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THE NOTION OF COMPLEMENTARITIES: ORGANIZATION OF R&D ACTIVITY AND INTERNATIONALISATION PROCESS

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Abstract

This paper addresses the relationship between complementarities in capabilities of firms and choice of organizational arrangements. The key focus is to generate an understanding of the incentives to invest in learning created by the choice of different ownership structures and how the nature of innovation activity affects the choice of such organizational forms. It develops a theoretical framework for the application of complementarities in the context of inter-firm collaborative arrangements. This paper presents a firm-level study of the role of complementary activities in network in organizing R&D activities of a firm and develops it into an actor-resource-activity model by IMP group. This paper has two objectives. First it elaborates on the approach of complementary activities and interprets it in A-R-A framework. The interpretation of the complementarities in A-R-A framework emphasizes on the relationship between process of transformation of a firm's capability into core competence and articulation of actors, resources and activities in an innovation system of a firm. Secondly, it aims at describing the implications of internationalisation of R&D activity of a firm on this transition process.

The underlying assumption for the conceptual framework is that the organization of innovation activities is a determinant for the incentives to engage in cooperation and share knowledge, which reciprocates the potential increasing returns to knowledge creation process or problem solving for that given innovation activity.

Keywords: complementarities, inter-firm learning, internationalisation, ownership structures, innovation activity

Introduction

Mobilization of different counterparts of a company and development of cooperative coordinating mechanisms in interaction with other firms to solve problems are two important issues that have a bearing on the capability development process in a firm (Håkanson and Snehota, 1994). For multinational firms international cooperative ventures are a vertical or horizontal arrangement that create value in the processes and products of firms. The international firm is a coalition of interlocked, quasi relationships where strategic issues are influenced by the globalisation of markets and the need to negotiate cooperative arrangements with other firms. The nature of the interaction process within the cooperative business relationship is a determinant of the possibilities of developing its capability by drawing on the capabilities of other firms.

For successful innovation information exchange both within the functions of a firm and its customers and suppliers is important (Rothwell et al. 1974). The integration of complementary strengths of all partners in international joint venture is a combined knowledge, which is a function of the individual sources of knowledge. The complementarity between diverse sources of knowledge and integration of knowledge assets such as communication and cooperation between actors in a system of innovation depends to a large extent on organizational arrangements. The mode of organization of knowledge is important for realizing its potential (Teece, 1986) for example, skills to use a technology is a complementary asset for that technology.

One of the other rationales for international cooperative ventures in research and development activity of a firm is the exploitation of the existing innovation that has already been explored in one firm and can be used for innovation activity of the other firm as a complementary activity. The development of knowledge from existing knowledge is the integration of diverse sources of knowledge through an interaction among the complementary activities and is critical for successful innovation. Therefore, innovation is conceptualised as a process of interaction between disciplines of knowledge residing in the different sub-units of the firm, between the firms and other external sources of innovation output (Kline and Rosenberg, 1986; Rothwell, 1994).

Organizational knowledge consists of the skills and capabilities possessed by individuals within an organization. Firms are clusters of complementary activities such as R&D, administration,

marketing, manufacturing and distribution. The process of knowledge creation and the integration of diverse sources (either individuals or firms) of knowledge is imperfect, which brings up the issue of capabilities and qualitative coordination (Langlois and Foss, 1998). The capabilities perspective is growing (Langlois 1992; Langlois and Robertson 1995; Kogut and Zander 1992; Teece and Pisano 1993) and the central theme in the perspective is the distinctive configuration of skills and knowledge of the firms that differentiates it from cooperating individuals. The term 'Capabilities' as introduced by G.B. Robertson (1972) refers to the range of productive knowledge firms and individuals possess. Productive Knowledge is developed through a chain of activities where some activities are similar and some complementary to each other. In his article the term capabilities is used as a limitation for firm.

Langlois and Foss (1998) give an explanation of the limitations of capabilities for an innovation system of a firm where a firm specializes and requires diversity of different capabilities. An existing capability of a firm is a limitation for development of new capabilities and firms need some complementary capabilities from other firms to organize an innovation activity. The cost of organizing an activity chain in the production process within a firm is high and firms rely on other kinds of market and hybrid arrangements to coordinate their activities. Integration of capabilities is less costly for firms and transaction costs are not higher as compared to development of the whole activity within a firm. As capabilities determine the relative costs of organizing an activity between firms, this suggests that capabilities are determinant of the boundaries of a firm and a source of integration of activities between firms. The concept of capabilities as *limitation* to *capabilities* of a firm and the notion that complementary activities between firms support the development of new capabilities provides the point of departure for this paper.

