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Harryson, Sigvald; Søberg, Peder Veng

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How transfer of R&D to emerging markets nurtures global innovation performance

Sigvald J. Harryson*

Lund University School of Economics and Management (LUSEM),
P.O. Box 117, SE-220 00 LUND
E-mail: sigvald.harryson@fek.lu.se
*Corresponding author

Peder Veng Søberg

Baltic Business Research Center,
Linnaeus School of Business and Economics,
Linnaeus University,
Gröndalsvägen 19,
39182 Kalmar, Sweden
E-mail: Peder.Soberg@lnu.se

Abstract: In the context of global R&D, we connect literature on knowledge management to a network-based theoretical framework helpful to explain the impact of R&D globalisation on innovation performance. This framework is applied to two case companies, both global leaders within their respective industries, in order to analyse the extent to which their strategic globalisation of R&D activities, from Scandinavia to China, has contributed to increased innovation performance. Our findings suggests that close interaction and cross-fertilisation with local knowledge networks are of eminent importance for newly established R&D offsprings to improve overall innovation performance. Pack Tech illustrates this through a collaboration-intensive approach to university competitions in China.

Keywords: innovation performance; R&D transfers; networking; ambidexterity; sources of exploration; university collaboration in emerging markets.

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Biographical notes: Sigvald J. Harryson is a Master of International Business (1991); Doctoral degree (1995) on R&D management, and PhD (2002) on Knowledge and Innovation Management. He has written several books and publications and made more than 2000 lectureship hours on Growth Through Knowledge Creation and Innovation at the Baltic Business School and the Universities of Lund, Göteborg, St. Gallen, and Copenhagen Business School. He has worked three years as engineer within the packaging industry, and twelve years as consultant in Industry-University Collaboration, Growth Through Innovation Strategies and R&D Globalization, mainly within Booz Allen and ADL as Partner, and BCG as Project Manager.

Peder Veng Søberg is a Business Development Engineer, Patent Engineer and Master of Growth through Innovation and International Marketing (MBA). The Master thesis "Exploring the transfer of R&D to China" won Sparbanksstiftelsen Kronan's award for best Master thesis in southern Sweden 2007. He has worked for Bang & Olufsen (DK) in the Business Innovation department of the company. Also, he has experience as a consultant concerning Intellectual Property Rights Management and R&D Management issues – mainly within the packaging industry. His research interests are centred on internationalisation of R&D, mainly from Europe to China and India, including IPR issues in this context.

1 Introduction

Over the past decade, emerging markets have received attention in terms of R&D globalisation efforts. Von Zedtwitz and Gassmann (2002) describe different principle determinants and trends in internationalisation of R&D and motivating drivers to locate R&D in specific geographical contexts. Gassmann and Han (2004) identify barriers for managing R&D activities in China and Von Zedtwitz et al. (2004) introduce six dilemmas for international R&D, which are interesting to consider in the Chinese context.

Pillania (2005) analyses how India takes an increasingly important role as global innovation hub, and he notes a focus on in-house knowledge creation as opposed to collaborations with external parties in the Indian context. Gertler and Levitte (2005) argue that although in-house technological capability is important, successful innovation is externally oriented. Lewin and Peeters (2006) describe how outsourcing as an activity evolves within multinational companies with a specific focus on the time lags between the outsourcing of low-level work and high-level work. Maskell et al. (2007) describe offshore outsourcing as a sequence of stages towards innovation sourcing, which can best be described as a process of learning by doing. Harryson et al. (2008a) explore how foreign R&D centres in China develop collaborative ties with local universities, but do not analyse how these links affect innovation performance.

The importance of innovation for wealth and social good on national level is evident (Pillania, 2008). However, although the Chinese context has been explored in several papers on R&D transfer, we have not yet found many contributions in the literature on how newly established R&D units can tap into local networks of universities, thereby improving innovation performance in the emerging market context.

