

**Blurred boundaries between firms, and new boundaries within (large multinational)
firms: the impact of decentralized networks for innovation**

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Abstract

Changes in the environment for international business activities have facilitated more open networked formations, both within and between firms. The spread of more open networks for innovation is increasingly blurring the boundaries between firms. Yet in contrast, more open relationships within large multinational corporations imply that some new boundaries are being correspondingly erected between different sub-units of the firm. A critical feature of more open structures is that internal and external networks have become more closely connected to one another.

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1. Introduction

To explain the existence of the firm as a mode of economic organization and coordination (although not the heterogeneity of firms), transaction cost theorists have sometimes drawn a clear and sharp distinction between the apparently purely hierarchical coordination of economic activity within the firm, and the apparently purely non-hierarchical coordination of activity between firms or between firms and other actors, at arm's length through market relationships (by extension of the analysis of Coase, 1937). This approach is designed to establish whether a given set of exchange relationships is more efficiently conducted within firms in general, or instead in markets. In the simplest version of this story, there are clear and distinct boundaries between firms and markets (and hence between firms themselves, which are connected essentially just through markets), and no relevant boundaries or sub-divisions within firms.

In the Schumpeterian literature, attention shifted to the role of the firm as a continuous creator of knowledge through localized search efforts in and around production, which better explains firm heterogeneity (Nelson and Winter, 1982; Rosenberg, 1982; Nelson, 1991). However, such problem-solving efforts often call forth knowledge exchanges between firms, and between firms and non-firm actors. If the flows of knowledge between firms, and the extent to which firms draw upon external capabilities rises sufficiently, then the boundaries between firms may begin to become blurred. In large firms the evolutionary trajectories or paths of corporate technological learning also involve knowledge creation across various divisions or business units, and in

multinational corporations (MNCs) they have increasingly involved knowledge creation both at home and in their foreign subsidiaries, and so knowledge often needs to flow within as well as between firms.

In this latter context, the barriers to knowledge exchange between different units of a large firm can become as much of an issue as the boundaries between firms, and in particular a tension may develop between the local inter-organizational networking relationships of an intra-firm unit, and its wider international networking relationships with other parts of its corporate group. Partly as a result of this line of research on international networks for knowledge creation or innovation (Hedlund, 1986; Cantwell, 1995), it has become apparent that such international business networks frequently need to be comprised and to connect both internal MNC networks (usually, across national borders) and various kinds of inter-firm networks (often arranged around a subsidiary within some local or regional geographical area) (Castellani and Zanfei, 2006).

The rise of so-called vertical specialization in some industries has helped reduce the role of in-house R&D in large firms, and made them more reliant on the outsourcing of some key aspects of knowledge creation and development, with large firms becoming instead more integrators of systems of knowledge derived from both internal and external sources (Ernst and Kim, 2002; Adams, Brusoni and Malerba, 2006; Mowery, 2006). This change implies a shift towards a more open structure of inter-firm network relationships, and a decline in the relative significance of any unitary pyramid-like structure of organizational hierarchy in the coordination of activity in the MNC. According to Langlois (2003), the

recent effects of the development and application of information and communications technology (ICT) and a more liberal anti-trust environment for inter-firm cooperative arrangements have removed the constraints which had meant that the capabilities for industrial growth became heavily centralized within large firms, as depicted for an earlier era by Chandler (1962, 1990). Another related development is the role of entrepreneurial flagship firms in initiating and crafting market-based inter-firm networks (of subcontractors, suppliers and distributors), and not just in planning and coordinating economic activity within the auspices of the firm itself considered in isolation (Ernst, 2005b; Dhanaraj and Parkhe, 2006). So the theoretical framework for the analysis of business activity is shifting. In an earlier phase of international business theory we had a theory of the MNC as such (eg. Buckley and Casson, 1976), which focused on the evidence of in-house activity in large MNCs in particular. Now we might rather think in terms of a steady evolution of international business networks that incorporate and may often be driven by the MNC, but are not necessarily restricted to it (Håkanson and Snehota, 1995; Andersson and Forsgren, 2000).

The MNC can now be perceived as being embedded in a series of internal and external business networks (Forsgren, Holm and Johanson, 2005), which decentralized and geographically dispersed networks it fosters to stimulate and better access a wider range of nodes of creativity in the changing environment of the information age. This process of business network formation simultaneously blurs the boundaries between firms, but erects new boundaries or divisions and creates new decentralized nodes of authority or influence within MNCs, given that subsidiaries or other sub-units independently initiate

and participate in different networks, and that the headquarters of the firm is unlikely to be able to acquire or retain a full knowledge of these diverse networks as they develop.

In addition, a given business network may connect a selection of internal and external actors, so that parts of the network belong to some common corporate group, but there are other sub-units of the same group that have no association with this network. So, if an entrepreneurial initiative begins in conjunction with network partners, the relevant focus of analysis may become the localized network, rather than the firm as such. This suggests a project-driven perspective (Whitley, 2006), but the sub-units of a group that participate in a network project must fulfill some broader firm-wide objectives in doing so. Hence, the role of the multinational corporate group as a whole continues to remain critical in the story of an internationally distributed system for innovation.

