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Research papers including a general theoretical framework on the effects of knowledge-based off-shoring and networking, emphasising expected sectoral dynamics drawn from previous research[1]

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[1] In the Description of Work the title of this deliverable is "Research papers including a general theoretical framework on the effects of knowledge-based off-shoring and industry reports focusing on the prospective implications with regards to 1) innovation, knowledge and technologies of the industries, 2) the structure and feature of the sectoral innovation system of the industry in the home country, 3) the effects in EU and emerging economies based on input from primary data".

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Background

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The main objective of this work package is to provide insights into inter-sectoral differences in drivers, degree and patterns of global innovation network formation. Three different sectors, each representing their own category in the influential Pavitt (1984) taxonomy, are chosen as cases. Thus, the project will provide insights into GIN formation in a) each of these sectors on their own, as well as generate b) broader insights into how sectoral conditions more broadly may be shaping such networks.

The main research question is:

Q9: What GIN patterns are forming in the selected sectors, and to what extent are these influenced (driven, constrained) by contextual conditions specific to these sectors?

This necessitates developing a theoretical framework which emphasizes how such contextual conditions may influence external networking. The point of departure is the recognition that sectors diverge with respect to knowledge, cumulativeness and opportunity conditions. Existing empirical work e.g. show that the "global footprints" of different industries diverge according to the degree of tacitness and complexity of involved knowledge; according to degree of modularity of the product; and with the distribution of actors and environments globally which can be identified and towards which relevant linkages may be formed. Thus, different sectors face different tensions between centrifugal and centripetal forces of internationalization; Understanding these is critical to the formulation of innovation policy in a context of globalization, as the patterns of GINs forming will determine home and host implications. National and EU level innovation policy must simultaneously account for the firm level need to interact and use the most competent and cost-effective partners world-wide; while ensuring that the linkages formed at this level strengthen rather than hollow out innovative capabilities at those same national and EU levels.

"Understanding sectoral dividing lines in the transition towards GIN"

WP 9 will look especially at the interplay between industry-specific conditions and the evolution or working of Global Innovation Networks. In order to address this research question, a theoretical framework which draws on theories focusing on the influence of sector specific contextual conditions on a) innovation activity in general, and b) network formation in particular, is developed below.

1 INTRODUCTION

Internationalization of industrial activities and innovation is not a new phenomenon, as companies such as Phillips (the Netherlands) and SKF (Sweden) established R&D units abroad already in the 1930s (Swedenborg 1982, Andersson, Fredriksson and Svensson 1996). But whereas the pre-war MNE was characterized by selective R&D localization decisions and showed a high degree of cross-border co-ordination of such activities, the main concern of the post-war MNE was production capacity and market access. R&D for new products, co-ordination and in-house synergies became a secondary issue, and first re-emerged as a strategic concern in the wake of the business cycle downturn in the 1970s.

Parallel to the growth of FDI we have witnessed increased outsourcing and off shoring of production and support services such as sales and marketing. Such coordinated and increasingly global production networks may now be transforming into Global Innovation Network. The agreed definition of Global Innovation Network is (Chaminade, 2009): "A globally organized network of interconnected and integrated functions and operations by firms and non-firm organizations engaged in the development or diffusion of innovations".

This definition captures the main features of a Global Innovation Network, which are:

- Its truly **global** character: going beyond the traditional triad of US-Europe-Japan.
- The **variety of actors engaged** in innovation: both firms and non-firms organizations are part of a GIN
- The **integration** of internalized and externalized networks
- The co-existence of different linkage mechanisms
- A high degree of functional integration
- **Focus on innovation**, as something new to the world but also new to the firm.

Value chains are fragmenting and globalizing; and the activity of innovating is becoming less embedded in individual firms and more embedded in distributed knowledge networks, such as GINs. This means that knowledge accumulate and evolve more broadly; and may be recombined more rapidly. All this is mirroring a trend of increasing product complexity, more rapid technological change and uncertainty; combined with factors such as the availability of low-cost production sites and the need for physical proximity to markets or knowledge communities and enabled, in part, by modern ICTs.

This paper in organized as follows:

- Section 2 presents general perspectives on the dynamics of FDI, GPN and GIN formation
- Section 3 discusses theoretical key concepts developed to capture fundamental sectoral dividing lines
- Section 4 discusses the spatial context of GIN formation
- Section 5 discusses the different dimensions of GIN formation – from committed collaborative ties to contractual sourcing.
- Section 6 brings these theoretical perspectives together and focuses on the organizational challenges of deep and broad GIN embedding
- Section 7 discusses loosely how sectoral dividing lines and dynamics can inform innovation policy

2 THE DYNAMICS OF GIN FORMATION

The interplay of globalization forces such as governmental drivers (e.g. reduction of tariff and non-tariff barriers to trade and creation of trading blocs), market drivers (e.g. convergence of consumer behavior, global customers, homogenous products), cost drivers (e.g. economies of scale/increasing minimum efficient scale) and competitive drivers (e.g. convergence of practices, global networks) pushes industries towards globalization (Yip, 1989 sited from Karlsen, 2007). Simply selling and producing products abroad is getting easier due to several ‘space shrinking’ technologies such as ICT and communication and transportation possibilities and that most world economies are relatively accessible. Other explanations why firms need to have a global presence can be found in that the specific industries may require an international presence in order to be competitive; i.e. to capitalize on its unique resources but also to access complementary capabilities and, increasingly (UNCTAD 2005), tap into localized knowledge bases and monitoring technological development. This we capture as **the sectoral and spatial contexts** of GIN formation.