The intent of this paper is to address this gap by exploring the extent to which newly established R&D centres in China can use local university collaboration to drive innovation performance.

1.1 R&D expansions in China

The rapid increase in foreign multinational activity in China during the past decade is mentioned extensively in the literature (Hu and Jefferson, 2009; Miesing et al., 2007; Li et al., 2007; Walsh and Zhu, 2007; Xie and White, 2006; Zhu and Li, 2007). Figure 1 lists some of the MNCs that are actively developing their value chains into China through new R&D centres.

Figure 1 shows the year of establishment and the initial number of researchers of some multinational R&D units in China. It also gives an indication of the amount of resources that are presently invested in R&D transfer. This ongoing development within innovation offshoring deserves attention due to the size of these investments, which mainly originate from Western multinational companies (Sun et al., 2006). Although this type of R&D globalisation has happened in China for many years, it has to our knowledge not yet been studied how it affects the innovation performance of the MNCs that are driving the R&D globalisation efforts. Before introducing two recent case studies in this context, we will introduce a network-based theoretical framework helpful to analyse and explain the impact of globalisation of R&D on innovation performance.

Figure 1 R&D investments in China made by MNCs[1]

MNC	*Starting year*	*Amount to invest*	*R&D Staff*
3M	2006	$40 Million	
AMD	2006		100–200
AstraZeneca	2007	$100 Million	
Bayer	2006		100
Carrier	2007	$50 Million	
Caterpillar	2008	$26 Million	
Cisco	2006		400
Degussa	2004	€22 Million	
DSM	2007		400
DuPont	2005	$20 Million	100
Ericsson	2006	$ 1 Billion	
Flextronics	2007	$10 Million	
Ford motor company	2007		
General Electric	2007	$50 Million	
Google	2007		
Honeywell specialty materials	2006	$13.5 Million	60
Intel	2006		1000
L’Oreal	2005		63
Lucent	2005	$80 Million	
Magna power train	2005		20
Microsoft	2007	$100 Million	500
Nokia	2002		500
Nortel	2003	$200 Million	1000
Novartis	2006	$100 Million	
Novo Nordisk	2005		50–60
Oracle	2004		75
Pfizer	2005	$25 Million	
Philips	2005	€40 Million	
Roche	2004		40

Figure 1 R&D investments in China made by MNCs[1] (continued)

MNC	*Starting year*	*Amount to invest*	*R&D Staff*
Rohm and Haas	2006	$60 Million	
MNC	*Starting year*	*Amount to invest*	*R&D Staff*
Siemens	2008	$100 Million	100
Symantec	2004		1000 (by 2009)
Unilever	2006		100
Volkswagen	2001		550

[1]Asia Times (2007). Foreign R&D investments in China. http://www.atimes.com, [accessed 05/2007], Astrazeneca (2007). Company information. Obtained through the Internet: www.astrazeneca.com, [accessed 05/2007], ED (2008). Research and development in China. http://www.English.dostor.com, [accessed 09/2008], Emsnow (2007). R&D in China. http://www.emsnow.com, [accessed 05/2007], EP (2007). Research and development in China. http://www.english.people.com.cn, [accessed 05/2007], Fujitsu (2007). Company information. www.jp.fujitsu.com, [accessed 05/2007], Global Auto Sources (2008). New investment in R&D units in China. http://www.gasgoo.com, [accessed 09/2008], Information Explorer (2008). New R&D establishments. http://www.chinainfoworld.com, [accessed 09/2008], International Herald Tribune (2007). R&D investment in China. http://www.iht.com, [accessed 05/2007], Managing Intellectual Property (2007). R&D establishment in China. http://www.managingip.com, [accessed 05/2007], Nokia (2007). Company information. http://www.nokia.com, [accessed 05/2007], Online European Electronics (2008). New R&D set-ups in China. http://www.evertiq.com, [accessed 09/2008], Roche (2007). Company information. http://www.roche.com, [accessed 05/2007], Shanghai Municipal Commission of Commerce (2007). New R&D establishments. http://www.smert.gov.cn, [accessed 05/2007], supplychain CONSULTANTS (2007). Growth of R&D in China. http://www.supplychain.com, [accessed 05/2007], The A-Z of Materials (2008). Investment in China. http://www.azom.com, [accessed 09/2008], Zhangjiang Hi-Tech Park (2007). New R&D establishments. http://www.zjpark.com, [accessed 05/2007].