However, in some ways the fact that sub-units of a firm belong both to decentralized business networks (by project-based activity) and to a corporate group (by ownership and resource ties) is bringing the transaction cost and the evolutionary accounts of the firm back closer together again. The transaction cost approach is exchange-based, and it incorporates the consequences of potential conflicts of interest between the parties to exchange arrangements (such as conflicts between the alternative networks to which different sub-units of the same firm may belong). The new and more open business networks may necessitate the management of such conflicts within the firm, but these networks also themselves consist essentially of exchange relationships, although of a longer term kind, and they often require more complex combinations of modes of

governance of economic activity rather than a simple one-off choice between alternative modes. Meanwhile, these international business networks can be viewed as co-evolving with the production (and distribution) technology and capabilities of firms, the paths of development of which lie at the heart of the evolutionary or competence-based theory of the firm. The open business networks in which they become embedded can themselves become relational assets for the participant firms (or sub-units of firms), and the capacity to build and sustain such networks has itself become an important differentiating capability for firms.

This paper aims to shed further light on the linkages between intra-firm and inter-firm networks for knowledge development and exchange, and the sometimes complex and potentially conflictual relationships between knowledge networks within as well as between firms. Attention will be paid to the changing nature of knowledge creation and exchange as such. This includes the increasing complexity and interdisciplinarity (cross-field character) of systems for knowledge creation, and the implications for the more intensive business-to-business cross-licensing of knowledge as a necessary complement of internal knowledge creation within the firm. Moreover, the number of technologies required per product is increasing in many industries, partly as a result of the facilitating of new combinations by information and communications technology (ICT). Therefore, companies increasingly have to deal with much more difficult and multidisciplinary technological problems.

Another important factor influencing the complexity of today's technology is the blurring of the boundaries between science and technology. Given the increasing costs of science-based research, as well as the persistence of firm-specific profiles of technological specialization of firms due to the path dependent and tacit nature of technology, cross-boundary research connections provide the outside support often needed to overcome internal technical limitations. Besides the complexity of technology itself, there are other factors that affect the organizational complexity of knowledge sourcing, such as the desire to enhance in-house R&D, the need to scan external scientific and technological opportunities, and to enter into and retain positions in international technological cooperation clubs.

Intra-MNC and inter-firm or inter-organizational relationships are in general complementary and interact with one another. This complementarity is now increasingly likely to be established at a network level, through networks that combine the relevant sub-units of a firm with external partners. As external knowledge creation becomes more important, so the monitoring function of internal R&D and a firm's absorptive capacity becomes more significant. The inter-firm component of networks facilitate this monitoring function, if partners have complementary know-how, and especially in they engage in cooperative learning activities. At least for large firms, cooperative ventures that support innovation are generally a complement to, not a substitute for, in-house development. As a consequence, the firm's own problem solving and learning sets the agenda for what is usefully searched for when monitoring the external environment.

The remainder of the paper is organized as follows. The next section broadens out the conventional typology of markets and hierarchies, to present a more appropriate framework for the analysis of internal and external, networked and non-networked forms of coordination of economic activity, in the context of the emergence of more open networks for innovation. Section 3 expands upon the concept of business network relationships, and examines the restructuring of MNC networks for innovation. Section 4 considers how changes in the environment have facilitated more open networked formations, and the implications for the pattern of knowledge flows in MNCs. Section 5 is concerned with the implications of the evolution of internationally distributed networks of innovation for internal boundaries, power structures and the potential for divergence and competition between sub-units within MNCs. Finally, section 6 provides some summarizing and concluding remarks on the increasingly complex interrelationship between internal and external MNC networks for innovation.

2. The spread of more open networks for innovation: a framework

The conventional analysis of governance structures in the coordination of economic activity might be represented by a 2x2 matrix, which would be comprised by cells (1), (2), (5) and (6) in Figure 1. Of these, the principal diagonal would be that which runs from top left to bottom right, comprising cells (1) and (6), that together provide the conventional dichotomy between markets and hierarchies (Williamson, 1975). The supposition that this dichotomy represents a complete statement of the axis around which all potential modes of governance can be arranged implicitly presumes that any non-

market exchange relationships are essentially synonymous with the more direct administration of the firm. Or vice versa, a simple dichotomy supposes that any relationship not directly administered within a firm is either a market or at least can be depicted as a 'market-like' form of coordination of economic activity. Furthermore, based on the work of Chandler (Chandler and Redlich, 1961; Chandler, 1962), it came to be commonly supposed that at least within large firms, relationships were generally structured in a centralized form of organizational hierarchy. In the case of MNCs, it was widely perceived that subsidiaries depended upon and took direction from their respective parent companies, but that there was little or no interdependence (parent companies did not depend much upon locally driven subsidiary level initiatives or positions of influence) (Brooke and Remmers, 1970). Therefore, the traditional approach entails a parent-driven or headquarters-driven perception of the MNC.

Such treatments of the institutional economics of governance structures were quite quickly and readily extended to incorporate the formations represented in cell (2). Negotiated partnership agreements between firms often came to be conceptualized as intermediate points on a spectrum of potential modes of economic coordination that run from wholly-owned ventures within a firm at one extreme, through to pure market relationships at the other end. Of the various inter-organizational modes of cooperation usually considered, contractual agreements were thought to lie mainly closer to the market transactions of cell (6), while equity joint ventures (especially if they were majority-owned ventures) were supposed to lie closer to the corporate group hierarchy of cell (1). Over time, an increasing amount of attention came to be devoted to the

'intermediate forms' of cell (2), often under the terminology of inter-firm alliances (eg. Hagedoorn and Schakenraad, 1992; Sachwald 1998; Lane, Salk and Lyles 2001; Reuer, Zollo and Singh, 2002; Dhanaraj, Lyles, Steensma and Tihanyi 2004; Gomes-Casseres, Hagedoorn and Jaffe 2006).