The mode of internationalization is an important strategic choice that can influence firms’ ability to gain vital information and to acquire external resources (Holmlund and Kock, 1998). According to Root (1987) an entry mode can be seen as an institutional arrangement for organizing and conducting international business transactions, such as contractual transfer, joint ventures and wholly-owned operations. The different entry modes will have different costs and benefits related to the degree of integration. Firms resource commitment to a foreign market has traditionally followed a pattern where firms start by serving foreign markets with agents and later internalize the activity by changing to wholly owned subsidiaries (Pedersen & Petersen, 1998), suggesting that firms start by using low-commitment then firms move towards higher commitment modes. Modes of entry into foreign markets are likely to differ on key dimensions such as the amount of resource commitment, the extent of risk, the potential for returns and the degree of managerial control (Wright et al., 2007), and different modes of entry involve higher levels of commitment and higher transaction costs and costs relating to acquiring resources. Zahra et al. (2000) detected that foreign acquisitions and other higher control modes of entry facilitated greater breadth and speed of technological learning than low control modes such as international export and licensing agreements. If such motives increasingly drive internationalization; it is likely to reflect in changing entry modes.

Johanson & Vahlne (1977), and their model of internationalization referred to as the "The Uppsala Internationalization Model", represent a process view of internationalization, and argues that gradual patterns of internationalization are based on the psychic distance to other markets (i.e. differences in language, culture, level of industrial development). The main argument being that internationalization is a process based on experiential learning in foreign markets (Madsen & Servais, 1997), and as such creates internal skills and knowledge. The Uppsala model therefore suggests an evolution towards internationalization based on learning and knowledge acquisition through experience and time that is internally driven in that managers steadily learn and therefore are more prone to take further steps towards new markets. This view is therefore *linked to the internal knowledge base* of the firms, and firms' learning ability. However, their perspective does not take into account external factors as drivers of internationalizations. If a firm lacks resources internally, one strategy could be to combine resources with an external organization using co-operative arrangement, explaining the growth of alliances in the global economy (Jolly, 1989). Network theory of internationalization emphasizes the impact of business relationships upon the growth and internationalization of firms (Johanson and Vahlne, 1990), being part of a network can provide external tangible and intangible resources that aid internationalization (DANA, 2001). As the knowledge-based industries are growing the role of networks in these industries has gained importance (Powell and Grodal 2006, p.59).

According to Håkansson (2002) a network is a structure where a number of nodes are related to each other by specific threads where the relations are a result of the investment done by both parties: The stronger the thread is the more content it is within the network (op.cit. p. 133-135). **This we capture by our focus on the dimensions of GINs.** An advantage of close-knit collaborative networks may be their superior ability to transfer tacit knowledge (Van Wijk, Van den Bosch and Volberda 2003, Hansen 1999), and as such be important channels for knowledge creation and innovation to happen. Looser network, on the other hand, may diffuse more diverse information (Granovetter 1973) – and if conditions are conducive to it, contractual sourcing may enable flexibility in the use of external resources and components. An important research aim is therefore to look into what flows through those connections and channels, and what are decisive for the type of flows that exists, and do these flows differ between knowledge bases?

3 THE SECTORAL CONTEXT OF GIN FORMATION

Pavitt (1984) presented an empirical classification of 'sectoral technological trajectories', a taxonomy that has been tremendously successful in empirical research and has guided the identification of firms and country advantages. According to Pavitt a key difference among sectors refers to the sources of innovation and the appropriability mechanisms (patents, secrecy, lead time, learning curves, and complementary assets). Pavitt pointed out the existence of a few major innovation modes in different groups of sectors, and provided a useful illustration of sectoral differences in terms of technological capabilities. Malerba and Orsenigo (1996, 1997) extended Nelson and Winters analysis and proposed that technological regimes are composed by a set of opportunity, appropriability and knowledge base conditions.

The discussion of GINs will be structured around these contextual conditions, as they pose systematic but divergent incentives and constraints upon organizational structure (see Malerba and Orsenigo 1993, Asheim and Gertler 2005).

Agro-processing can, according to Pavitt (1984), be characterized as a supplier-driven industry; or alternatively as a representative of a continuous process regime (Marisli and Verspagen 2002). Emphasis is on process innovations and technological opportunity is generally characterized as low, thus increasing the importance of non-technological forms of innovation. Knowledge bases are fairly complex, often relying on a variety of technologies and fields. There are also generally large potentials for applying technologies from other areas, such as ICT and biotechnology (see Herstad et al 2009). This places specific importance on interaction with suppliers and on acquiring technologies that firms do not have the know-how to develop themselves. Thus, sourcing of technology in the form of equipment is important, and often linked to tight collaboration with equipment providers (see Laestadius 1998). Automotive can according to Pavitt (1984) be characterized as production-intensive; or in the Marsili and Verspagen (2002) taxonomy as a representative of complex product systems. Key characteristics here are product innovation supported by process innovations and a wide range of external knowledge providers; as its knowledge base involves the combination of mechanical, electrical and transportation technologies. Last but not least, ICTs can according to both taxonomies be labelled a representative of science-based regimes; assumed to be characterized by a knowledge base firmly embedded in the life sciences and physical sciences. The regime includes pharmaceuticals, computers and other information processing equipment, electronics, and telecommunication equipment (Bloch et al 2009).