The underlying assumption for the conceptual framework is that the organization of innovation activities is a determinant for the incentives to engage in cooperation and share knowledge, which reciprocates the potential increasing returns to knowledge creation process or problem solving for that given innovation activity (Leiponen, 2000). Complementarity in capabilities of cooperating firms is a source of integration for the organization of innovation activities. Technological collaboration and outsourcing of R&D is a way to internalise knowledge between specific partners to new knowledge about an innovation activity. If innovation is the result of integration of diverse sources of knowledge and is coordinated with other activities within and between firms, the question arises that by what mechanism the coordination of

activities is mediated across borders. The integration of R&D activities not only advances successful innovation but also expedites the process of acquisition of knowledge.

This paper is a part of the series of papers that attempt to answer a broad research problem; how internationally integrated innovation R&D networks within firms originate when firms capitalize on their capabilities in interaction with other firms in complementary fields of technological activities? The present paper focuses on internationalisation of capabilities i.e. technological capabilities of a firm and attempts to analyse the firm level determinants that influence the process of internationalisation of capabilities. Therefore the objective here is to explore the firm level determinants that provide an incentive for the firm to engage in cooperative R&D activities across border and influence their organizational choices. This approach highlights the tradeoffs between contractual and collaborative strategies and research joint ventures. The key focus is to increase our understanding of the incentives to invest in learning created by the choice of different ownership structures and how the nature of innovation activity affects the choice of organizational forms? Therefore this paper is an attempt to apply the concept of organizational interdependencies (Chandler, 1962; Richardson, 1972) for organizing complementarities of activities between firms. Complementarity in capabilities of firms as a coordinating mechanism of generating international cooperation is the explicit focus of this paper.

An emerging phenomenon in the Internationalisation and management of R&D is the development and integration of technological and organizational capabilities (Zander, 1999, Cantwell, 1991, Pavitt et al., 1995, Bartlett and Goshal, 1987). The development of capabilities for international integration leads to different patterns of R&D cooperation. The internationalisation of technological capabilities has been focused on MNCs and their affiliates in advanced industrialised countries. Internationalisation of production is followed by the internationalisation of R&D in MNCs (Reddy, 2000) and the focus of R&D activities is mostly on technological innovations. The internationalisation of R&D is viewed as an objective to create an adaptation of their existing technologies and processes for foreign markets and developing new technologies and processes from the existing technologies. The interaction between the existing technologies is considered important in this regard so as to reduce costs and to avoid duplication of technological activities in different geographical regions.

Internationalisation of research and development activity of a firm (R&D) has been predominantly analysed in relation to multinationals (Bartlett, Doz and Hedlund, 1990;

Dunning & Narula, 1995; Cantwell, 1992; Granstrand & Sjölander 1990, 1992; Håkanson, 1981, 1990, 1992, Pearce and Singh 92, Pearce, 1989, Zander 1994) in terms of the geographic diversification of multinational companies research units. These studies have concentrated on highlighting the determinants that lead multinational clusters to localize their R&D units in countries other than the home country of the parent company. In these studies the scope of the internationalisation has mainly been focused on TBCs and analysed based on patents, R&D statistics and macroeconomic data. Exploitation of innovation in different geographical locations has increased the opportunities for moving into international markets with R&D sub units, showing an intimate relationship between research and development expenditure and multinational firm (Zander 1994).

These studies mainly ignore the firm level characteristics especially the organizational characteristics of the firm that influence in organizing the cooperative R&D structures in firms. Pearce and Singh (1992) have presented a firm level analysis of the determinants of Internationalisation of R&D. Their analysis focuses on the size of firm, overseas production ratio, export ratio, overall R&D intensity and Industry and country/areas. Organization of activities in a firm's operating environment had not been investigated in theory of the firm. Empirical research on innovation and capability accumulation has investigated the organization of activities separately. The issue of why firms coordinate and in what conditions has been extensively studied by transaction cost theory (Williamson 1975). A static framework of analysis is a shortcoming of the transaction cost analysis explanation of this view and lacks the potential to give an interpretation to the interaction and articulation of processes and activities between partners.

The paper begins with brief review of literature that investigates into the dynamics of organizing R&D activity of a firm across borders. The literature review also refers to the dynamic capability perspective of the firm. Next, hypotheses are developed from the theoretical framework and a model is presented.

THEORETICAL FRAMEWORK

This paper gives a competence-based view of co-operation among firms and draws inspiration from a seminal article by Richardson (1972:889) where he points out that 'organizations will tend to specialize in activities for which their capabilities offer some comparative advantage i.e., in similar activities.' Afterwards he also remarks that 'organization of an industry will have to be adapted to the fact that activities may be complementary to each other in the sense that

they represent different phases of a process of production and require in some way or other to be coordinated (p.889).' Conceptualisation of cooperation on the basis of complementary activities gives an explanation when firms collaborate with other firms to combine their own specific assets and core competencies with other firms.