However, little attention was paid to the other side of the off-diagonal in cell (5). This was because a separation of the operations of different individual subsidiaries was taken to be an incidental consequence or side-effect of the centralized hierarchy described in cell (1). Each subsidiary depended upon its parent company, but they did not depend much upon one another, except perhaps through the mediation and direction of the parent company itself. Since subsidiaries were not thought to be usually themselves the independent source of new creative initiatives within their corporate group, there was no reason for inter-subsidiary relationships or potential conflicts to emerge. So cell (5) was not empty, but inter-subsidiary separation and lack of contact (except occasionally through the agency of the parent company) was a rather trivial and uninteresting outcome of the top-down administration of a large multidivisional and geographically dispersed MNC operating across a variety of markets or multidomestic settings.

In evolutionary accounts or learning-based explanations of cell (2) formations, issues of absorptive capacity (Cohen and Levinthal, 1989) became central to the understanding of the ability of a potential recipient to acquire knowledge benefits through inter-firm partnership agreements. The role of absorptive capacity could also be applied to thinking about a wider range of inter-firm knowledge spillovers (and most notably to localized

knowledge spillovers), in which there need be not cooperative (networked) or transactional relationships at all. For localized knowledge spillovers, geographical proximity may be sufficient in the presence of an adequate absorptive capacity. So cells (2) and (6) offer special cases of the set of inter-organizational associations in which a given company may acquire external knowledge from other actors in its environment (which may include non-firm actors, such as universities or public research laboratories).

More recently, attention has been given to the further possibilities described in cell (4), in which external network relationships tend to spread wider and are not confined to selected exclusive (often legally binding and codified) partnership agreements. Open networks are more complex than closed networks, precisely because they are continuously open to extension to new partners rather than being closed on the basis of some original established agreement that itself specified the composition and scope of the partnership, while open networks are also open to selective withdrawals as interests change over time. Indeed, a focal actor that is embedded in an open network may find that the network grows or contracts (evolves over time) even without changes in that actor's own direct relationships, through a growth or contraction in the relevant relationships of other partners in the network. So-called open innovation systems are thought to be increasingly common, and have even been held to be the major organizational form for the promotion of innovation by firms in the future (Chesbrough, 2003, 2006; Laursen and Salter, 2006). Vanhaverbeke et al (2007) discuss how the emergence of such open innovation systems enables us to enhance our understanding of the nature of absorptive capacity of potential recipients.

Although they relate to the formations of cell (2) rather than cell (4), there has been a continuous trend in inter-firm R&D alliances since the mid-1960s away from equity joint ventures and towards contractual forms of R&D partnerships (Hagedoorn, 2002). This shift in the share of joint ventures in all formal R&D alliances, from over 90% to less than 10%, has been documented for arrangements that lie within cell (2) (which agreements are easier to identify reasonably comprehensively, and hence to be able to measure trends in their composition quantitatively). Yet this observed trend is entirely consistent with and suggestive of the notion of innovation becoming more open, and hence with the perception of a further trend away from cell (2) and towards the more open inter-firm network ties of cell (4).

Also reflecting a changing context, on the side of analysis as well as on the side of the evidence of recent trends, there has been an increasing tendency in the literature to speak of the informal social systems of groups of actors that share common social capital as a 'third mode' of governance that is distinct from either bureaucratic control in firms or contractual relationships in markets (see eg. Granovetter, 1995; Jones, Hesterly and Borgatti, 1997; Oh, Labianca and Chung, 2006). The value of treating informal social systems as a third governance mode becomes far more apparent in the open network relationships of cell (4) than it is when explaining just the closed network relationships of cell (2). The alliance forms of cell (2) mainly entail formal agreements rather than informal understandings, and they can therefore usually be rightly represented as essentially a mixture of hierarchical corporate control and contracts. Instead, the non-

exclusive and generally non-contractual ties of cell (4) must of necessity rely on some informal social systems. It has been further argued that such informal group ties (which can be represented through the methods of social network analysis) are especially relevant in the context of network learning and innovation, whenever the knowledge base of industries becomes more complex and widely distributed or dispersed (Powell, Koput and Smith-Doerr, 1996).

However, for the purposes of our discussion here, the drawback of most of this recent literature on networks is that it treats 'network governance' purely in terms of inter-firm external network relationships, and so it typically seeks to combine an analysis of cells (2) and (4), rather than to understand the more open character of network relationships as a combined feature of cells (3) and (4). Instead, open network relationships may also connect some particular sub-set of intra-firm actors through ties that exist largely outside the context of the hierarchical structures through which they are also linked, but such additional ties rely on some professional or project-based network of which they are all members, together with other actors outside the firm and in other organizations. In this sense while closed inter-firm networks may have been an intermediate form with elements of both markets and hierarchies, open network relationships introduce a genuinely new third layer, which can be more accurately represented as a third mode of governance than could the more closed types of alliance agreements.

This, though, brings us to the question raised by Mowery (2006), as to whether there is anything new in open innovation systems, given the greater role of individual inventors,

of their agents, and of subcontracted research in the innovation systems of 100 years or so ago. A related contention, that as institutions have evolved there has been an historical transition in relative shares within the population of coordination mechanisms from market forms to hierarchies and now more recently back to more market forms, can be found in Lamoreaux, Raff and Temin (2002) and Langlois (2003). Our argument here is that what is new is that open innovation systems combine elements of cells (3) and (4), and it is this closer, more direct and persistent collaboration between intra- and inter-firm elements in open networks that differentiates cell (4) from either (2) or (6). The modern open innovation network tends to rely on a higher degree of integration of, and a continuous interaction between, the operations of network participants, and this is often sustained in part through the deliberately designed initiation and sustained orchestration of such networks by key sub-units of flagship firms (Dhanaraj and Parkhe, 2006).