The three chosen sectors are distinct with respect to underlying regime characteristics:

3.1 Opportunity and appropriability conditions

Opportunity conditions are linked to both upstream technology conditions and downstream market conditions; i.e. to the pace of technological and market change; the *pervasiveness* or multi-purpose nature of knowledge developed, and the willingness of markets to absorb radical change. High opportunities are created in the interplay between specific external conditions at the input and output side. On the input side, it implies that the knowledge relevant for innovation is easily accessible or can be developed at cost which is low compared to its returns; and at the output side that the clients and markets in question are willing to support – through willingness to pay for - a high rate of product change. The combined effect of availability of knowledge and demand for innovations at the output side may create a very dynamic industrial landscape of intense competition and high rates of new entrants on to markets. Conditions where opportunities are constrained we find in markets ranging from the production of commodities to business-to-business markets for capital goods. High *pervasiveness* exists when knowledge or technologies developed may be applied to a variety of products and markets, such as e.g. developments within biotechnology, ICTs or nanotechnology. Low pervasiveness means that new knowledge or technologies have a limited market outside its initial domain (Malerba and Orsenigo 1993), or are perceived so, hence limiting investments in the development of these and the search for alternative uses.

Appropriability conditions refers to the possibilities of protecting innovations from uncontrolled imitation, consequently protecting own returns from investments in innovation. More specifically, it refers to the possibilities of protecting own intellectual property when revealing knowledge through engagement in collaboration; and the possibility of "commodifying" knowledge as the basis for alternative means of commercialization. Hence, appropriability can be assumed to directly influence network formation. Measures such as patents or copyrights provide formal means of protecting intellectual properties, whereas complexity or tacitness of, and firm specialization in, knowledge bases may provide effective functional substitutes of formal IP (Cassiman and Veuglers 2006:76-77). A high degree of strategic protection may often be linked to high cumulativeness conditions (Malerba and Orsenigo 1993, Castellacci 2008).

3.2 Cumulativeness conditions and the characteristics of knowledge bases

The nature of knowledge has been found to be a strong predictor of organizational structure and patterns of external interaction (Asheim and Gertler 2005, Birkinshaw et al 2002, Malerba and Orsenigo 1993, Laursen and Salter 2006, Cassiman and Veuglers 2006); and hence knowledge base diversities to be an important factor in explaining firm and sectoral networking diversity. Many industrial knowledge bases are complex composites, developed by drawing on and integrating knowledge from a wide range of research disciplines, and combining this with experience-based knowledge developed internally or sourced externally. Other knowledge bases are less complex, and can to a larger degree directly reflect e.g. advances within disciplinary research (see Asheim and Gertler 2005). Different degrees of cumulativeness refer to the extent to which the innovative activities of today – by means of contributing to the accumulation of complex, specialised knowledge which is not easy to imitate or relocate - serve as the building blocks of innovations tomorrow (Malerba and Orsenigo 1993:48). Firm level cumulativeness contains core productive knowledge within the boundaries of the organization and its immediate network of collaboration partners; and regional level cumulativeness contain (by means of externalities) such core productive knowledge within specialized regional labor markets.

According to Asheim and Gertler (2005:296) 'an analytical knowledge base dominates economic activities where scientific knowledge is highly important, and where knowledge creation is often based on formal models, codified science and rational processes' (ibid:296). Analytical knowledge bases exist when firm core competencies directly reflect specializations in academic disciplines or other research conducted external to the firm itself. When firms predominantly build on and contribute to bodies of such scientific understanding this can be referred to as the "science-technology-innovation" (STI) mode of learning and innovation. As knowledge is codified, it flows easily across space, within those epistemic communities which understand the codes. Nelson (2004:458) however point out how solutions and practices result from experimentation and "learning that it works", without necessarily understanding (first) their underlying scientific principles. Such processes of "doing, using, interacting" (DUI) remain critical for the ability of enterprises to solve specific problems and meeting specific market needs; and they result in the development of industrial knowledge bases which evolve cumulatively along highly specialized development paths. When corporate knowledge bases are cross-disciplinary and multi-technology, incorporating a strong element of experience-based knowledge, these can be referred to as synthetic (Laestadius 1998). Such knowledge bases "….prevails in industrial settings where innovation takes place mainly through the application or novel combinations of existing knowledge'. In such a context, 'knowledge is created less in a deductive process or through abstraction than through an inductive process of testing, experimentation, computer-based simulation or practical work'. Synthetic knowledge bases are thus built on experimentation and re-combination outside the spheres within which its basic building blocks originate; i.e. within and between industrial enterprises.

The nature of scientific knowledge indicates that it only rarely, directly and in itself, translates into industrial innovation. Know-how of researchers may be very powerful as an economic resource if combined with the experience-based knowledge of non-academic personnel, other departments and other firms. Conversely, purely DUI mode learning within established internal and external networks may be prone to technological lock-in, in that it decreases the exposure of actors towards radically new ideas (Powell and Grodal 2005) and comes with a weaker ability to absorb and assimilate science-based knowledge even when identified as relevant. Hence, firms and regimes may be characterized by combinations of DUI and STI learning. Different degrees of transparency, tackiness or system embeddedness influence the degree to which knowledge easily can be communicated; which in turn influence the need for internal cross-functional communication and challenge external interaction.