This paper describes relationship between innovation, capability accumulation and organizational choice as theoretical constructs. As this explores the elements that influence the organization of R&D activity in collaborative arrangements, the hypotheses are developed at the network level, firm level and at the activity level between the firms. Development and creation of a cooperative relationship is a process embedded in a network of interdependent relationships and the single relationship is a part of the larger whole. In this study a network of interdependent relationship is analysed but the focus of analysis is on the dyadic relationship between the two parties involved. Therefore, theoretical framework is developed on the relationship perspective and the network approach (Håkansson and Snehota, 1995). Organization of a cooperative arrangement and coordination mechanisms in interaction with others for creation of innovation is an important issue that has a bearing on the capability development activities in a firm. One of the critical characteristics of the cooperative business relationship is the interdependence of relationships in different activities, which makes specific context and circumstances of the relationship. The degree of embeddedness of different interdependent relationships in context and circumstances influence the relationship development process.

Managing Interdependencies of activities

The research and development activity of a firm is an interdependent relationship with different activities within the firm and between other activities of the cooperating firm. The dominant interdependence is between the activities related to technology and the knowledge. It is difficult to draw a clear distinction between the two. The only argument that can be given is that technology is an explicit form of knowledge and knowledge itself is tacit unless it is applied with its explicit elements such as technology without the skills to use it (as stated earlier). For innovation to take place, integration of different sources of knowledge is required. These different sources of knowledge (firms or individual) are connected in interdependent relationships with each other. The development of competence in a firm is dependent on a firm's relationships and the knowledge of the other firm. The interaction of existing knowledge with other parties' knowledge brings out new knowledge.

Complementarity and Interdependence

In business relationships interdependence is synonym to 'connectedness' in relationships. It is that state of the connectedness of relationships where change in one relationship affects the interaction in others (Håkansson and Snehota, 1995). Therefore interdependence creates a ripple affect. Complementarity is that state of a level of an activity in a relationship that complements any other level of activity at a given point in time without causing changes in the connectedness of relationships as a whole (Richardson, 1972). This implies that complementarity is measured at a given point in an activity pattern and only affects that level or phase of an activity without disturbing the whole relationship. This also means that complementarity is a governance mechanism in initiating a process and keeping different phases of the process intact with each other. Interdependence encompass the relationship as a whole whereas complementarity of an activity in a relationship is at a particular level or phase of that relationship

A scheme of analysis is developed in relation to the underlying research question for this study; how does the choice of organizational form for R&D activities differ in terms of its effect on innovation process? The main idea for this scheme of analysis is derived from Håkansson and Snehota (1994). This scheme is used to identify the factors that affect the relationship development approach to foreign entry process. The focus of analysis in this broad scheme is on the direct effect of activity structure and resource collection on the choice of organizational form. This depends on the interplay between the variables for activity structures on one side and the interplay between variables for resource collection on the other side. The development of a cooperative relationship in this scheme of analysis means developing or intervening in activity links, resource ties, and actor bonds in an interaction with the other firm. When one firm intervenes in activity links, resource ties and actor bonds with another firm, the three key areas where effects of this intervention are prominent and need to be managed are capability development, marketing and purchasing activities, and strategy development processes. To enter or not to enter in a cooperative relationship across borders is a strategic issue. In the context of research and development activity of firm, the innovation process affects this decision because innovation is the integration of different sources of knowledge no matter if knowledge is residing in firms (suppliers or customers), individuals or in the research and development activities.