1.2 Organisational prerequisites for innovation performance

It is clear that management of innovative knowledge is important for innovation performance, but how does this affect the transfer of R&D to widen the knowledge-creating parts of a company? Blanc and Sierra (1999) describe how multinational firms managing dispersed units of R&D are facing a tension creating an organisational trade-off between external proximity and internal proximity, where external proximity concerns the scanning and absorption of external scientific and technological capabilities and internal proximity concerns internal relations within the company. Orlando (2000) suggests that interfirm spillovers from innovative activity are attenuated by both geographic and technological distance. In relation to the Chinese context, Baark (2007) mentions historical legacies and preferences in the Chinese culture concerning innovation. He mentions that due to a number of historical and cultural factors the Chinese preference is focused more on exploitation than exploration. This has caused many of the Western R&D centres in China to be quite reluctant to establish close interaction with local universities in China. Harryson et al. (2008a) and Von Zedtwitz (2004) summarise common barriers in this context:

- reluctance to share innovation-relevant knowledge from the home-base R&D unit – partly based on fear of losing control over strategic IPR
- focus on exploitation as opposed to exploration generally inhibits radical innovation
- lack of creative thinking, excessive respect of top management and passive obedience of top-down orders as opposed to own initiative.

With more than 1000 universities and institutes for higher education in China, and close to six million students enrolled (Chen, 2006), it seems relevant to challenge the conventional wisdom that China is not offering a strong base for exploration. Companies that manage to establish new centres for exploration in China and link these to global networks of for exploitation may be able to enjoy significant improvement of innovation performance. The question is how to manage this link? A network theory-based theoretical framework is introduced to address this question.

2 Theoretical framework

2.1 Knowledge transfer as a launch pad of innovation performance

Miesing et al. (2007) propose a model of global knowledge transfer within transactional, which outlines relationships between enabling constituents and core elements in the knowledge transfer process where they see the creation of organisational best practices as an important outcome. Gupta and Govindarajan (2000, p.475) put forward five factors focused on the information flow to or from a subsidiary: value of the source unit's knowledge stock, motivational disposition of the source unit, existence and richness of transmission channels, motivational disposition of the target unit and absorptive capacity of the target unit. Moreover, they emphasise the importance of transfer channels to make an effective transfer. A similar approach is used by Wang et al. (2004) when they connect the knowledge contributed from the MNC and the knowledge acquired by the China subsidiary. They link contributed knowledge, divided into capacity to transfer and willingness to transfer – to the knowledge received, separated into capacity to learn and intent to learn. Szulanski (1996, 2000) views the transfer of knowledge from a flow perspective dividing the transfer into different stages of the process: initiation, implementation, ramp-up and integration. He also points to the fact that the transfer process may be hindered both by the sender and by the receiver, as well as by the degree of internal stickiness of the knowledge to be transferred. Internal stickiness can be related to factors associated to lack of absorptive capacity at the receiver and to other barriers such as difficulties in the relation between sender and receiver (Miesing et al., 2007).

Absorptive capacity, or the "ability to recognise the value of new information, assimilate it, and apply it to commercial end" (Cohen and Levinthal, 1990, p.128), is the perhaps most crucial element of knowledge transfer and a vital ability for a new R&D centre to transfer and transform any external knowledge into radical innovation (Buckley and Carter, 1999; Chen, 2004; Harryson and Lorange, 2005; Minbaeva et al., 2003; Wang et al., 2004). In this context, Harryson et al. (2008b) explore the importance of personal interaction for successful transformation of exploration into exploitation.