Hence, compared to the more traditional concept of networks in terms only of inter-firm alliances or contractual relationships, in an open innovation network the unit of analysis is likely to be a project-based team (Whitley, 2006), or a decentralized corporate sub-unit or a subsidiary, rather than the firm as a collective entity. In most conventional discussions of networks the term is assumed by definition to be restricted to inter-firm relationships, and so it can be used to distinguish cell (2) from cell (1), or indeed supposedly to separate cell (4) from cell (3). So long as the firm itself remains a relatively closed and centrally coordinated structure, then this is a reasonable approach. But if the locus of innovation and entrepreneurship within the firm shifts to more autonomous sub-units as the firm itself evolves towards a more open structure for innovation, it becomes

very difficult to map so clearly the domains of different modes of governance to intra-firm hierarchies, inter-firm networks and arms length markets. As the firm itself becomes more open, organizationally decentralized networks or informal social systems that connect selected actors or sub-units within large firms become increasingly significant.

3. Business network relationships, and the restructuring of MNCs

Thus, with the expansion of the traditional 2x2 matrix of governance modes to a 3x2 matrix which differentiates between the open and closed types of networks, it becomes important to clarify what we mean by business network relationships in general, as opposed to other kinds of exchange relationships for the conduct of economic activity. In the way in which these terms are used here, network relationships require some element of continuity and stability, and their purpose is to create a platform for future business activities that are anticipated to involve each of the network partners as a participant, and they are not intended just to undertake some immediate or current transactions. This definition of business network relationships implies that through the relationship itself, a party to such a regular association geared to future business opportunities becomes knowledgeable about (relevant aspects of) each of its partners' resources, capabilities and strategies, and by the same token it discloses to its partners relevant information about its own position. Hence, network relationships can be distinguished from arms length transactional relationships, in which only the price and the quality of what is being traded now matters; or competitor relationships, in which different actors compete to be selected as the chosen provider of goods or services, or to obtain inputs from a common market or

resource pool, and so they may not share information with one another at all (indeed, they may actively try to inhibit knowledge transfer to potential or actual rivals). Business network, market transactional and competitor relationships need not be mutually exclusive, but they are conceptually distinct categories.

Market relationships are defined by trade or transactions, firm relationships are ultimately defined by employment contracts (according to Coase, 1937), while network relationships are defined by ongoing or future business projects. So, unlike the other modes of coordination or governance, on this definition a business network is inherently dynamic or evolutionary in character. On the conventional definition of network governance (such as that provided by Jones et al, 1997), networks are defined as inter-firm non-market relationships, and so they are confined to cells (2) and (4). In the sense we are using the term here as illustrated in Figure 1, networks to develop business projects can comprise both intra-firm and inter-firm relationships, and so they span cells (1) through (4). A network may be project-based, but in general it only becomes a network if it is the vehicle for the development of a connected series of projects over time (or a series of activities within an ongoing project), so that there is some longer term consistency or coherence to the composition of actors in the network, and some continuing interaction between the parties involved. In these terms, firms typically combine networks and hierarchies. If knowledge becomes more widely distributed within firms, then their networks are more likely to combine external and internal actors (to become more open), while the structure of hierarchies are likely to become more complex with a greater variety of nodes or powerful hubs.

Now while there is an emerging literature that is concerned with the open innovation systems represented by cell (4), much less recognition has in general been given in the innovation field to the counterpart of cell (4) to be found in cell (3), or to the changing nature of what is represented in cell (5), each of which is just as much an outcome of the increasing significance of open (as opposed to closed) business networks. There is a specialist literature in the international business field (from at least Ghoshal and Bartlett, 1990) that has begun to address what is represented by the contents of each of the cells (3) and (5), but even in that work these phenomena have not generally been understood as necessary counterparts of the emergence of open innovation systems shown in cell (4). Conversely, in the literature on the evolution of innovation systems, the implications of the emergence of more open systems for the internal organizational structures of firms has not much been explicitly addressed or incorporated into the discussion, as opposed to the need to create more outward-looking business models (Chesbrough, 2006).

To a far greater extent than do the exclusive partnership agreements described in cell (2), the open innovation systems of cell (4) are increasingly blurring the boundaries between firms. Yet in contrast, on the other side of this coin, within large MNCs some new boundaries are being correspondingly erected between different sub-units of the firm. While initially most subsidiary activity may be parent-driven as depicted in the traditional model of the MNC in cell (1), over time subsidiaries tend to evolve, and may increasingly do so under their own volition (Birkinshaw and Hood, 1998). Accordingly, subsidiaries may evolve to become competence-creating in their own right (Cantwell and Mudambi,

2005), bringing new areas of competence into their respective corporate groups, and this is facilitated when the relevant corporate groups themselves have evolved to encourage subsidiary entrepreneurship (Birkinshaw, 1997). The trend towards systems of distributed innovation within MNCs has become especially evident in the international environment that has prevailed since around 1980 (Cantwell and Piscitello, 2000; Zander, 2002), and the characteristics of internal MNC networks for innovation as depicted in cell (3) will be discussed further below.

The subsidiaries of MNCs are the organizations that most commonly connect the internal network relationship structures of cell (3) with the external network structures of cell (4), just as parent companies are most commonly the intra-group entities that connect the arrangements of cells (1) and (2). Thus, subsidiaries, and especially competence-creating subsidiaries, are embedded in two kinds of business network - internal networks with other parts of their MNC group, and external networks with a variety of other actors in their own environment. Indeed, as mentioned earlier, some networks may themselves combine both internal and external elements. Subsidiaries can be understood as co-evolving with each of these kinds of networks, which is why cells (3) and (4) are connected, and in the process tensions may well arise between the requirements placed on a subsidiary as a result of its development through accessing capabilities from both of these different kinds of network relationships.