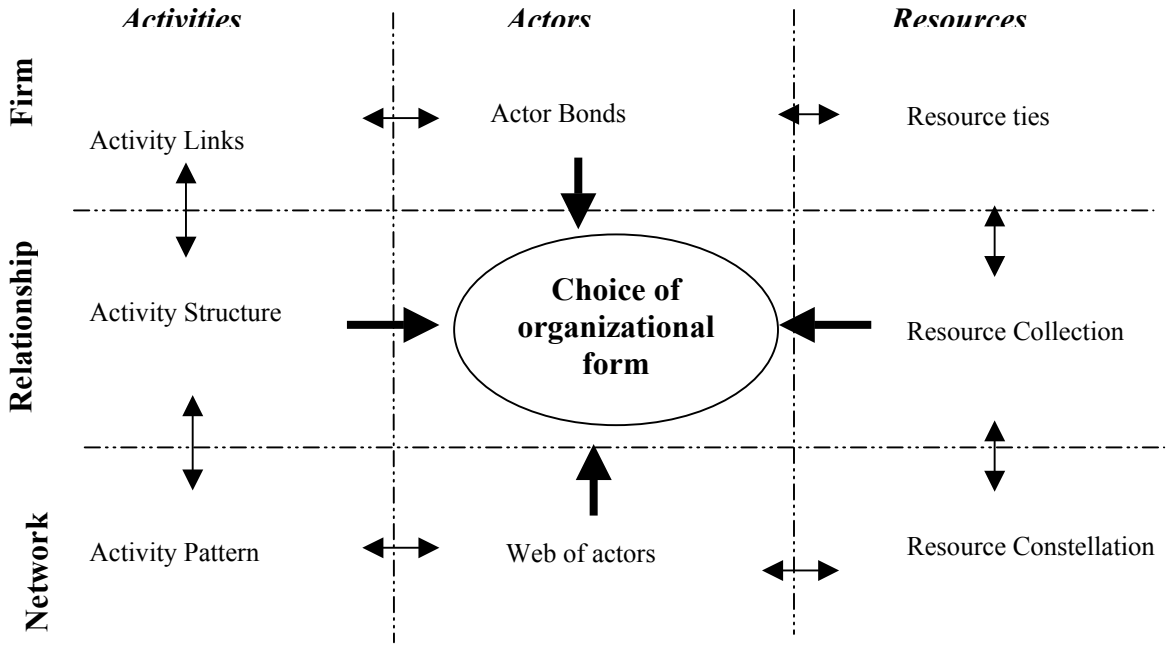

Figure 1: A scheme of analysis for the choice of organizational form

Organization of technological innovation process

Firms engaging in R&D activity have experimented with organizational changes, in an attempt to create the environment for effective innovation (Twiss, 1982). There are three elements of a firm's context that influence the process by which it adopts and implements technological innovations: organizational context, technological context, and environmental context. In literature, different phases of innovation are presented to give a complete view of the process. These phases mostly give an explanation to production of technology phases rather than to the phases of innovation as a whole. Many of such phases include basic research, applied research, development, evaluating, manufacturing, and marketing stages respectively (Tornatzky and Fleischer, 1990). The focus of analysis in this study is not on specific phases or stages of development of technology, rather it specifically emphasises the factors that influence in initiating the process towards integrating different phases of technology production. The factors that are realized as those factors contributing to the initiation of innovation process are mediating factors through out the whole process of innovation. Therefore, three factors are identified as;

- R&D Spillovers
- Complementary Capabilities which are further subdivided into
    a) Knowledge capabilities
    b) Organizational Capabilities
    c) Technological Capabilities
- Learning and accumulation of capability

The next stage of the focus of analysis is on the relationship between these three factors and the choice of organizational form and see how innovation process influences the tradeoffs between different organizational forms such as Research joint ventures, Contractual arrangements, Mergers, Alliances, Acquisitions and Research alliances. This suggests that the approach gives a comparison of the each of the organizational form with the innovation process and the selection of the choice of organizational arrangement (see figure 2).

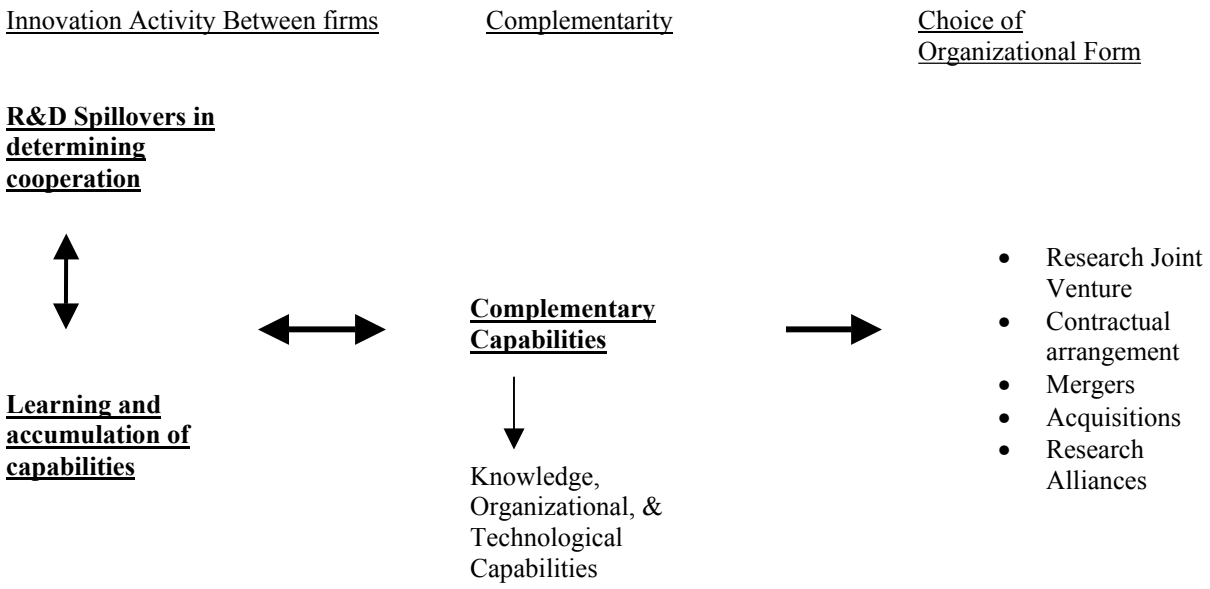

Figure 2: Theoretical Framework

COLLABORATIVE R&D

Collaborative R&D is viewed as a transaction in organizational knowledge. Collaborative arrangements like R&D alliances, Research joint ventures, and Research consortia, mergers and acquisitions are becoming increasingly common. In order to make of other firm's knowledge a firm needs to possess sufficient internal competencies or in other words absorptive capacity (Cohen and Levinthal, 1989). Contractor and Lorange (1988) have discussed several types of

cooperative arrangements between the two extremes of spot transaction and their complete merger. The arrangements differ on the basis of the legal form of the agreement as well as their strategic impact on the global operations of each partner. They rank the cooperative arrangements in order of increasing interarganizational interdependence and mention that there has not been any empirical work that compares the various types of cooperative arrangements on the extent of interarganizational dependence they create. (See figure 3)