We will now explore how these two activities relate to each other and how they can contribute to innovation performance.

2.2 The organisational paradox of exploration and exploitation

Innovation can often be seen as clearly related to exploration, i.e., searching for new knowledge to develop new organisational capabilities securing future innovation, whereas the notion of exploitation refers to utilisation and future development of the existing corporate reservoir of knowledge (Harryson and Lorange, 2006; Levinthal and March, 1993; March, 1991; Murray, 2001). To elaborate on the ability to perform both activities, the term ambidextrous organisation emerged, describing a corporate ability to handle both the creative process and the commercialisation of innovation (Tushman and O'Reilly, 1996).

The notion of exploration and exploitation has emerged as an underlying theme in research on organisational learning and strategy (Levinthal and March, 1993), innovation (Danneels, 2002) and entrepreneurship (Shane and Venkataraman, 2000). While the importance of pursuing both types of activities has often been highlighted (Benner and Tushman, 2003; Burgelman, 2002; Gibson and Birkinshaw, 2004), much more remains to be understood about how ambidextrous organisations coordinate the development of exploratory and exploitative innovation in organisational units.

The first study to analyse how organisational structures, managerial hierarchy and management systems affect innovation was probably that of Burns and Stalker (1961), who found that an organic system is most appropriate for invention and technological change (cf. Duncan, 1976). It also seems to be widely accepted that the creation of radical invention, or a breakthrough, requires flexible organisations that are flat in hierarchical levels, informal and collegial, with cosmopolitan researchers who have numerous contacts outside the firm (Harryson, 2006).

As opposed to exploration of invention, exploitation and commercialisation of innovation usually call for institutionalised routines in an organisation with a mechanistic management system (Burns and Stalker, 1961) based on rigid processes and strong hierarchies. The dilemma is that hierarchic control is associated with decreasing innovativeness – as noted by a large number of authors after the pioneering work of Burns and Stalker (Ancona and Caldwell, 1992; Cheng and Van de Ven, 1996; Duncan, 1976; Hedlund, 1990; McDonough and Leifer, 1983; Nonaka and Konno, 1998; Martins and Terblanche, 2003; Ridderstrale, 1997; Simmie, 1997; Stern, 2004). It also seems that size matters in exploration and exploitation – as outlined here.

2.3 Small units for exploration vs. large for exploitation

Mansfield (1968b) argues that the small independent inventor is willing to undertake research projects that corporate R&D is not imaginative enough to pursue. In research for inventive exploration, the optimal size may thus be fairly small. This is further intensified by his later findings that

> "when the size of R and D expenditures is held constant, increases in size of firm are associated with decreases in inventive output" (Hamel and Prahalad, 1994; Kline and Rosenberg, 1986; Mansfield, 1968a, pp.137–138; cf., 1968b; Mansfield et al., 1977; Nonaka, 1988).

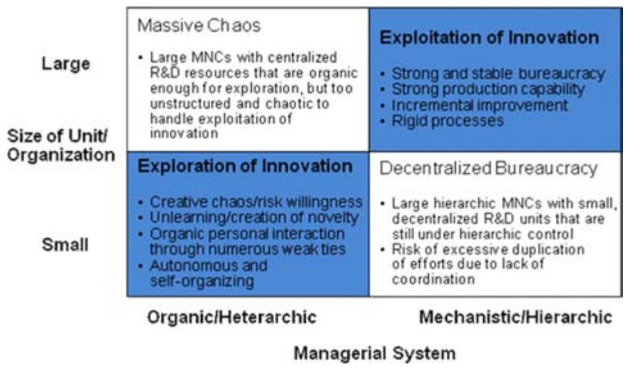
Mansfield (1968b) also holds that large, hierarchic and departmentalised organisations are desirable for exploitation-oriented activities. Similarly, Nelson and Winter (1982, p.279) argue that

> "large firms have a level of production, productive capacity, marketing arrangements, and finance that enables them quickly to exploit a new technology on a relatively large scale" (cf. Knott, 2002).