Now, in the international business field there is quite a long standing literature on the tensions within MNC organizational structures between the desirability of the global

integration of corporate groups and the benefits of local responsiveness at the level of individual subsidiaries, sometimes referred to as the integration-responsiveness (I-R) dilemma (see especially Doz, Bartlett and Prahalad, 1981; Prahalad and Doz, 1987; Bartlett and Ghoshal, 1989; and Ghoshal and Westney, 1993). Since corporate group integration concerns the coordination of activity across the internal network of the MNC, while the capacity for local responsiveness depends critically upon the associations of subsidiaries with actors in external business networks, the I-R framework is very much about how these networks interact.

However, in most studies conducted within this I-R framework - motivated, as they have been mainly, by the conventional parent-driven view of the MNC - the focus of attention has been on how the internal organizational arrangements of the MNC have affected this interaction between internal and external networks, and little has been said from the other side about the influences on the structure of the firm coming from subsidiary level initiatives, and from the effects on the MNC of variations in the characteristics of the distinct external business networks of subsidiaries. The I-R framework has also been used to distinguish within individual subsidiaries between competence-creating activities that create local innovations or diffuse them to other parts of the MNC network, and competence-exploiting efforts that facilitate the local adoption of innovations obtained from other parts of the MNC (Ghoshal and Bartlett, 1988). Yet in doing so, the issue has generally been how features of the focal MNC group as a whole, such as the extent of subsidiary autonomy or the quality of intra-firm communication, have differentially affected these distinct categories of subsidiary innovation.

For MNC operations, the external networks of subsidiaries are often geographically localized, but especially where the subsidiary has evolved to become a business unit for the MNC or is recognized as a corporate center of excellence, the external business networks that are specific to the subsidiary may well also be international (Forsgren, Holm and Johanson, 2005). So in this context, the need to maintain local responsiveness may refer to being local in a functional or line of business sense, rather than (or as well as) in a geographical sense. In terms of the intra-firm versus inter-firm distinction between the columns of Figure 1, we might roughly think of the intra-firm side as depicting mainly international network relationships, and the inter-firm side as representing mostly local network associations. However, this approximate correspondence between the ownership structures and geography of linkages has been weakening, as locations also become more open, and so the inter-firm network ties of subsidiaries have become more international too (even when originating from contacts established through local partners, as opposed to other parts of the MNC group).

The wider geographical dispersion of knowledge-creating nodes within MNCs, including the establishment of subsidiaries in new centers in Asia, and the rapid evolution of those subsidiaries or subcontractees towards competence-creating activities, partly reflects the more general dispersion of innovative efforts across countries since 1992 (Athreya and Cantwell, 2007). This shift in the international location of dynamism in the external environment of the MNC implies that even without any shift in the competitive advantages of MNCs and in their incentives to preserve more highly centralized corporate

structures, MNCs may have been required to internationally restructure their activity especially towards East Asia, and in part through subcontracting and greater inter-firm cooperation in those new locations (Teece, 2006). In other words, MNCs have needed to ensure access and connections to a new stream of innovation among local firms (potential network partners), but in doing so they have reinforced the significance of knowledge creation in such new centers (Ernst, 2002, 2005a).

Largely as a result of the potential to create new intra-firm tensions or conflicts engendered by the efforts of subsidiaries to search for an appropriate balance between the increasingly significant open business network relationship structures depicted in cells (3) and (4), there has been a transformation in the nature of intra-MNC relationships represented in cell (5), between non-networked units that belong to a common corporate group. In the traditional centrally-driven model of the MNC as reflected in cell (1), there was a relative lack of direct communications between subsidiaries themselves, and indeed a lack of strategic significance of actors in other sub-units for the activities of any given subsidiary, except perhaps to the extent that a newer subsidiary might be encouraged (by the parent) to learn from the experiences of a more mature subsidiary. Now instead, creative subsidiary level initiatives of the kind that may emanate from cells (3) and (4) need to factor into their own strategic calculations the likely position of other actors in the MNC group. Hence, the gradual development of organizationally decentralized distributed innovation systems in MNCs shown in cell (3) necessarily imply a reconfiguring of relationships within the firm, even with actors with which one does not have a networked connection. Subsidiaries may well compete for mandates, or for other

positions of responsibility within the MNC. This may lead to the emergence or deliberate construction of new boundaries within the firm, perhaps even to the point of attempts to disrupt or inhibit internal knowledge flows (Mudambi and Navarra, 2004).

4. The drivers of more open networks for innovation, and the implications for knowledge flows in the MNC

The ability of MNCs to usefully combine knowledge from different subsidiaries in an international network for innovation has depended upon the increasing significance of technological interrelatedness and fusion. Such greater potential for novel technological combinations is one aspect of what has been described as a new techno-socio-economic paradigm (Dosi, 1984; Perez, 1985; Freeman, 1987; Freeman and Perez, 1988; Freeman and Louça, 2001). In this context a techno-socio-economic paradigm is a system of scientific and productive activity based on a widespread cluster of innovations that represent a response to a related set of technological problems, relying on a common set of scientific principles and on similar organizational methods. The old paradigm was based on energy and oil-related technologies, and on mass production with its economies of scale and specialized corporate R&D. In recent years this has gradually been displaced by a new paradigm grounded on the economies of scope derived from the interaction between flexible but linked production facilities, and a greater diversity of search in R&D. Individual plant flexibility and network linkages both depend upon the new ICT.