The term joint venture implies the creation of a separate corporation by sharing the stocks between two or more partners on a proportional share of dividends as compensation. Many no equity cooperative arrangements between the firms involve joint activity without the creation of a new corporation. These arrangements often involve defined rules and formulas that govern the allocation of tasks, costs and revenues. Several alliances in the pharmaceutical and biotechnology fields are built on the rationale of pooling in of complementary technologies of the partners. For high-technology industries cooperative arrangements are a vehicle for bringing together complementary skills that is necessary to bring out an innovation. In the figure above, the no equity cooperative arrangements are highly characterised by high extent of inter-organizational dependence. This is due to the diverse nature of the sources of knowledge that contribute in a specific innovation activity.

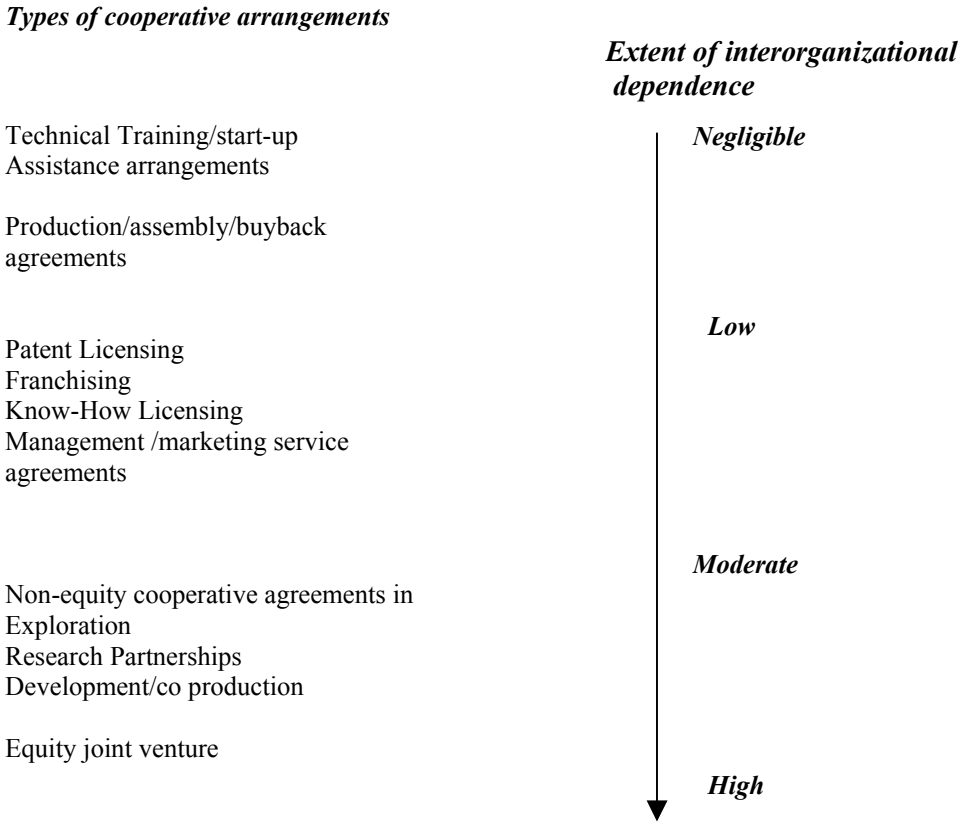

Figure 3: Types of Cooperative arrangements

Network externalities and R&D Spillovers

One cause for market failure in the development of innovation is the existence of R&D spillovers. Cooperative R&D offers a possible solution for market failure, which results from the existence of R&D spillovers. When firms contribute cooperatively on R&D investments the externalities, which arise because of the R&D spillovers are internalised (Steurs, 1994). Liebowitz and Margolis (1994) use a narrower definition of Network externalities. They define a network effect as a circumstance in which the net value of an action is affected by the number of agents taking equivalent actions. Network externalities are defined as a specific kind of network effect in which the equilibrium exhibits unexploited gains from trade regarding network participation. Spillovers are a specific kind of externality. In general, the spillovers concept is vaguely defined. Some authors use a broad definition (Mohnen, 1990). Spillovers are one form of technology diffusion, which is still a broader concept. In this paper, R&D spillovers are discussed as voluntary or involuntary leakage of knowledge or know how. "… Spillovers will here be equivalent to knowledge spillovers: involuntary leakage or voluntary leakage of useful technological information." (De Bobdt 1995, pp. 3). Therefore R&D spillovers imply that other firms can use the research done by one firm without the latter purchasing the rights to do so. It includes involuntary leakage, as well as voluntary exchange of useful technological information.