The drawback of size in the context of innovation is that it causes inflexible and tightly specified systems of knowledge, which over time can reduce a firm's ability to perform both creation and implementation of innovation.

On the basis of the above-mentioned arguments, the ideal organisation for exploration and creative invention seems to be the opposite of the one that performs exploitation of innovation. The dilemma can be summarised in a matrix (Figure 2), which depicts the paradoxical organisational needs of ambidexterity.

Figure 2 The organisational paradox of exploration and exploitation (see online version for colours)



Source: Own adoptions from Harryson (2006)

In Figure 2, the lower left-hand square seems to be more adequate for organic knowledge flows that stimulate exploration of creative invention, whereas the upper right-hand square depicts the ideal conditions for well-structured and efficient processes required for the exploitation of innovation. This is why ambidexterity requires both hierarchy and heterarchy, and why there is a symbiotic relationship between big and small in innovation processes. In addition, the two organisational opposites (grey-tinted in Figure 2) need to be interlinked without moving into the direction of massive chaos or decentralised bureaucracy, both of which are organisational disequilibria that seem to favour neither exploration nor exploitation of innovation. We will use selected network theories to better understand how to interlink exploration and exploitation.

2.4 The conflicting network structures required for exploration and exploitation

The network structure expresses a certain combination of nodes and relationships. Connectivity or the degree to which the organisations or persons are linked to each other is a major aspect of the network structure. The other two are the number of direct links and the number of indirect links that organisations have Ahuja (2000). To better understand the ideal network structures for exploration and exploitation, we find the dimensions of open vs. closed networks based on weak vs. strong ties of particular importance.

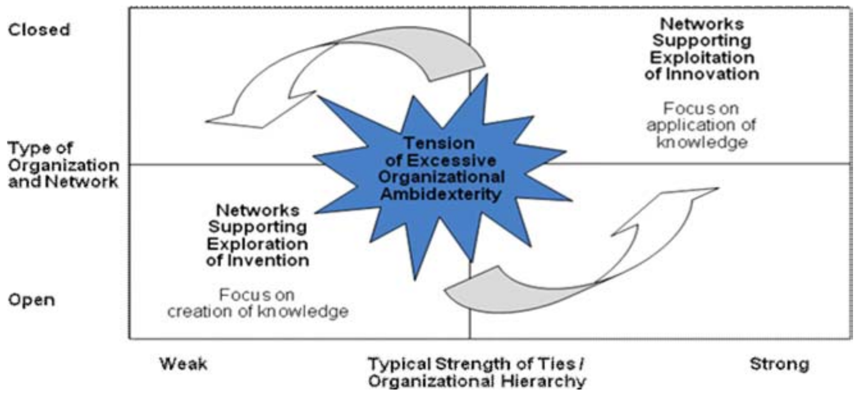
2.5 Open and closed networks

Along the connectivity dimension of the social network, a distinction is made between open and closed social networks. On the basis of the idea that organisations are embedded in social ties (Granovetter, 1985), the characteristics of these networks are also assumed to be valid at the organisational level of the network (Ahuja, 2000; Gulati, 1999; Gulati and Gargiulo, 1999). The open network is mainly about resource exchange of information, whereas the closed network focuses on social exchange, trust and shared norms. An example of an open network is one in which firms have direct social contacts with all their partners, but these partners do not have any direct contacts with each other. A high number of such non-connected parties, or structural holes, means that the network consists of few redundant contacts and is information rich, since people on either side of the hole have access to different flows of information (Burt, 1992). Burt (1993) argues that to enhance network efficiency an actor should focus on maintaining only primary contacts and delegate the task of maintaining all (complementary) contacts to these primary contacts. The major selection criterion for such partners then concerns how many contacts they have. This implies that the structure of an open network is suitable when gathering, processing and screening of information is the primary purpose as well as identifying information sources. This kind of innovation network then stresses the indirect linkage, has mainly weak relationships and is loosely coupled. The opposite is the tightly coupled closed network, where all partners have direct and strong ties with each other. This network is centred on social capital, which is built through trust and shared norms and behaviour (Coleman, 1988). The contradiction between open and closed networks is also stressed by Ahuja (2000), who proposes that the larger the number of structural holes spanned by a firm, the greater its innovation output. There seems to be a trade-off between an open network that maximises information benefits and a closed network promoting trust building and more reliable information. This contraction is studied by Soda et al. (2004) regarding the organisation of project teams. They found that the best-performing teams (action networks) are those with strong ties among the project members based on past joint-experience, but with a multitude of current weak ties to complementary (non-redundant) resources.