Part of the reason for the increased extent of technological interactions in networks within and between firms lies in the more sophisticated modern system of production as well as in the more intensive linkages between science and technology in the current techno-socio-economic paradigm, which relies on flexibility through computerization and diversity through new combinations drawing upon a wider range of disciplines. The development of the capability to manage a geographically complex international network may lie partly in a firm's specialization in ICT. The opportunities created for the fusion of formerly unrelated types of technology through ICT has made feasible new combinations of activities (Kodama, 1992), the best centers of expertise for which may be geographically distant from one another. The enhanced expertise in ICT seems to provide a company with greater flexibility in the management of its geographically dispersed network, and an enhanced ability to combine distant learning processes in formerly separate activities (Langlois, 2003).

Of course, the increasing significance of ICT-supported new combinations and coordination across distance, and rising technological complexity are not the only changes in the business environment that have influenced organizational decentralization in firms, and the more open character of management and innovation processes within and between firms. Other considerations include more effective industrial relations and recruitment strategies to increase internal motivation, or the need to share risk as well as the escalating costs of R&D. However, the explanation of the drivers of more open innovation networks in MNCs needs to be historically grounded, to account for why this major shift has been occurring recently. This is where the emergence of a new techno-

socio-economic paradigm is critical, since its combinatorial characteristics require a setting in which products are more modularized and production processes are fragmented, and this in turn necessitates the organizational flexibility or openness to pass authority to undertake entrepreneurial initiatives to more autonomous project-based teams or networks (Sanchez and Mahoney, 1996; Langlois, 2002).

Freeman and Perez (1998) had argued that in the latest techno-socio-economic paradigm ICT has become a 'carrier branch' or a 'transmission belt' for the transfer of innovation across sectors, analogous to the role played by the capital goods sector in the mechanization paradigm in the nineteenth century (Rosenberg, 1976). Company evidence now suggests more than this that ICT has become also a core connector of potential fields of technological development within firms (or between firms in technology-based alliances) that facilitates the technological fusion of a formerly disparate spread of innovative activity (Hagedoorn and Schakenraad, 1992; Santangelo, 2002). Thus, while in the past the machine-building industry simply passed knowledge of methods from one field of mechanical application to another, ICT potentially combines the variety of technological fields themselves and so increases the scope for wider innovation. Hence, innovation has become a still more central part of MNC development in the ICT age. Thus, this role of ICT as a promoter of innovation within the MNC is a further key factor in the shift from the MNC as an institution for technology transfer between established activities frequently organized along miniature replica lines in different locations, and towards the MNC as a developer of international networks for technology creation, which combine formerly unconnected streams of innovation. Internationalization through the

MNC and the corporate development and application of ICT have become interconnected in the new open innovation networks.

The source of technological creativity and the entrepreneurial initiation of new business network formation is increasingly to be found at the subsidiary level within MNCs, and so when considered as whole entities, MNC corporate groups have become engaged in multiple potentially disparate knowledge networks. There has therefore been a fundamental restructuring of the composition of technological knowledge flows, both within MNCs across borders, and between firms, especially within local areas. Subsidiary activities can be either competence-exploiting (building upon some established area of specialization of the relevant MNC group) or competence-creating (new to the corporate group). Competence-exploiting activities draw on a common technological base across the group and have been associated with increasing internal cross-border knowledge flows, while competence-creating activities are more varied and localized and they are associated with sub-unit networks that link only selected internal and external actors.

Inter-subsidiary diversity and differentiation within the MNC (allied to an embeddedness of individual subsidiaries in separate and distinct external local networks) tends to increase the capacity for exploration in learning across the corporate group as a whole, relative to exploitation. Yet the divergent capacity of subsidiaries to evolve successfully towards competence-creating mandates may be grounded upon substantial differences in the power and influence they are able to exercise within their respective MNC groups owing in part to their different origins (most notably, whether they were formerly part of

an acquired business - see Cantwell and Mudambi, 2005). In turn, the divergence or differentiation of subsidiary capabilities has affected the internal boundaries, power structures and the potential for competition between sub-units within MNCs.

The traditional view of knowledge flows within the MNC is essentially based on the competence-exploiting component of activities, which emphasizes the commonality of knowledge development and the sharing of knowledge in use. From an evolutionary perspective, barriers to knowledge transfer within the MNC may be avoided by the establishment of common social communities with shared values across the differentiated subsidiaries of an international MNC network (Kogut and Zander 1993; Nohria and Ghoshal 1997). Subsidiary level variety or novelty in knowledge creation through local search or exploration of a competence-creating kind is in fact built upon this foundation of the internal exchange of competence-exploiting knowledge held in common, as well as on the advantages of local external networks. Competence-creating (versus competence-exploiting) efforts have tended to account for a rising share of activities in the course of evolution of at least some subsidiaries, but it is still necessary to retain a balance between these two complementary strands of learning (as argued for organizational learning more generally by March, 1991). This is why, even with greater inter-subsidiary variety and the potential for internal competition, there is a continuing rationale for an integrated MNC, rather than for it to break-up into its constituent parts.

