Siemens, Toshiba and Hewlett-Packard (see Figure 2).

Most illustrative is the case of the IBM-Apple collaboration. The two created eight R&D

[3] The network plots result from a two-step procedure. First, all firms' MDS coordinates are generated in a two-dimensional space, based on R&D partnering data from the MERIT-CATI database. Second, we use the network visualization software tool Najojo (see the Appendix) to add firm labels to the nodes and connect the nodes based on the number of partnerships among the firms in IBM's ego network.

partnerships in 1991, followed by five partnerships in 1993. In the following three years, IBM and Apple annually introduced a small number of two or three partnerships but the opportunities for further collaboration at such an extensive scale appear to have diminished during the second half of the 1990s, when most partnerships were terminated and no new R&D partnerships were established (see also Hagedoorn *et al* 2001). The R&D partnerships formed by IBM and Siemens, IBM and Toshiba, and IBM and Hewlett-Packard portray a somewhat similar pattern. In a short period during the first half of the 1990s, IBM created seventeen R&D partnerships with Apple, ten with Siemens, nine with Toshiba, and seven with Hewlett-Packard.

[FIGURES 2 AND 3 ABOUT HERE]

During the second half of the 1990s, most of the existing R&D partnerships were only continued for some time but R&D collaboration was not extended at the same level and with the same degree of intensity (see Figure 3). IBM started extensive collaborative efforts on joint R&D with a different set of firms with which it had no or only few prior R&D partnerships. During that period, IBM established multiple R&D partnerships with AT&T, Intel, Motorola, Netscape, Novell, Oracle, and Sun-Microsystems. Apparently, opportunities for further R&D cooperation with individual firms from the first local group of partners—in which IBM was well-embedded through multiple dyadic ties—had dried up in a relatively short period of time and other firms became attractive partners for R&D collaboration.

Inter-organizational Overembeddedness and Inter-firm Partnership Formation

At the level of inter-organizational embeddedness, the phenomenon of overembeddedness occurs in networks of partnering firms when they become locked-in within densely connected

sub-networks (groups, cliques or blocks). In such case, groups of well-connected firms become isolated from others in the broader network of (potential) partners. Some contributions show the nonlinear, or inverted U-shaped, effects of inter-organizational embeddedness on various performance outcomes at the firm level. For example, Uzzi (1996b) found that high levels of inter-organizational embeddedness through 'embedded ties' result in significantly higher organizational failure rates.

As suggested by e.g. Duysters *et al* (2003), Gargiulo and Benassi (2000) and Gomes-Casseres (1996), inter-organizational overembeddedness leads to excessively cohesive networks that concentrate on inter-firm partnerships within existing groups of partners. Information about potential partners outside the existing sub-networks does not reach the participants, and the group of partners becomes inflexible and inert, while the number of valuable new partnerships declines over time.

For example, Garcia-Pont and Nohria (2002) show, in the global automobile industry, that initially inter-organizational embeddedness positively influences new partnership formation but that it is beyond a certain intra-group density threshold that the probability for new tie formation decreases significantly. Firms may even implicitly experience social pressures from their partners to replicate their ties within their own network, e.g. to prevent knowledge spillover effects outside their existing network. This is somewhat akin to Portes and Sensenbrenner (1993: 1340) who mention "… the constraints that community norms put on individual action and receptivity to outside culture …". Thus, an implicit expectation of loyalty to other network members can prevent firms from allying with firms from competing groups (Gulati *et al* 2000) as this might result in conflicting interests among partners (Nohria and Garcia-Pont 1991). Hence, certain potential outside partners are not part of a firm's choice set when they have ties to competing groups. In this way, competing partnership groups can foreclose further partnering opportunities

with non-group members (Gimeno 2004; Gomes-Casseres 1996). As a consequence, potentially interesting outside partners are simply excluded from partner selection and, based on their initial choices, firms can become locked-in within their own group of partners (Kim *et al* 2006).

Gargiulo and Benassi (2000) and Uzzi (1997) point at the danger of being cognitively locked-in when the rigidity among group members will increase the likelihood that they are isolated from firms outside of their own network. The group of partners functions as a filter that selects the information and new perspectives for its members. In the end, an inter-organizationally over-embedded group of partners consists mainly of exclusively connected, strongly embedded inter-firm ties (Uzzi 1997) where firms face a strategic gridlock (Gomes-Casseres 1996) as they only engage in local search for partners within their own network of partnerships.