R&D spillovers in determining the cooperation between firms

Development and acquisition of capabilities by interacting with other firms is difficult because knowledge and technology has certain noncodifiable elements specific to its location and context of origin. Therefore firms rely on spillover effects of technological activity to learn the tacit and non-codifiable elements of the R&D activity. To understand how spillover effects of technological activity influence the organization of R&D innovation networks, an understanding and analysis of the nature and pattern of complementary activities of firms in similar R&D activity, at different phases of production that require in some way or another to be coordinated, is important.

The patterns of complementary activities between firms describe the extent to which the companies direct knowledge flows and the extent of knowledge spillovers that is retained by the firm. The extent of the knowledge spillover that is retained by the company contributes in the

development of a particular capability of a firm. Therefore an analysis of the pattern of complementary activities explores the relationship between knowledge spillovers and the evolution of technology. The attention of focus in R&D literature has been much on the impact of intra-industry R&D spillovers, i.e. spillovers between firms operating in the same industry. The empirical literature has stressed the greater importance of inter industry R&D spillovers i.e. R&D spillovers between firms operating in different industries.

H1: *Individual firm's choices of whether or not to cooperate depend largely on the magnitude of knowledge spillovers in the industry. The larger the spillover the more beneficial the cooperative R&D.*

H2: *Complementarity in technological activities of cooperating firms causes knowledge leakage.*
H3: *Investment in productive cooperation decreases the amount of involuntary knowledge spillovers, which increase the incentives to put effort into cooperation in innovative activities.*

COMPLEMENTARY CAPABILITIES

A set of capabilities or 'absorptive capacity' as identified by Cohen and Levinthal (1989) that a firm requires to interpret and use the knowledge is built by R&D activity in a firm. Without capabilities to interpret, synthesize and make use of new knowledge, an organization or an individual cannot benefit from exchange of existing knowledge. Richardson (1972) extended the internal growth dynamic of the Penrosian firm to inter-firm relations. Firms specialize in activities utilizing the existing capability in the firm and affiliate with other firms that specialize in a complementary activity. Therefore, economic activities are not only coordinated by hierarchy within the vertically integrated firm or by price mechanism in the market rather by an affiliated mechanism of complementary activities. The organization of the industry and the division of labour on the basis of complementary activities, inter-firm cooperation and affiliation has been discussed in his seminal article. A capability is defined as a collective ability to carry out an activity. It consists of simple skills like technical, social and communication skills considerable parts of which are tacit. Knowledge needs to be shared in an organizational context, so that skills possessed by individuals are connected with those of others engaged in a common activity.

Firms engage in collaborative arrangements in order to cope with technological complexity, reduce the uncertainty and costs of R&D, capture partner's knowledge and reduce product development times (Hagedoorn, 1993; Contractor and Lorange, 1988). Pisano et al (1988) have identified that collaborative arrangements are aligned with strategies to minimize transaction costs. Time and resources involved for making the collaborative arrangements make it costly for the firms. However, the costs and benefits of collaborative projects are a function of the existence and scope of the firm's complementary internal knowledge assets. A firms needs to have certain internal competencies to internalise and utilize effectively the knowledge created or accessed through collaboration (Cohen and Levinthal, 1989). Organizational routines, skills are important components of absorptive capacity of a firm. Thus, it suggests

H4*: Firms lacking complementary internal competencies will find it less probable to engage in collaborative innovation and vice versa.*

a) Knowledge Capabilities

Knowledge concerning one type of activity may enhance the returns to knowledge creation in another. Therefore knowledge production in two or more domains can be complementary in innovation. Capabilities are developed internally. The firm outsource only the outputs produced by capabilities, not capabilities themselves. Complementarity of capabilities is necessary condition for bilateral resource redeployment, i.e. when both the target and the acquiring firms' resources are shared and modified during the integration process, bilateral redeployment of resources is associated with improved R&D capabilities.

H5: *Interaction between firms due to the integration of the dynamically complementary capabilities of the cooperating increases innovation capacity.*

H6: *The increased stock of capabilities increases the chances of adopting an innovation*

b) Organizational Capabilities

Organizational Capabilities are firm specific advantages and are also strategic advantages based on tacit knowledge, internal routines, firm-specific skills, and organizational learning. Grant (1996) has identified that the primary role pf the firm and the essence of organizational