Now it has been argued that as evidence for a restructuring of MNC international networks, and a greater reliance upon those networks for (geographically dispersed)

knowledge creation in MNCs, we have observed increases in technological specialization at a subsidiary level (Cantwell and Janne, 1998). However, showing increasing affiliate specialization alone yields no direct evidence of the necessary corollary of the proposition that the rise in subsidiary specialization is to be explained by cross-border inter-unit MNC restructuring – namely, that there should be an increase in internal MNC knowledge flows. An alternative supposition has it that this may be explained instead by subsidiaries just going their own way, creating a kind of federative and divisionalized MNC (Sölvell and Zander, 1998). We do now have some recent evidence for a connected process of the restructuring of internal MNC knowledge flows associated with a greater intensity of technological knowledge exchange within the MNC across subsidiaries, and in particular an increase in intra-MNC transfers within technological fields (Cantwell, Noonan and Zhang, 2007; Zhao, 2007). The rising level of international knowledge sourcing in the MNC has entailed a reshaping of the internal firm network, while at a sub-unit level subsidiaries have become relatively more dependent on localized inter-organizational knowledge exchanges, especially between technological fields.

In other words, the restructuring and intensification of knowledge exchange mechanisms across units within MNCs (as depicted in cell (3) in Figure 1) are essential for subsidiaries to play a more creative role in localized knowledge generation (drawing upon the external networks shown in cell (4) in Figure 1). When sourcing knowledge from both their own internal MNC network internationally, and from a local network of other organizations, subsidiary units need to be increasingly embedded in knowledge flows in both these networks in order to become more locally creative (Marin, 2006).

This may sometimes be a difficult balance to achieve between internal and external network commitments, but it is an increasingly critical combination for innovation in the large firm and its partners.

Another change in the environment in the ICT age, that has contributed to the trend towards more open innovation systems (Chesbrough 2003; Laursen and Salter 2006), has been the rise in intellectual property or so-called technology markets (Arora, Fosfuri and Gambardella 2001). This development of intellectual property markets has helped to account for the wider international dispersal of innovative capacities (Athreye and Cantwell, 2007), which in turn helps to explain the motivation for encouraging a broader spread of subsidiary level innovative initiatives in MNCs, as well as the growth of more open innovation networks in general. The strengthening of basic capabilities especially in smaller entrepreneurial firms in catching up locations such as India has been further strongly encouraged especially since the early 1980s by the rapid growth of intellectual property markets, which has created an opportunity for the emergence of new players, and has helped to promote the newer forms of international inter-firm business networks for knowledge exchange.

5. The evolution of distributed innovation in MNCs, and consequent shifts in internal power structures

The contemporary MNC has a more widely geographically distributed innovation system, partly due to changes in the business environment. There are often marked variations in

the extent of local initiatives as between individual subsidiaries in a corporate group, and a bottom-up evolution in the networks emerging within and from MNCs, rather than a carefully centrally planned top-down MNC strategy to develop such networks. Hence, international business networks derive from a process of dynamic interaction between many actors, and not just from some prior determination by one single actor. It has become far more common for selected individual subsidiaries to evolve towards a capacity to initiate competence-creating lines of activity, usually in association with some product mandate or some similar specialized and acknowledged responsibility on behalf of their MNC group (Birkinshaw, Hood and Jonsson 1998).

Although hierarchies have always remained present within the various administrative structures that have evolved for the organization of the firm, the traditional model of the MNC as a well defined singular and uniform hierarchy has become misleading, owing to a shift in management structures, the emergence of newer and less centralized hierarchical organizational forms, and the dispersion of knowledge-creating activity. There is growing evidence of the transformation of MNC headquarters to include - inter alia - aspects of decentralization despite the retention of core central control (Ferlie and Pettigrew, 1996), which make the MNC organizational forms of today a more complex, hybrid and distributed form of hierarchy rather than the simpler singular hierarchy visualized by the conventional model.

In the current international business literature, MNCs are more commonly conceptualized as integrated global networks, with multiple geographically distributed higher value

creating centers. This contemporary view of MNC has been reflected in the notion of the networked firm or firms as networks in Håkanson and Johanson (1993), Håkanson and Snehota (1995) and Kobrin (2001), and the notion of MNCs as organizational heterarchies rather than as simple hierarchies in Hedlund (1986, 1993).

When MNCs have reached a mature stage, MNC advantages can be argued to derive from a continuous process of innovation throughout an international network rather than from the exercise of power in some specific national or geographically segmented market (in a former system of multidomestic subsidiary operations). The competitive advantage of established or mature MNCs increasingly stems instead from their abilities to build and control a network of global flows of information, resources, and people. This ability to create global networks, utilize geographically specialized resources, and transfer knowledge between different knowledge-creating nodes, lies at the core of many current conceptualizations of the MNC (Cantwell and Mudambi, 2005; Håkanson and Snehota, 1995).

The evolution of organizational systems for cross-border knowledge exchange within the innovative and open networked MNC has carried with it an important implication for the potential inclusion of competence-creating activities in subsidiaries located in developing countries. In the context of discussions such as those over TRIPS, it has been suggested that developing countries will remain unattractive hosts for competence-creating innovation unless they substantially tighten both their intellectual property regimes, and the mechanisms for enforcement. However, where technologies have become

modularized and component knowledge is developed at more than one location, then the MNC itself provides an alternative institutional device for intellectual property protection (Zhao, 2006). Even if the component knowledge developed locally in a developing country leaks out, it is of little value to others without understanding how it fits into a broader system of knowledge. While this finding of the role of knowledge integration within the innovative MNC may apply more to some industries than others, there is evidence that it applies especially to the areas of electronics - computers and telecommunications - in China (Zhao, 2006).