2.6 Weak and strong ties

On the basis of Granovetter (1973) and Hansen (1999) uses a network study to explore how weak inter-unit ties help a new product development team with purposeful knowledge-sharing. His findings are that while weak ties help the team find knowledge located in other units, they are not useful in supporting the actual transfer of complex knowledge. The more complex the knowledge, the stronger the ties required to support its transfer. Research findings by Uzzi (1996), Rowley et al. (2000) and Van Wijk et al. (2004) confirm that strong ties are positively related to firm performance when the environment demands a relatively high degree of exploitation and weak ties are beneficial for exploration purposes and to prevent the network's insulation from market imperatives. Our arguments are summarised in Figure 3:

Figure 3 The conflicting network structures of exploration and exploitation (see online version for colours)



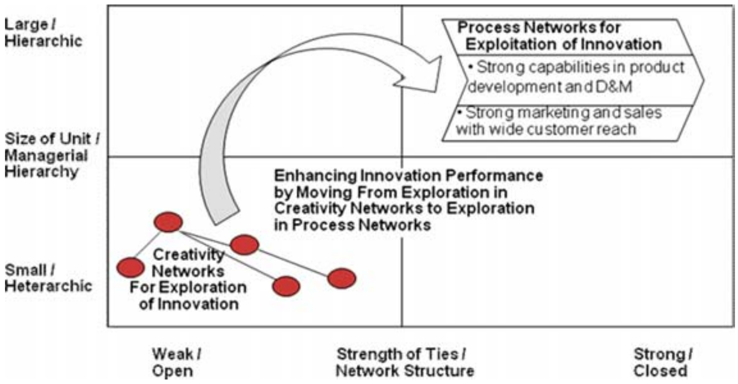
Source: Own adoptions from Harryson (2006)

On the basis of Granovetter's (1973) arguments, we assume that strong and weak ties are complementary from the perspective of time, and that the structure of an ideal network should maximise the yield per primary contact (Burt, 1992). We also conclude that weak ties are more likely to accelerate development speed in early phases of exploration when the required knowledge is not complex. Conversely, weak ties may slow down speed in situations of high knowledge complexity where strong ties are required to support exploitation of innovation. In this context, we combine the theories on organisation, ambidexterity and networking to make a distinction between the two, previously introduced, polarised organisational extremes now positioned into two interrelated network levels with different foci and abilities:

- Extracorporate *creativity networks* with weak ties as primary sources of specialised knowledge and technology focused on exploration of innovation
- Intracorporate *process networks* with strong ties focused on exploitation of innovation through strong linkages between R&D and marketing & sales (M&S) for market alignment, and from R&D to design & manufacturing (D&M) for commercialisation.

Innovation performance requires both creativity in exploration and speed in exploitation – and hence involves both dimensions illustrated in Figure 4. How can an organisation leverage both weak ties during the exploration phase and strong ties during the exploitation phase to somehow interlink the complementary creativity networks and process networks? This paper will present and analyse how the two case companies achieve different impacts on innovation performance by taking different pathways across and making different bridges between the polarised creativity and process networks outlined in Figure 4.