4 THE SPATIAL CONTEXT OF GIN FORMATION

The notion of cumulativeness and path-dependent evolution at territorial levels points towards the importance of accounting for national and regional innovation systems; and consider GIN formation as potential linkages not only between actor nodes of the network but also between the larger systems in which they are embedded. A regional innovation system can be thought of as the knowledge infrastructure supporting innovation tandem with the production structure and specialized labor market of a region (Asheim, 2006, p. 47). The ideal example is characterised by intensive interactive relationships and continuous flows of knowledge between and within the two subsystems of a RIS, by means of organisational linkages (see below and labor market mobility). This knowledge flow is stimulated by two types of supporting institutions (Cooke 2001). These institutions incorporate a set of informal rules and social capital, which facilitate the cooperation and the coordination of joint activities among actors in the regional innovation system. Innovation activity is also supported by specific policy tools.

It is increasingly recognized (see Herstad et al, fortcoming) that the path-dependent nature of endogenous learning within territorial systems necessitates external linkages, this to avoid lock in to diminishing return paths (see Bathelt et al 2004). The forces of globalization may necessitate that regional or national innovation systems deconstruct as sets of user-producer interaction. Depending on degrees and directions of technology transfer within GPN and GINs, as well as the relative position of regional nodes in global networks (see e.g. Ebersberger and Herstad 2008), they may however reconstruct as gravitation and accumulation nodes within these networks. Thus, whereas the question of technology transfer traditionally has been linked to the activities of multinational enterprises (Unctad, 2005), it must now be linked to GIN formation more broadly (Knell & Srholec, 2008; Coe, Dicken, & Hess, 2008). This question cannot be assumed to have a clear answer, but will rather depend on numerous contextual conditions such as sectors, locations and policy initiatives involved. Theser expectations are motivated by the fact that existing empirical evidence on technology transfers linked to FDI at best can be considered mixed (Görg & Greenway, 2004; Kvinge, 2007; Unctad, 2005). It is riddled with problems such as that of knowledge base diversity (Kaiser, 2002), biases built into statistical models and available data (Döring & Schnellenbach, 2006; Henderson, 2007), and the fact that the nature of the context (i.e. the specific characteristics of the territorial innovation system) into which a spillover may be induced mediate its measurable impact.

This focus on diversity is also supported by other streams of research. A recent survey of multinationals and their GIN affiliation found that broad R&D footprints follow from codifiability of knowledge, and much more concentrated R&D structures follow from tacitness and complexity (Doz et al 2006) (cf knowledge conditions above). The flow of analytical knowledge is, to a large extent, global and involves researchers in firms and universities etc., which may be dispersed throughout a wide geographical area (Moodysson 2008). The flow of synthetic knowledge occurs mainly on two geographical levels. One level is between customers, producers and suppliers in geographically-extended value chains and in particular, when producers are engaged in solving new problems for customers. The other level is inside firms and in local communities of practice, which include groups of people performing similar tasks (Amin and Cohendet 2004, pp. 76–77). Asheim and Gertler (2005) maintain that tacit knowledge does not travel well and that the exchange of tacit knowledge may require shared experience and face-to-face interactions. Therefore, physical proximity is an important premise for the sharing and transmission of synthetic knowledge.

In general, we therefore expect GINs on average to develop less extensively and more gradually in industries where knowledge is less codified, spillovers more localized (automotive design) and learning more cumulative; than in others where knowledge is more readily codified (software) in a commonly accepted (scientific) language, less cumulative and consequently more distributed across organizations and individuals. As an extension, we assume that the long-run consequences of GINs differ between industries. One can for instance argue that cumulativeness at the firm level, in particular when combined with high appropriability and complexity of knowledge, paves the way for a different geography of production and innovation that low cumulativeness and weak appropriability. In the former case, the cost of relocating an established knowledge base is high; as are the potential costs of co-ordinating innovation on a global basis. Similarly, few if any regions may offer the skills and competencies necessary to attract greenfield investments; nor the existing firms necessary to trigger acquisitions; while some regions may be highly specialised and offer abundant information and knowledge externalities related to specific technologies. In the latter case, rapid technological change may be related to weak appropriablity and create cumulativeness at the level of the region. These externalities may arise from university research, or from industrial agglomerations. As this information and knowledge is not communicated intentionally, physical presence in such environments may be necessary to access them by means of embedding in the regional labour market.

5 DIMENSIONS OF GIN FORMATION

GINs are, by definition, characterized by evolving interfaces which link different actors and knowledge domains, within and across value chains, sectors and space. Such interfaces come in various forms, with various properties. The regime and spatial conditions described above represent the context in which firms decide or are forced to engage in various networking and internationalisation activities. Firms search for new information and knowledge, collaborate to transfer it and source to gain access to complementary capabilities and products on a contractual basis. The weight of these different processes, and their complementarities, can be assumed to vary across different technological regimes.

5.1 Searching

Innovation entails the establishment of novel combinations and rests on the generation of new ideas; both resulting from explorative innovation search. Intentional and unintentional exposure to information and ideas defines search spaces (Katila & Ahuja, 2002), the inputs from which form the basis for experimental reinterpretation against the background of own knowledge, experiences and preferences. Sourcing, collaboration and location decisions' follow as results from search; and contribute to defining the composition and geographical configuration of search space accessed in the next round.