The understanding of the sub-optimal cohesiveness in strategic groups within particular industries (where strategic groups are defined as collectives of interacting firms) also reflects the notion of inter-organizational overembeddedness. As Thomas and Carroll (1994) explain, stable and dense networks of firms can be seen as robust building blocks of strategic groups. However, once these dense networks within strategic groups become insensitive to external signals of potentially valuable change, their robustness and stability become sub-optimal. Also, the level of inertia frustrates further economic growth within these strategic groups. Thus, after a certain threshold level of inter-organizational embeddedness has been reached, the likelihood that social structural mechanisms supersede rationality with respect to external initiatives—such as inter-firm partnership formation—will steadily amplify and, consequently, hinder effective economic action (cf. Gulati and Westphal 1999; Uzzi 1997: 59).

Firms' cognitive lock-in and the decreasing marginal informational and substantial returns they experience will influence their performance and partnering behaviors. We expect that firms

who become cognitively locked-in within a group of partners will only endure the negative informational consequences of such lock-in up to a certain threshold. Although research documents that firms allow such overembedded alliances to persist (Inkpen and Ross 2001), their negative performance impact will at some point in time cue the search for novel, nonlocal partners (see e.g., Baum *et al* 2005), even despite group-level pressures to replicate local ties. Even absent such dramatic negative performance effects, firms may start to look for nonlocal contacts as to avoid the overdependence on key local players in case such players malfunction themselves (cf. Uzzi 1997).

The network in the information technology industry from the 1990s, in which IBM was well placed, represents an interesting example of inter-organizational overembeddedness. During the first half of the 1990s, the core of the wider inter-firm network in which IBM participated consisted of multiple partnerships between Apple, Hewlett-Packard, IBM itself, Siemens, and Toshiba. This created a dense multi-dyadic network of computer hardware manufacturers with a variety of interests in other sub-sectors of information technology. IBM became well embedded in a network of R&D partnerships of firms with similar research objectives that were all well connected to each other. However, this group of firms, with IBM as a major player, appeared to have become over-embedded. During the early years of the 1990s, the firms mentioned in the above created a densely populated clique of cooperating firms that quickly dismantled during the second half of the 1990s. During that period, a new inter-organizational network gradually emerged through a variety of new R&D partnerships within another group of firms. IBM also became part of this new network and so did many other computer hardware firms. Because of these changes in the mid-1990s, IBM became embedded in a new network of multiple R&D partnerships with other players such as AT&T, Intel, Motorola, Netscape, Novell, Oracle, and Sun-Microsystems.

As a further illustration, Figure 4 shows the number of newly established R&D partnerships with firms from both the original as well as the new group of partners. Whereas during the first half of the 1990s IBM created 43 partnerships with Apple, Hewlett-Packard, Siemens, and Toshiba, it only formed 24 with these firms between 1995 and 1999. In contrast, the partners that obtained prevalence in IBM's partnership portfolio during the second half of the 1990s—through the formation of 40 new partnerships—participated in only 12 partnerships with IBM between 1990 and 1994. IBM's group of most important allies (in terms of numbers of partnerships) thus changed drastically, especially considering the fact that our data indicate that the biggest changes actually occurred only after 1996.

[FIGURE 4 ABOUT HERE]

Environmental Overembeddedness and Inter-firm Partnership Formation

Obviously, given the relatively large number of potential partnerships at the level of environmental embeddedness, we expect that the potential degree of overembeddedness at the level of industries is limited. Nevertheless, some research indicates that the finite possibility of increasing partnership formation at this level is not just a theoretical notion. For instance, a study of partnership formation in the electronics industry by Park and Ungson (1997) demonstrates that, given the degree of partnership formation in that industry, inter-sectoral partnerships with firms from other industries appear to have a higher likelihood of continuation than intra-sectoral partnerships that focus on firms from the electronics sector per se.

The tendency to 'cavalierly' use inter-firm partnerships in the belief that they are the key to success in particular industries (Inkpen and Ross 2001) may lead to saturation and decreasing numbers of newly-established inter-firm partnerships. Partnerships that, often unconsciously,

result from herd behavior in some way lack an inherent 'raison d'être' in terms of their substantial and relational aspects. This may lead firms to be increasingly dissatisfied with given partnerships as firms are unconscious of the discrepancy between, on the one hand, the exact environmental forces that drove them to engage in certain partnerships in the first place and, on the other hand, their (misplaced) expectations given these forces.[4] Ceteris paribus, we expect that the dissatisfaction with intra-industry partnerships will lead to shifts in the firm-level pattern of intra- versus inter-industry partnership formation.