capability is the integration of knowledge. Knowledge integrated fro m diverse sources transforms into organizational capability of a firm. Integration of knowledge is viewed as a hierarchy of integration. At higher levels of integration are capabilities, which require wide-ranging cross-functional integration. He has identified the hierarchy as the single task capability, specialized capabilities, and Activity related capabilities and cross-functional capabilities. The argument given in his article is that the higher-level capabilities involve the integration of lower level capabilities that is only achievable through integrating individual knowledge. The higher-level capabilities involve new product development capability, customer support capability and quality management capability. Then the question arises if higher-level capabilities are the result of integrating lower level capabilities then why firm cooperate with other firm at product development level and acquire knowledge from each other's complementary activities. Also another question arises about the mechanism of integrating that knowledge which becomes a part of an organizational capability once it is applied and incorporated in a firms system. The mechanism for the integration of tacit knowledge is yet unknown. In order to answer all these questions the notion of complementarily in activities and capabilities of the cooperating firms becomes quiet relevant in the context of internal and external Integration. Interfirm collaboration through relational contracts is viewed as the likely mechanism of knowledge integration. When there is lack of correspondence between the knowledge bases of firm and its set of products available then that firm realises the need to collaborate with other firm for the provision of necessary capabilities corresponding to its set of products. In this case the scope of firm boundaries is not clear and knowledge resources are fully utilized (Grant 1996). Thus,

H6: L*ack of correspondence between the knowledge base of the firm and its set of products increases incentives to engage in collaborative R&D activity.*

H7: *Complementarity in the knowledge bases of two firms provides an incentive to join in inter-firm collaboration.*

c) Technological Capabilities

The scientific and technological knowledge a firm posses is an intangible resource (Foss, 1996). Strategically intangible resources are the most important as these provide a basis for a firm's competitive advantage. These intangible assets are also most difficult to detect or learn by the other firm. These intangible assets are a determinant for the absorptive capacity of a firm and

provide a set of capabilities to exploit technological opportunities. Technological capabilities can be distinguished into human resources and the commercial resources. Human resources include the knowledge, skills, and experience of the individuals associated with the firm. This human capital implies higher skills and knowledge into the firm, which is critical to the organization of the R&D activities. From this it is deducted that,

H8: *The greater the firm stock of human capital, the greater are the chances to engage in R&D activity with other firms.*

The commercial technological capabilities include a firm's reputation or its image. These commercial resources are a kind of complementary resources for exploiting the innovations that are the result of internally developed R&D (Teece 1987). The amount and characteristics of the complementary resources are a decisive factor in the relationship between innovation and profitability. Venturing into an export activity with foreign clients increases with the higher value of commercial resources.

H9: *An increase stock of human capital increases the probability of firm to engage in R&D exporting activity.*

Learning process and accumulation of capabilities

The fundamental factor behind knowledge accumulation is unknown in the organizational literature. Recent studies on innovation and firm capabilities provide evidence for innovation performance and the accumulation of knowledge capital. Knowledge capital is the ability of the firm that enables a firm to bring new products to market and improve productivity through process innovation. Differences in the knowledge capital among firms describe their different capabilities to learn and innovate, owing to different R&D investments and innovation performance (see also (Hedlund & Kogut, 1993, Hedlund, 1986; Bartlett and Goshal, 1989).

The learning process varies form firm to firm and across industries and sectors. Learning is a form of an exploration that includes R&D activities, hiring skilled employees, licensing, IP acquisitions collaborations with other organizations and the internal organizational design. The exploration process is complemented by assimilation of the skills into the organizational routines and systems to make it a capability for the firm. Therefore first hypotheses could be developed as

H10*: Investment in learning will have a positive relationship with the capability accumulation and maximized expected profits.*

Conclusion

This paper attempts to establish theoretical grounds for the mechanism of inter firm collaboration for organization of R&D activities across borders. Different organizational arrangements for inter-firm collaboration have been discussed and the affect of innovation activity in the choice of this organizational arrangement is explored theoretically. The paper is at the developmental stages and feedback is required to proceed further and see its application for the internationalisation of R&D activity of a firm.

References

Bartlett, C.A. & Goshal, S., 1989, 'Managing Across Borders – The Transnational Solution,' Harvard Business School Press, Boston, MA, USA.

Bartlett, C.A. & Goshal, S., 1990; 'Managing innovation in the Transnational Corporation.' In C.A. Bartlett, Y. Doz & G. Hedlund (eds.), Managing the Global firm. Routledge.

Bartlett, C.A., Doz, Y. & Hedlund, G., 1990, Managing the Global Firm Routledge

Cantwell, J., 1991, 'The Theory of Technological Competence and its application to International Production.' In D. G. McFetridge (ed.), Foreign Investment, Technology and Economic Growth. Calgary: University of Calgary press.

Chandler, D.A., Hagström, P. & Hagström and Sölvell, Ö., (eds.), 1998, 'The Dynamic Firm: The role of Technology, Strategy, Organization and Regions.' Oxford and New York: Oxford University Press.

Cohen, W.M., and D.A. Levinthal 1989, 'Innovation and learning: The two Faces of R&D,' Economic Journal 99, 569-596.

Contractor, F. J., and P. Lorange, 1988, *Cooperative Strategies in International Business,* Lexington, MA: Lexington books.

(De Bobdt 1995, pp. 3

Dunning, J. H. & Narula, R., 1995, 'The R&D Activities of Foreign Firms in the United States.' In Ö. Sölvell & I. Zander (eds.), The Dynamic Multinational Firm, International Studies of Management and Organization, ISMO, spring-summer, 25 (1).