It is commonly assumed that (Nelson & Winter, 1982) the more alternatives there are to select from, the better are the effects of the alternatives selected. Firms should search beyond organizational boundaries and product domains (Rosenkopf & Nerkar, 2001); actively seek out and use technologies from outside own sectoral boundaries (Katila, 2002) and search knowledge domains characterized by lack of shared experiences (Hargadon & Sutton, 1997; Majchrzak, Cooper, & Neece, 2004) rather than similarity with the searching firm. Presence in different contexts may thus be associated with increased innovativeness; as it allows for access to more diverse information flows.

For value to be acknowledged, information must be novel but also interpreted as related to the pre-existing knowledge base and system of shared understandings. Different individuals and departments of the organization, different units of the corporation and different nodes in broader networks search their respective and often well-known external domains. But the initial point of entry of information into organisations and networks is not necessarily equal to the point in which value is identified. This point towards the importance of intra- and inter-organisational diffusion and experimental reinterpretation of information on a broad basis (see Cohen and Levinthal 1990, Zahra and George 2002).

- What search channels are used
- What is the geographical pattern of search
- To what extent does it overlap with value chains?
- What bottlenecks exist in the diffusion of information within the network?

5.2 Sourcing

Search informs companies about opportunities, but does not in itself necessarily allow firms to act according to what is identified. Sourcing is part and parcel of global production networks, and refers generally to the acquisition of knowledge (contract R&D) or solutions (components, machinery, services) on a market basis (Fey & Birkinshaw, 2005; Granstrand, Bohlin, Oscarsson, & Sjöberg, 1992). Input-output analysis has revealed large international product embodied technology flows in sectors such as ICTs, automotives and machinery (Hauknes & Knell, 2009). Sourcing in global production network linkages may evolve into technology sourcing linkages; form part of the search space and overlap with collaborative linkages.

Innovation sourcing presupposes certain characteristics of the transaction process, and come with distinct limitations. Solutions needed should be modular, and the problem codifiable in a language which allow for clear-cut contracts to be written. Modularity of product systems may enable the use of different components to achieve different product characteristics. Contract R&D targeting thirdparty public or private labs enable companies to draw on competences accumulated through the previous rounds of development work conducted by these (Hargadon & Sutton, 1997), in part for other (competing) firms (Fey & Birkinshaw, 2005). Sourcing provides solutions with less knowledge accumulation (Lane & Lubatkin, 1998:462), and de facto leaves the sourcing firm with less control over the full set of assets developed. Over time, this translates into a risk of hollowing out of internal competencies (Novak & Eppinger, 2001).

- Who are you sourcing from?
- Who are sourcing from you?
- Role of parent corporate network.
- Perceptions of technology transfer through sourcing.

5.3 Collaborating

However, under conditions of low modularity, high complexity and high tacitness of involved knowledge sourcing may not be feasible (see Teece 1988 for a discussion) and more committed forms of interaction may be necessary to achieve knowledge transfers and enable coordination of uncertain tasks. Collaboration can be defined as committed, two-way communication between participating actors, for the purpose of achieving knowledge transfer or conducting new knowledge development. Collaboration is distinct from search and sourcing in that partners gain access to the tacit components of each other's knowledge bases. Industrial firms may collaborate a wide range of actor groups, from universities or research institutes (Bailetti & Callahan, 1992; Conway, 1995), suppliers, customers (Helper, DacDuffie, & Sabel, 2000; Lettl, Herstatt, & Gemuenden, 2006; von Hippel, 1988) and competitors (Chiesa & Manzini, 1998; Hagedoorn, 1993). These differ with respect to the knowledge, problem-solving and risk-management capabilities the may contribute, at what stage of the innovation process. Thus, the extent to which collaborative relationships form towards *different actor groups* in *in different industrial contexts* is a key characteristic of GINs.

Collaboration requires trust (Lundvall, 1992; Storper, 1997), mechanisms to regulate opportunism (Helper et al 2000) alignment of objectives and allocation of internal resources. As opposite to search, collaborative linkages are established based on thorough, prior analysis of what internal competencies that are need to mirror those external competencies that are to enter, when, to meet these objectives. Project progression may be monitored and their composition as well as mandate continuously adjusted according to evolving circumstances. The a priori experimentation internal communication problem of search is in this way replaced by an ex post problem of partner selection, project group composition, resource allocation and management coordination processes. If combined with high modularity and low uncertainty, such may extend over large geographical and cultural distances.