Relatedly, increasing numbers of ties across groups of densely connected firms will lead to decreases in the requisite differentiation among (groups of) firms that is foundational to the achievement of competitive advantages (Baum and Ingram 2002; Schilling and Phelps 2007). Driven by increased numbers of industry-wide connections among firms, the increased convergence of the knowledge base underlying an industry's main activities likely drives out the variety necessary for firms to progress and differentiate themselves from others.

The inter-firm R&D partnerships in the information technology industry illustrate the possible effect of environmental overembeddedness on changes in the network. During the early 1990s the emphasis in the inter-firm network in information technology in general, and for IBM in particular, was on R&D partnerships in computer hardware and related activities such as computer-based telecommunication systems and supporting software. Given the limited number of firms that were active in these particular activities and given their focus on somewhat similar interests, many of them started to establish R&D partnerships in other information technology fields and in sectors outside information technology. These new inter-sectoral R&D partnerships

[4] We note, however, that the performance consequences of imitation are likely contingent on the specific nature of the cooperative environment, see e.g. Soda *et al* (2008).

concentrated on related fields such as microelectronics, software, various internet-related products and services, and a host of multimedia technologies.

Some additional data on the R&D partnerships of IBM illustrate the ramifications of environmental overembeddedness for IBM's ego network. Although IBM's ego network does not present the industry's whole partnership network, it reflects very clearly the trend that can be observed in the industry at large (see also Cloodt *et al* 2006, 2007). Between 1990 and 1999, IBM alone established new R&D ties with 163 different firms. During the period 1990-1994, it tied to 95 firms. Of the 93 firms it tied up with between 1995 and 1999, it had only set up R&D partnerships with 25 during the previous period 1990-1994. What this shows is that of IBM's entire R&D partnership portfolio during 1990-1999, only 15% of the firms served as R&D partner in both 1990-1994 as well as in 1995-1999. Most of IBM's newly established ties in the latter half of the 90s were thus of an un-embedded nature (68 out of 93), see also Figures 2 and 3.

Interactions among Levels of Overembeddedness

As indicated by e.g. Hagedoorn (2006) and Uzzi (1997), the nested interaction of different levels of social embeddedness can jointly affect the negative impact of overembeddedness even further than in the case of single level effects of overembeddedness. Figure 5 summarizes our understanding of the effects of the growth in embeddedness and its effect on the firm-level choice of local, embedded partners, versus nonlocal, novel partners. Similar to Hagedoorn's (2006) theoretical understanding of the strengthening, positive, and multiplicative effects across levels of embeddedness in determining rates of inter-firm partnership formation, we also expect such effects at increasing levels of embeddedness. Essentially, such multiplicative effects progress along a continuum, the effects of which we understand to reflect an aggregation of parabolic, inverted U-shaped effects at the individual embeddedness levels as depicted in Figure 1. In other

words, at each of the three levels of embeddedness we described, we expect a parabolic effect to find place. The difference among the progression of these three parabolic effects is the time it takes for the individual curves to evolve, which should aid in the empirical identification of such effects in a longitudinal research design.[5]

[FIGURE 5 ABOUT HERE]

As presented in Figure 5, we expect a positive effect of the growth of embeddedness at each level on the degree of overembeddedness, which will ultimately cause a shift in the nature of newly established partnerships. As indicated before, this shift has two faces, the order and intertwinement of which is to be identified empirically. First, firms will quit forming local partnerships and gradually dissolve extant local partnerships. Second, firms will start engaging in nonlocal partnerships.

The expected curvilinear effect of increasing levels of embeddedness on the growth of valuable newlocal partnerships (see Figure 1) is more pronounced for various combinations, i.e. interactions, of different levels of embeddedness than for individual levels of social embeddedness. Given the expected effects of overembeddedness at different levels, based on theory development and the empirical evidence from previous research, we postulate that at a given point in time the effects of overembeddedness on partnership formation will differ for each of these different levels of embeddedness. Ceteris paribus, dyadic and inter-organizational

[5] Such a design ideally spans several decades; see e.g. Gulati and Gargiulo (1999: 1478) who indicate that their design that spans 10 years was effectively too short to observe parabolic sector-level phenomena of interest. See also Hagedoorn (2002).

embeddedness will see the effects of overembeddedness at an earlier point in time than environmental embeddedness. We also expect differences between dyadic and inter-organizational levels of embeddedness, where the stage of dyadic overembeddedness will be reached earlier than the stage of inter-organizational overembeddedness.