Figure 4 Moving from exploration to exploitation of innovation (see online version for colours)



Source: Own adoptions from Harryson (2008) and Harryson, Dudkowski and Stern (2008b)

While this model draws on Harryson (2006, 2008) and Harryson et al. (2008b), they do neither link their framework to R&D transfer, nor relate it to university collaboration. Our argument is that the transfer of R&D activities from mother-company to subsidiary can contribute to greater organisational ambidexterity, which in turn enhances the innovation performance – if strong ties are built to local universities and the transformation from exploration into exploitation is managed correctly.

3 Methodology

Our approach was to build a deep understanding of how the R&D transfer processes evolved over time. Accordingly, we started the interview process back in 2007 and finalised our last interviews only a few weeks prior to re-submission of this paper. We chose to focus on Scandinavian MNCs both based on good access to the companies and to their global leadership positions in their respective industries. The two cases also serve as our preferred basis for further investigation of the topic of this paper – based on the long-term relationships developed with the informants who share our interest in advancing the knowledge frontiers in this area. While both companies are Scandinavia-originated globalised R&D-intensive companies, they show quite different models of interaction with the local universities in China. The cases are analysed and structured into one consolidated case chapter following the logic of our theoretical framework – rather than presenting two separate cases one after the other.

Abduction (Alvesson and Sköldberg, 1994; Dubois and Gadde, 2002) is the main methodological strategy behind this research combining elements from both the inductive approach and the deductive approach. Continuous matching of theories with reality and vice versa has been the approach to secure empirical support for the theoretical framework. Empirical findings initiated the search for further theories triggering a continuous interchange between empirical data and theory. The basis for this process is a holistic multiple case study (Yin, 2003).

The empirical data covers two case companies – both Scandinavia-originated global leaders within treatment of chronic diseases and packaging. The interviews covered the persons in charge of the establishment of the R&D unit in China and the overall R&D

transfer process. Furthermore, several researchers, with and without expatriate experience, were interviewed. Informants were interviewed several times to enable tracking of the development of the investigated case over time. Twelve interviews were conducted with Pack Tech and 14 interviews were conducted with Med Tech. In all, six rounds of interviews were conducted from February 2006 until November 2009. For both companies, interviews were made both in Scandinavia and in China. In China, we also interviewed both the foreign R&D centres as well as the universities. Out of 26 interviews, 12 interviews were conducted with the two R&D centres in China – lasting approximately two hours and taking place at the company premises. Eight interviews were conducted with R&D managers out of Scandinavia and six interviews were conducted locally at the Chinese university that collaborated with Pack Tech. All interviews were recorded and carefully transcribed.

Complementary information in terms of secondary data was collected as well, but the main parts of the empirical data are primary, which were collected through semi-structured interviews in person. Through the use of multiple sources for the case studies, internal validity has been addressed for the case studies in terms of number of interviewees and their positions in the organisations. The purpose of presenting quotes from a large number of interviewees is to add verisimilitude and represent a wider network of the different actors across multiple levels in the cases. The issues of construct validity and reliability have been addressed, as key informants have reviewed the case reports – both the individual cases as well at a previous draft of this paper. External validity is enhanced by covering two quite different industries and by developing a relatively industry-independent theoretical framework using the abductive approach outlined in this section. Feedback from the Editor and two Reviewers triggered improvements in terms of robustness, stringency and clarity of this paper.

4 Case studies: Med Tech and Pack Tech

4.1 Drivers of the R&D transfer process

Med Tech established a research unit near Beijing to conduct protein expression research focused on the global market. The opportunity to tap local brainpower was also central when establishing a new R&D centre. Research conducted in the Chinese R&D unit of Med Tech was not conducted in any other of their R&D units, hence the new unit immediately took a global responsibility. The company had turned to other markets to recruit research personnel – a scarce resource in the home country.