6 THE CONSTRAINTS OF COORDINATION, COMMUNICATION AND ABSORPTION

The broader the presence of a company is in numerous business contexts, the more it is exposed to novel ideas and knowledge; the more diverse labour markets it can tap into and the more diverse actor groups it can form co-located collaborative relationships with. Further, the broader the external network of a company, the more is it exposed to knowledge and ideas from various different knowledge domains. Hence, breadth in the geographical scope and network linkage or organizations provides exposure to novelty. However, geographical scope and broad network linkages comes with a cost. With increasing number of contact points in a network, the complexity of the network as a whole increases exponentially, potentially leading to problems of co-ordination, communication and integration between and of its constituent element. With more diverse actor groups involved, problems of knowledge system compatibility and relative absorptive capacity emerge (Lane and Lubatkin, 1998). Hence, a fundamental trade-off exist between the ability of companies to establish broad external contact points, and the ability of companies to absorb, diffuse and use this knowledge on a larger scale. GINs, it can be assumed, thus evolve partly as a result of how companies, assisted by modern communication technologies and management tools, balance between opportunities stemming from breadth in external contact points and geographical reach, and the organizational costs related to building and coordinating network interfaces *combined* with internal knowledge diffusion and accumulation systems. This is referred to as “the Penrose-effect” (Rugman & Verbeke (2001), i.e. a limitation to a firm’s growth rate (is) due to managerial and organizational constraints (p. 6). This effect may, however, be countered by learning (Bosch et al, 1999).

7 POLICY

According to Herstad et al (forthcoming), the globalisation of innovation and the emergence of GINs means that public policy can no longer build territorial knowledge bases (at regional, national and EU levels) without accounting for the need to link such development processes to external knowledge, information and capabilities. This means that public policy must balance between a focus on the intramural activities of domestic industries; the mechanisms through which their spillovers diffuse within territorial economies (the traditional territorial innovation system concept, with related tools focusing on linkages and networking within economies) and the build-up of necessary external networks. The latter come in numerous forms, such as schemes attempting to attract inward FDI and support for domestic industries collaboration with customers abroad, funding of research abroad or engaging in large international consortia (e.g. EU projects). As these three dimensions are both complementary to each other, and contradict each other, a careful balancing of tools and policies are necessary (ibid). Part and parcel of seeking out this balance is accounting for sectoral diversities (see Herstad et al 2008).

This means that no one best practice innovation policy approach that can be applied to any type of region (Tödtling and Trippl 2005). The literature emphasises the need to construct regional advantage as one way to compete in the global economy, and the literature simultaneously maintains that regional advantage can be constructed by a proactive public-private partnership (Asheim et al. 2007). Factors considered in fine-tuning of policy instruments are the workings of the regional innovation system, the importance of related variety and knowledge spillovers in the regional industry, and thus platforms upon which knowledge diffusion mechanisms can be built; and how to link regional industry and knowledge organisations to national and international knowledge sources (Asheim et al. 2007) without decoupling them from regional linkages conducive to regional spill-overs (Ebersberger & Herstad 2009).

Innovation policies directed towards the STI mode typically address formal scientific and technical knowledge and formal processes of R&D. The DUI mode can be intentionally fostered by building structures and relationship which enhance and utilize learning by doing, using and interacting (Jensen et al., 207 p. 684) – balanced at different territorial levels (Herstad et al forthcoming). The tendency among policy makers has been to think in terms of the linear model of innovation and give priority to supporting R&D activities to the neglect of those mechanisms, processes and linkages which contribute to the build-up of those specialised knowledge bases into which scientific inputs must enter to be transformed into commercial value (Jensen et al., 2007 p. 690). Jensen et al. (2007, p. 690) find it problematic that policy gives little attention to the strengthening of linkages to sources of codified knowledge for firms operating in traditional manufacturing sectors and services. The cluster analysis carried out by Jensen et al (2007) showed that what really improved innovation performance is using mixed strategies that combine strong versions of the two modes. This again points towards the importance of context-specific balancing of tools.

Literature

Carpenter, M., Lazonick, W. and O'Sullivan, M., 2003. The Stock market and innovative capability in the New Economy: The optical networking industry. Industrial and Corporate Change, 12 (5), pp. 963-1034.

Cassiman, B. and Veuglers R., 2006. In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge. Acquisition Management Science, 52 (1), pp. 68-82.

Castellacci, F., 2008. Technological trajectories, regimes and paradigms forthcoming, . Research Policy, 37, [online] Available at:<http://www. google. Carpenter, M., Lazonick, W. and O'Sullivan, M., 2003. The Stock market and innovative capability in the New Economy: The optical networking industry. Industrial and Corporate Change, 12 (5), pp. 963-1034.

Cassiman, B. and Veuglers R., 2006. In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge. Acquisition Management Science, 52 (1), pp. 68-82.

Castellacci, F., 2008. Technological paradigms, regimes and trajectories: Manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. Research Policy, 37, [online] Available at: <http://www.nupi.no/Publikasjoner/Notater/2007/Technological-paradigms-regimes-and-trajectories> [Accessed 27. 10. 2011].

Chesbrough, H., 2003. Open Innovation. Cambridge, MA. : Harvard Business School Publishing.

Chiesa, V. and Manzini, R., 1998. Organising for technologial collaboration. A managerial perspective. R&D Mangement, 28 (3), pp. 199-212.

Cohen, W. M. and Levinthal, D. A., 1990. Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly, 35, pp. 128-152.

Cooke, P., 2004. Evolution of Regional Innovation Systems – Emergence, Theory, Challenge for Action. Regional Innovation Systems. 2nd ed. London: Routledge, pp. 169-187.

Conway, S., 1995. Informal boundary-spanning communication in the innovation process. An empirical study. Technology Analysis and Strategic Management, 7, pp. 327-345.

Cyert and March., 1963. A behavioral theory of the firm. New Jersey: Prentice Hall.

Danneels, E., 2007. The process of technological competence leveraging. Strategic Management Journal, 28, pp. 511-533.