We briefly return to the illustration of the possible effects of overembeddedness for IBM. It is obvious that, after a number years of intense R&D collaboration, the number of options for continued R&D partnering between IBM and Apple had grown limited compared to the potential number of other interesting options in IBM's network that were still open to the firm. In addition, given the somewhat limited scope of the core of the network of R&D partnerships of computer firms in which IBM operated during the first half the 1990s, there were still multiple other opportunities for R&D partnership formation outside its existing network. Hence:

Proposition 1: Growth in the dyadic embeddedness of inter-firm partnerships will have an earlier impact on overembeddedness than the growth in environmental embeddedness and inter-organizational embeddedness will. As such, dyadic embeddedness will lead to (i) decreasing opportunities for valuable new local *partnership formation, and (ii) increasing opportunities for valuable* nonlocal *partnership formation sooner than environmental embeddedness and inter-organizational embeddedness will.*

Along similar lines, the development of groups of connected firms will have an earlier impact on patterns of partnership formation than industry-based forces that develop rather sluggishly over time. Therefore:

Proposition 2: Growth in inter-organizational embeddedness will have an earlier impact on overembeddedness than the growth in environmental embeddedness will. As such, inter-organizational embeddedness will lead to (i) decreasing opportunities for valuable new local *partnership formation, and (ii) increasing opportunities for valuable* nonlocal *partnership formation sooner than environmental embeddedness will.*

In addition to the expected greater impact of the interaction of different levels of embeddedness compared to the effect of individual levels of embeddedness, we also anticipate that the interaction of various levels of social embeddedness will have alternative effects. Following the various expected increasing effects at different levels of embeddedness and the empirical evidence from other studies, we postulate that at a given point in time the effects of the interaction for different levels of embeddedness will have an increasing effect on the overembeddedness of new partnership formation. However, again, there are a larger number of potential partnerships at the level of environmental embeddedness, where the risk of overembeddedness is smaller than at the level of inter-organizational embeddedness and certainly at the level of dyadic embeddedness. This implies that various combinations of interacting levels of social embeddedness of inter-firm partnerships generate differential outcomes as to their aggregate effect on new partnership formation.

In the context of the exemplary setting of IBM and the information technology industry, this implies that the level of overembeddedness of IBM's R&D partnerships with Apple, in combination with IBM's well-embedded network with other computer hardware manufacturers during the first half of the 1990s, was very high and with increasingly limited opportunity for useful future partnership formation. Consequently:

Proposition 3: The interaction of dyadic embeddedness with inter-organizational embeddedness will have (i) a greater negative impact on new local *partnership formation and (ii) a greater positive impact on new* nonlocal *partnership formation than the interaction of environmental embeddedness with the other levels of embeddedness will.*

CONCLUSION

To date, the literature on the relationship between social embeddedness and inter-firm partnerships has typically stressed the positive effects of embeddedness on inter-firm partnership formation. However, increasing numbers of inter-firm partnerships at different levels of social embeddedness can generate negative effects that we characterized as the gloomy side of embeddedness through overembeddedness.

We point at some of the specific multi-level effects of the gloomy side of embeddedness on new partnership formation and the temporal nature of developments of these effects. In particular, we expect that the interaction between dyadic overembeddedness—the redundant relationship between two firms through long-term repeated ties—and inter-organizational overembeddedness—through crowded groups or congested cliques of exclusively cooperating firms—is a major cause of overembeddedness. In the end, the overembeddedness will become evident through the actual redundancy of newly created local inter-firm partnerships, the increased dissolution of such partnerships, and the subsequent formation of—what are to the firm—novel, nonlocal partnerships.