However, the development of more open international business networks for innovation may create a new potential for tensions or conflicts within the MNC, or between subsidiaries and their local external partners. This may result in the emergence of new boundaries within the MNC. Sölvell and Zander (1998) stress the role of the isolating mechanisms that may be associated with the greater local embeddedness of subsidiaries, and with a greater degree of subsidiary autonomy, such that the international diffusion of knowledge within the MNC may be constrained or even sometimes reduced. Power struggles and inter-subsidiary competition within the MNC may act as a further constraint on the willingness to share knowledge. Zander and Sölvell (2002) argue that a continuing dominance of competence-exploiting activities within the MNC suggest that cross-border innovation efforts continue to be small relative to the overall system of innovation within the MNC. Yamin and Forsgren (2006) have gone so far as to suggest that the parent companies of MNCs have reacted to the trend towards increasing subsidiary authority by seeking to reduce the federative nature of multinationality. The outcome of this process,

they contend, is that most MNCs have remained regional rather than global in their strategy and structure, as shown by Rugman (2005).

Since subsidiaries rely upon locally embedded resources in developing their capabilities, this has tended to increase the political power of certain subsidiaries within their respective MNC groups (Mudambi and Navarra, 2004). Therefore, the dispersion of knowledge and innovation implies a dispersion of control in the MNC network. In the current knowledge-based economy, in which knowledge has become the key asset, control comes increasingly from the possession of knowledge, and the ability to create new knowledge or access complementary knowledge. Control in MNCs is increasingly subject to elements of decentralization to specialized nodes of excellence because MNC headquarters often cannot fully understand the complexities of the knowledge-related activities of their subsidiaries (Prahalad, 1976; Prahalad and Doz, 1981). In addition, MNC headquarters has to allow selected subsidiaries to evolve towards greater autonomy (and their own control over some sub-set of networks) for them to become competence-creating in their own right (Birkinshaw and Hood, 1998). For subsidiaries to develop their own independent competence-creating capabilities in turn demands that they become more embedded in external networks in their own localities (Birkinshaw, Hood and Jonsson, 1998; Andersson and Forsgren 2000; Andersson, Forsgren, and Holm, 2002), a process that must be initiated and managed locally, and so which implies a dispersal of concentrations of power within the MNC.

International MNC networks for innovation have been evolving over time, and they are not the outcome of the introduction of some readily made and planned structure. An evolutionary perspective can incorporate issues of learning to accommodate continuing and enhanced inter-subsidary differentiation within the MNC, and differences in the ability of subsidiaries to exercise power and influence within their respective MNC groups.

6. Conclusion

The building of more open networks for innovation, and the organizational restructuring of MNCs has tended to increase two-way knowledge spillovers both within and between firms, in the social context of wider business network formation. This has blurred the boundaries between firms, and sometimes between firms and other organizations. However, it has also generated some new boundaries or potential conflicts within firms (between the sub-units of MNCs) that were not there before, or were much weaker and less noticeable. Individual corporate teams or sub-units of larger firms now belong not just to the firm, but also to various business networks. From the perspective of an individual corporate sub-unit, a business network may join together parties from other parts of its corporate group with partners outside the firm, and so some parts of the relevant firm 'belong' to the same or perhaps to closely overlapping networks, while other parts of the same group do not. In the latter case there may be a mutual separation of activities (if there is a clear division of labor between networks), but even with network specialization there may still be areas of competition or conflict, not least over resource

allocation within the corporate group. MNCs have thus become less monolithic bodies, if indeed they ever were. However, the greater decentralization and localization of their competence-creating search efforts still continues to rely on an even more intensive common exploitation of a shared knowledge base, and this provides the glue that continues to hold the MNC together.

As networks for innovation become more open, the central conclusion is that internal and external (components of) networks have become steadily more closely connected. This has been missed in much of the previous literature, which has put into different camps issues of subsidiary devolution within MNCs and issues of inter-firm alliances. It has certainly been missed where the term 'networks' is restricted by definition to refer only to inter-firm cooperation (perhaps in the interest of presenting networks as a 'third' form of governance [Jones et al, 1997], thus distinct from internal coordination mechanisms within firms). The opening of networks is itself associated with a greater openness in firms, and with a greater decentralization in authority structures and in areas of local autonomy within large firms. Hence, the main suggestion for future research here is that internal and external networks should be considered in terms of their mutual interactions and relationships. The conventional separation in the treatment of the two is increasingly unhelpful, and may now often be misleading.

The restructuring of organizational arrangements within MNCs is the inevitable consequence of the complementarity between internal and external networks (see also Vanhaverbeke et al, 2007), and so building these two dimensions of networks happens

together, and is obviously selective with respect to partner choice in each case. Network creation is especially vital in constructing cooperation in innovation, since what is being exchanged is often complex and experimental in character, and so unlike with market transactions of established products, the content of the knowledge exchange may be in a continuous process of transformation and fluctuation. What these networks do is to combine internal and external diversity (see also Laursen, 2007). For the MNC, this requires a more organizationally decentralized and distributed system of innovation, but one that is still selectively connected and integrated within the firm.

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Figure 1: Internal and External Network Formations, and Non-Networked Forms of Coordination of Economic Activity

	<i>Intra-firm</i>	<i>Inter-firm</i>
<i>Closed network relationships</i>	(1) Centrally organized and coordinated, traditional unidirectional hierarchy	(2) Alliances, business groups, equity joint ventures, exclusive cross-licensing, franchising, subcontracting, supplier or distributor partnership agreements
<i>Open network relationships</i>	(3) Organizationally decentralized distributed innovation systems across corporate teams or connected units, each of which has evolved towards a greater degree of autonomy	(4) Open innovation systems, flexible and experimental structures of non-exclusive ties
<i>Non-networked relationships</i>	(5) Inter-subsidary or inter-business unit distance, divergence, or competition for influence, resources, mandates or other corporate group responsibilities	(6) Pure market connections, arms length transactions in a competitive context