Doz, Y, Wilson, K., Veldhoen, S., Goldbrunner, T. and Altman, G., 2006. Innovation – is global the way forward?. Report, INSEAD [online] Available at:<http://www.boozallen.com/media/file/Innovation_Is_Global_The_Way_Forward_v2.pdf> [Accessed 27. 10. 2011].

Ebersberger, B. and Herstad, S., 2008. Go abroad or have strangers visit? On organizational search spaces and local linkagesGIPOL working paper. Oslo: NIFU STEP.

Fey, C. and Birkinshaw, J., 2005. External sources of knowledge, governance mode and R&D performance. Journal of Management, 31 (4), pp. 597-621.

Floricel and Miller., 2003. An exploratory comparison of the management of innovation in the New and Old economy. R&D Management, 33, pp. 501-525.

Forsgren, M., 1997. The Advantage Paradox of the Multinational Corporation. In: Forsgren, M. and Björkmann, I. eds., 1997. The Nature of the International Firm. Copenhagen: Copenhagen Business School Press., pp. 60-80.

Granovetter, M., 1973. The strength of weak ties. American Journal of Sociology, 78 (13), pp. 111-133.

Granstrand, O., Bohlin, E., Oscarsson S. and Sjöberg, N., 1992. External technology acquisition in large multi-technology corporations. R&D Management, 22 (2), pp. 109-122.

Hagedoorn, J., 1993. Understanding the rationale for strategic technology partnering: Inter-organizational modes of co-operation and sectoral differences. Strategic Management Journal, 14, pp. 716-749.

Hargadorn, A. and Sutton, R., 1997. Effectiveness in a product development firm. Administrative Science Quarterly, 42 (4), pp. 638-652.

Harrigan, K. R., 1984. Formulating vertical integration strategies. Academy of management, review 9, pp. 638-652.

Helpers, S., MacDuffie, J. P. and Sabel, C., 2000. Pragmatic Collaborations: Advancing knowledge while controlling opportunism. Industrial and corporate change, 9 (3), pp. 443-487.

Herstad, S., Bloch, C., Ebersberger, B. and van de Velde, E., 2008. Open Innovation and Globalisation. Report. Vision Eranet., [online] Available at:<http://www.perkrull.dk/wp-content/uploads/open-innovation-report.pdf> [Accessed 27. 10. 2011].

Herstad, S., Bloch, C., Ebersberger, B. and van de Velde, E., 2010. National innovation policy and global open innovation: Exploring trade-offs, balances and complementarities. Science and Public Policy, 37(2), Available at:<http://www.berndebersberger.com/wp-content/uploads/2010/06/HerstadBlochEbersbergerVanDeVelde_10_SciPublicPolicy.pdf> [Accessed 27. 10. 2011].

Holmlund, M, Kock, S., 1998. Relationships and the internationalization of Finnish small and medium-sized companies. International Small Business Journal, 16, pp. 46–63.

Jacobides, M. and Billinger, S., 2006. Designing the boundaries of the firm: From "make, buy or ally" to the dynamic benefits of vertical architecture. Organization Science, 17 (2), pp. 249-261.

Katila R, Ahuja G., 2002. Something old, something new: a longitudinal study of search behavior and new product introduction. Academy of Management Journal, 45 (8), pp. 1183–1194.

Knell, M., 2008. Embodied Technological Diffusion and intersectoral Linkages in Europe. Athens: Innovation Watch- Systematic

Knell, M0 Srholec, M., 2008. Technological collaboration and foreign ownership across firms in Europe. Athens: Innovation Watch- Systematic

Lam, Alice., 2000. 'Tacit knowledge, Organisational Learning and Societal Institutions: An Integrated Framework. Organization Studies, 21 (3), pp. 487-513.

Lane, P. J. and M. Lubatkin., 1998. Relative absorptive capacity and interorganizational learning. Strategic Management Journal, 19 (5), pp. 461-477.

Laursen, K. and Salter, A., 2006. Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. Strategic Management Journal, 27, pp. 131-150.

Laursen, K. and Salter, A., 2004. Searching high and low: What types of firms use universities as sources of knowledge?. Research Policy, 33, pp. 1201-1215.

Lazonick, W., 2005. The innovative firm. In Fagerberg et al Understanding innovation. Oxford: Oxford University Press.

Lazonick, W., 2007. The stock market and innovative enterprise. Industrial and Corporate Change, 16 (6), pp. 983-1035.

Lazonick, W. and O'Sullivan, M., 2000. Maximizing shareholder value: A new ideology for corporate governance. Economy and Society, 29 (1), pp. 13-35.

Leiponen, A. and Drejer, I., 2007. What exactly are technological regimes? Intra-industry heterogeneity an the organization of innovation activities. Research Policy, 36, pp. 1221-1238.

Lepak, D. P. and Snell, S. A., 1999. The human resource architecture: Toward a theory of human capital allocation and development. Academy of Management Review, 24, pp. 31-48.

Lettl, C., Herstatt, C. and Gemuenden, H. G., 2006. Users' contributions to radical innovation: Evidence from four cases in the field of medical equipment technology. R&D Management, 36, pp. 251-272.

Lichtenthaler, U., 2005. External commercialisation of knowledge: Review and research agenda. International Journal of Management Reviews, 7, pp. 231-255.