Necessarily, our conception of firms' embeddedness in networks of external partnerships has limitations. Two are conspicuous. First, our model does not specifically identify exogenous

drivers of partnership formation. Our focus on the gloomy side of embeddedness has led us to focus predominantly on endogenous mechanisms that determine the choice of local versus nonlocal partners. We note, however, that firms' specific choice of nonlocal partners will without doubt reflect more exogenous factors, such as e.g. the distribution of technological and financial resources among firms (cf. Ahuja 2000; Baum and Ingram 2002; Gulati and Gargiulo 1999). Second, we cannot pinpoint the exact sequencing of the dissolution of local partnerships on the one hand, and the formation of nonlocal partnerships on the other. At any rate, the empirical identification of how firms sequence these actions, and the mechanisms that underlie this sequencing, poses a formidable research challenge. After all, firms seldom—if at all—make public the dissolution of partnerships with the same aplomb that characterizes the announcement of new partnerships. This thus requires careful quantitative *and* qualitative analyses of networking processes (such as the mixed-methods explanatory design in Madhavan *et al* 2008).

Overall, we hope to have illustrated that building an understanding of the nested, multi-level implications of overembeddedness ultimately necessitates the consideration of complex interactions between those levels over time. Although temporal differences in the impact of levels of embeddedness on inter-firm partnership formation require longitudinal research designs spanning decades, the upshot is that they allow for pealing apart the macro-, meso-, and micro-level drivers of interest. We hope to have encouraged efforts in this direction.

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APPENDIX: NAJOJO

To visualize the ego networks of IBM, we use of our own network visualization software tool Najojo. This tool is capable of visualizing large, dense networks involving more than 500 firms. There are two separate input (text) files underlying the generation of networks in Najojo: one holding the MDS coordinates for each of the individual firms participating in the network and a different one holding all unique firm pairs and their numbers of partnerships.

Based on the first input file, Najojo determines whether it visualizes the particular network in landscape or portrait orientation. As a second step in the visualization process, Najojo divides the landscape in X points and it then maps the firms' coordinates held by the first input file onto those points, visualizing them as dots. While creating this 'scatter' plot, the program makes sure that the relations among dots remain constant and that dots belonging to different firms do not overlap. Next, the program places firm labels with the dots in such a way that they do not overlap with other labels or dots. Najojo variably determines the font size of firm labels depending on network density and the number of firms participating in the network.

Based on the second input file, Najojo then visualizes the total number of partnerships entered into by all unique firm pairs making up the network. The tool first identifies both research partners, i.e. the beginning and ending dots, and subsequently draws polybezier lines between these dots, making sure that these lines do not cross dots belonging to firms that are not part of the partnership. The type and thickness of lines indicate the number of partnerships between firms.

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Figure 1. The relationship between (over)embeddedness and valuable new partnership formation

Figure 2. IBM's ego network based on newly established R&D partnerships in 1990-1994