Granstrand, O. & Sjölander, S., 1990, 'Managing Innovation in Multi-Technology Corporations.' Research Policy, 19, pp. 35-60.

Granstrand, O. & Sjölander, S., 1992, 'Internationalisation and Diversification of Multi technology Corporations.' In O. Granstrand, L. Håkanson & S. Sjölander (eds.), Technology, Management and International Business- Internationalisation of R&D and Technology. Chichester: John Wiley& Sons.

Grant, M. Robert, 1996, 'Prospering in Dynamically-competitive Environments: Organizational Capability as Knowledge Integration,' Organization Science, 7(4), 375-387

Hagedoorn, J., & Schakenraad, J., 1994, 'A comparison of Private and Subsidized inter-firm linkages in the European IT Industry,' Journal of Common market Studies, 31, pp. 373-390.

Hedlund, G., 1986, 'The Hypermodern MNC - A Heterarchy?' Human Resource Management, 25 (1)

Hedlund, G., & Kogut, B., 1993, 'Managing The MNC: The end of the Missionary Era.' In G. Hedlund (ed.), Organization of Transnational Corporations, United Nations Library on Transnational Corporations, Vol. 6. Routledge.

Håkansson, H., Snehota, I. (eds.), (1995): Developing Relationships in Business Networks, London: Thompson (Rothwell et al. 1974)

Kogut, B. and Zander, U. 1992 'Knowledge of the firm, Combinative Capabilities, and the replication of technology,' Organization Science, 3(3), 383-397

Leiponen, A. 2000, 'Competencies, Technological Regimes, External Modes of Innovation: Services vs. Manufacturing,' Mimeo, ELTA

Liebowitz, S. J. and Margolis, S. E. 1994, 'Network externality: An uncommon tragedy,' Journal of Economic Perspectives, 8, Nr. 2, S. 133-150

Parahald, C. K., & Hamel, G., 1991, 'The Core Competence of the Corporation.' Harvard Business Review, May-June, pp. 79-91.

Parahald, C. K. & Doz, Y. L., 1987, 'The Multinational Mission – Balancing Local Demands and Global Vision.' The Free Press

Pearce, R. D., and Satwinder Singh, 1992, 'The internationalisation of Research and Development: A Firm-level Analysis of Determinants' In Pearce R. and Singh S. (eds.), Globalizing Research and Development, The Macmillan Press Ltd, London

Pisano, G. P., W. Shan, and D. J. Teece, 1988, 'Joint ventures and Collaborations in biotechnology industry,' in International Collaborative Ventures in U.S. manufacturing, edited by David c. Mowery, Cambridge: Ballinger Publishing Company, 183-222

Richard N. Langlois and Nicolai J. Foss, 1998, **'***Capabilities and Governance: the Rebirth of Production in the Theory of Economic Organization,'* paper presented at DRUID conference.

Richard N. Langlois and Paul L. Robertson, 1989, 'Explaining vertical Integration: Lessons from the American Automobile Industry,' " *Journal of Economic History* **49**(2): 361-375 (June 1989). Langlois and Robertson 1995;

Richard N. Langlois and Paul L. Robertson*, 1995 'Firms, Markets and economic change: A dynamic Theory of Business Institutions,'* London: Routledge

Rothwell, R, & Dodgson, M, 1994, 'Innovation and Size of firm,' In Rothwell, R and Dodgson, M (eds.), The Handbook of Industrial Evolution, Edward Edgar, London

Richardson, G. B., 1972, 'The Organization of Industry,' Economic Journal, 82: pp. 883-896.

Rumelt, R., 'Towards a Strategic Theory of the Firm.' In R. B. Lamb (ed.), Competitive Strategic Management. Englewood Cliffs, NJ: Prentice Hall.

Steurs, Geert, 1994, ' Technological Spillovers and incentive schemes for R&D,' Doctoral dissertation, Leuven: Katholieke Universiteit, Departement voor Toegepaste Economische Wetenschappen

Teece, D.J., 1986, 'Profiting from Technological Innovation,' Research Policy 15, 285-306

Teece, D. J., Pisano, G. & Shuen, A., 1997, 'Dynamic Capabilities and Strategic Management.' Strategic Management Journal, Vol. 18: 7, pp. 509-533.

Tornatzky G. Louis and Fleischer Mitchell, 1990, The processes of technological Innovation, Lexington Books, Lexington.

Twiss, Brian. 1982, 'managing technological Innovations- second edition', London, Longman Group Limited.

Zander, I. 1994, 'The Tortoise Evolution of the Multinational Corporation – Foreign Technological Activity in Swedish Multinational Firms 1890-1990.' A Dissertation for the Doctor's degree, ISBN 91-971730-29

---------- 1999, 'whereto the multinational? The evolution of technological capabilities in the multinational network,' International Business Review, Vol. 8, 261-291