Lichtenthaler, U. and Ernst, H., 2007. External technology commercialisation in large firms. R&D management, 37 (5), pp. 383-397.

Lundvall, B. -Å., (ed.)., 1992. National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning.London: Pinter Publishers.

Lundvall, B-Å., 2006. Innovation Systems between Policy and Research. Paper for the Innovation Pressure Concerence, march 2006Tampere.

Lundvall, B. -Å., 2007. National innovation systems – analytical concept and development tool. Industry & Innovation, 14 (1), pp. 95–119.

Malerba, F., 2005. Sectorial systems: How and why innovation differ across sectors. In: Fagerberg et al. eds., 2005. The Oxford Handbook of Innovation. Oxford: Oxford University Press. ch. 14.

Malerba, F. and Orsenigo, L., 1993. Technological regimes and firm behavior. Industrial and Corporate Change, 2(1), pp. 45-71.

Marsili, O., 2001. The Anatomy and Evolution of Industries: Technological Change and Industrial Dynamics. Cheltenham: Edward Elgar Publishing Ltd.

Marsili, O., Verspagen, B., 2002. Technology and the dynamics of industrial structures: an empiricaln mapping of Dutch manufacturing. Industrial and Corporate Change, 11, pp. 791-815.

Maskell, P., Bathelt, H. and Malmberg, A., 2006. Building global knowledge pipelines: The role of temporary clusters. European Planning Studies, 14 (8), pp. 997-1013.

Moodysson, J., 2007. Sites and modes of knowledge creation. on the spatial organization of biotechnology innovation. Meddelanden fram Lunds Universitets Geografiska Institution. Avhandlinger, CLXXIV.

Moodysson, J., 2008. Principles and practices of knowledge creation: on the organisation of “buzz” and “pipelines” in life science communities. Economic Geography, 84 (4), pp. 449-469.

Narula, Rajneesh., 2002. Innovation systems and ‘intertia’ in R&D location: Norwegian firms and the role of systemic lock-in’. Research Policy, 31, pp. 795-815.

Narula, R., 2003. Globalization & technology: interdependence, innovation systems and industrial polic. Cambridge: Polity Press. 51-75

Nooteboom, B., 2001. Learning by interaction: Absorptive capacity, cognitive distance and governance. Journal of Management and Governance, 4, pp. 69-92.

Pavitt, K., 1984. Patterns of Technical Change: Towards a Taxonomy and a Theory Research Policy., 13, p. 343.

Persaud, Ajax., 2005. Enhancing Synergistic Innovative Capability in Multinational Corporations: An empirical investigation. Journal of product innovation management, 22, pp. 412-429.

Peneder, M., 2007. Entrepreneurship and technological innovation. An integrated taxonomy of firms and sectors. Europe innova sectoral Innovation Watch, Vienna, September 2007.

Root, F. R., 1987. Entry Strategies for International Markets. Lexington: Lexington Books.

Rothaermel, F., Hitt, M. and Jobe, L., 2006. Balancing vertical integration and strategic outsourcing. Strategic Management Journal, 27, pp. 1033-1056.

Smith, K., 2000. What is the knowledge economy? Knowledge intensity and distributed knowledge bases. Discussion Paper Series, 2002-6Maastricht: INTECH- The United Nations University.

van de Vrande, V., Lemmens, C. and Vanhaverbeke, W., 2006. Choosing governance modes for external technology sourcing. R&D Management, 36 (3), pp. 347-363.

von Hippel, E., 1988. The Sources of Innovation. Oxford: Oxford University Press.

Whitley, R., 1999. Divergent Capitalisms. Oxford: Oxford University Press.

Zahra S., Ireland D. and Hitt M., 2000. International expansion by new venture firms: international diversity, mode of market entry, technological learning, and firm performance. Academy of Management Journal, 43, pp. 925–950.

Zahra, S. A. and G. George., 2002. Absorptive capacity: A review, reconceptualization and extension. Academy of Management Review, 27(2), pp. 185-203.

Dana L. -P., 2001. Introduction: networks, internationalization and policy. Small Business Economics, 16, pp. 57–62.

Powell, W. W., Grodal, S., 2006. Network of Innovators. In: Fagerberg et al. eds., 2006. The Oxford Handbook of Innovation. Oxford: Oxford University Press. Ch. 4.

Holmlund, M. and Kock S., 1998. Relationships and the internationalization of Finnish small and medium-sized companies. International Small Business Journal, 16, pp. 46–63.

M., Wright, Westhead, P. and Ucbasaran, D., 2007. Internationalization of Small and Medium-sized Enterprises (SMEs) and International Entrepreneurship: A Critique and Policy Implications. Regional Studies, 41 (7), pp. 1013–1029.

M., Wright, Westhead, P. and Ucbasaran, D., 2004. Internationalization of private firms: environmental turbulence and organizational strategies and resources. Entrepreneurship and Regional Development, 16, pp. 501–522.

Van Wijk, R., Van den Bosch, F. A., Volberda, H. W., 2003. Knowledge and Networks. In: M. Easterby-Smith and M. A. Lyles. eds., 2003. The Blackwell Handbook of Organizational learning and Knowledge Management. Oxford: Blackwell. Ch. 22.

Håkansson, H., Ford, D., 2002. How should companies interact in business networks. Journal in Business Research, 55, pp. 133-135.