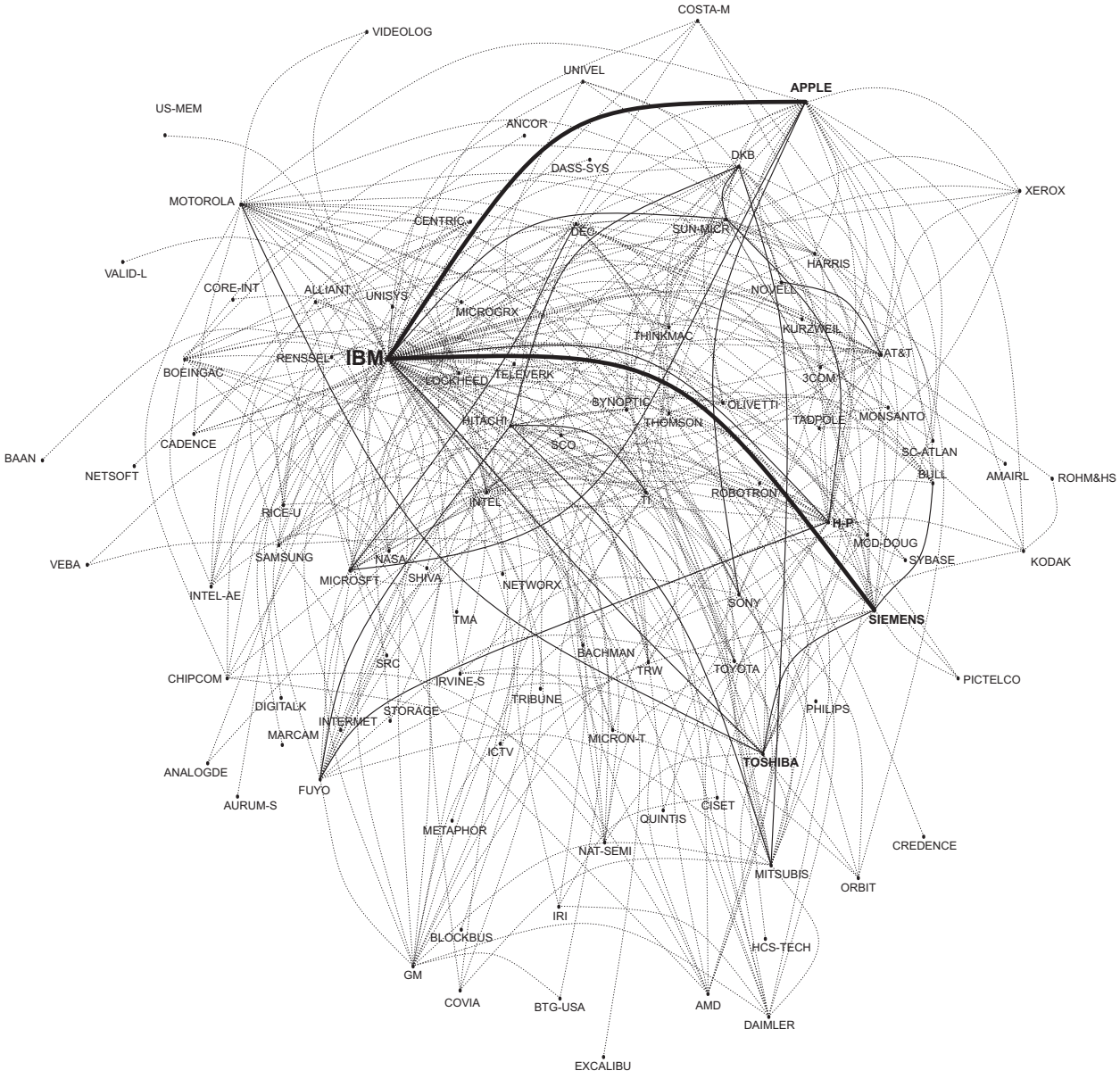


Figure 3. IBM's ego network based on newly established R&D partnerships in 1995-1999

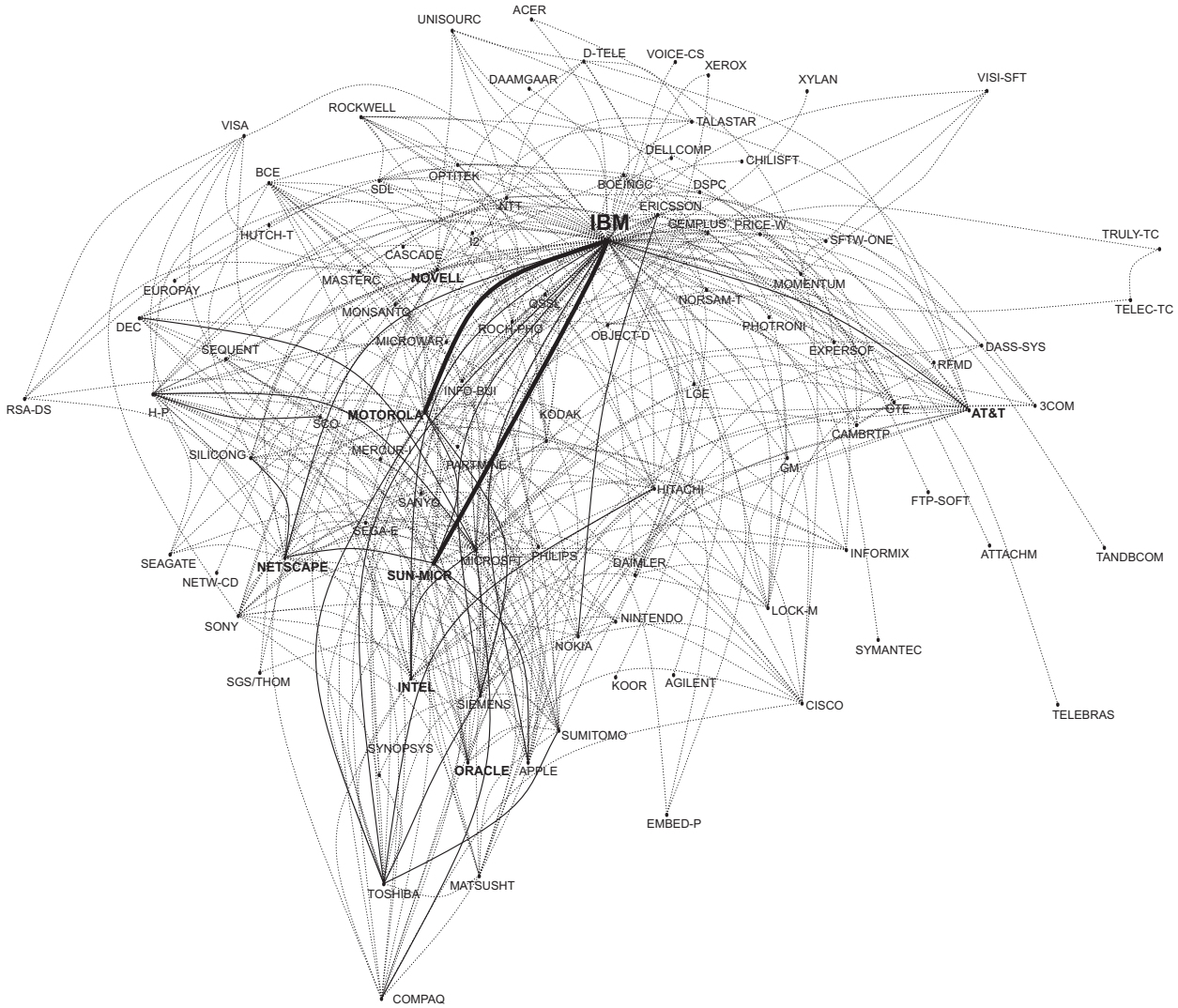
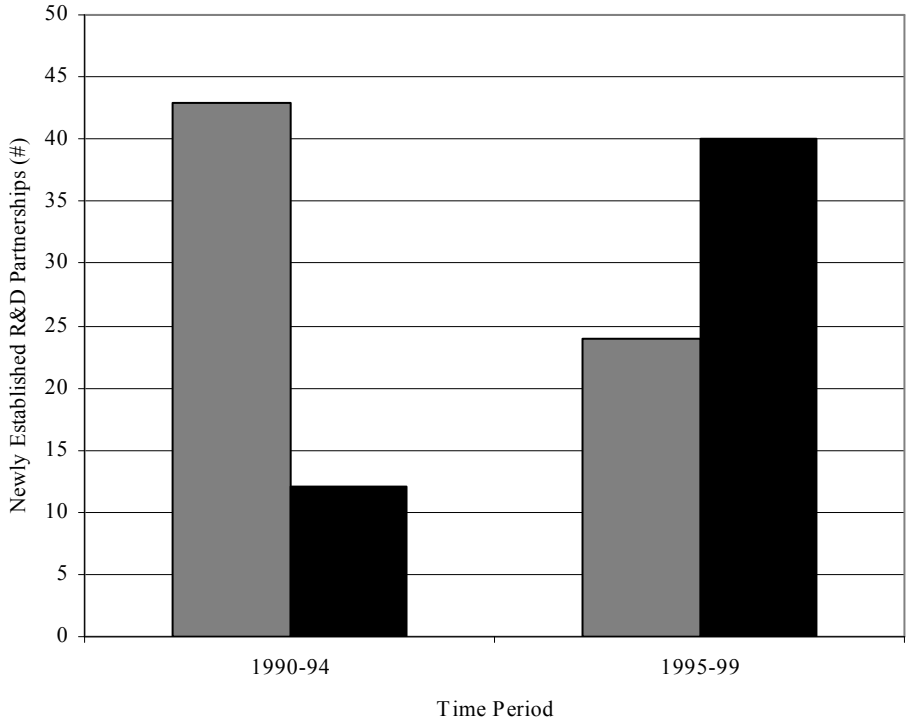


Figure 4. Numbers of IBM's newly established R&D partnerships with firms in two main groups, 1990-94 and 1995-99



Legend: The grey columns represent IBM's R&D partnerships with Apple, Hewlett-Packard, Siemens, and Toshiba. The black columns represent its R&D partnerships with AT&T, Intel, Motorola, Netscape, Novell, Oracle, and Sun-Microsystems.

Figure 5. The interaction of the growth in environmental, inter-organizational and dyadic embeddedness and their effects on overembeddedness and partnership formation