Pack Tech already had a strong local footprint with China being the single largest market. Manufacturing capability had been established since early 2000 and the plan was to follow with R&D – mainly to reduce time to market for new higher-performance and lower-cost distribution equipment. There was a need for low-cost distribution equipment in China, but this would require significant innovation to fulfil the very challenging cost and performance targets. Transferring R&D to China was a bold move to take a fundamentally new approach to the whole innovation process. Rather than doing R&D at the home-base R&D unit and then transfer the results to China for manufacturing, it was decided to establish a new R&D centre dedicated to innovation excellence through a more open and networked university collaboration approach. A company-specific summary of the driving and triggering forces behind the transfer of R&D to China is provided in Figure 5:

Figure 5 Summary of R&D transfer triggers

	Med Tech	*Pack Tech*
Driver of transfer	Marketing and public relations driven plus gaining access to new brainpower	Innovation driven. Strong need for better performing and lower cost distribution equipment
Access point	Access to Chinese brain power and better access to the Chinese market	Access to local universities used as exploration networks to accelerate R&D and innovation in distribution equipment
Nature of research/ Innovation	Radical. Global research	Radical innovation with China as lead-market followed for by global implementation

4.2 Industry–University (I–U) collaborations

Although Med Tech established a scholarship fund to support PhD and master student collaboration in 2007, the company is not having any direct collaboration project with any Chinese university for the time being. At the time of establishment, the Chinese universities did not have anything to offer in terms of innovation collaboration opportunities according to the Protein Research Manager:

> "Establishing industry university collaborations was not part of the motivations because the Chinese universities are not yet able to deliver anything that makes it relevant to initiate collaborations to a larger extent than the small technical collaborations we perform in China today." (Protein Research Manager, interview, 2007.02.15)

This opinion is supported by an expatriate researcher:

> "When I was in the R&D unit in China we did not work together with the local universities. We visited them in order to check out which equipment they had in place but other than that we did not work with them." (Expatriate researcher A, interview, 2008.09.23)

Rather than seeing the local universities as potential innovation partners, they were used to find out what equipment for the R&D unit could be bought locally in China. The Chinese R&D unit of Med Tech continuously increases both technological abilities and research responsibility:

> "R&D and innovation outsourcing will support innovation performance in the long run. You get better opportunities to recruit talented people when you globalise R&D and university collaboration. Since we are recruiting from the local universities there is a certain degree of interplay with the R&D unit and the universities." (Expatriate researcher A, interview, 2008.09.23)

Another expatriate researcher highlights that the Chinese R&D unit enables the company to decrease the time to market (interview, 2009.01.29). However, practical difficulties inhibit the extent to which the R&D unit interacts with local universities since the R&D unit is situated on the outskirts of the city and it takes a long time to drive back and forth to universities:

> "The Chinese scientists have found that it was not worth it to interact with the local universities. They do not have research contacts as such. But they follow the research literature within their research areas and they have been able to develop their skills significantly." (Expatriate researcher B, interview, 2009.01.29)

Universities in China sometimes serve a facilitating role in terms of testing medicine on relevant populations. The empirical data from Med Tech concerning this issue is of a diverging kind and it remains somewhat unclear to which extent this might be the case for the company (cf. Boutellier and Ullman, 2007). To prepare for more direct university collaboration in the future, internships are offered to selected university students. A small Research foundation has been established with China Academia of Science based on a donation of three million USD as well as one fully sponsored professor scholarship (mainly to support research overseas).

A different approach was used by Pack Tech when it established an R&D unit in China. The company arranged an innovation contest in distribution equipment between well-selected key-universities. External consultants were engaged to support identification of the right researchers. Professors coached masters and PhD students to conduct joint brainstorming sessions to develop new concepts. New relationships between employees of Pack Tech and local students were fostered during the brainstorming sessions and the consecutive coaching sessions.

To update and develop the concepts further, additional information was given to the student teams during the review sessions of the early concept ideas. These sessions were organised such that all teams had access to the feedback given to each individual team thereby ensuring cross-fertilisation of ideas between the competing teams. During two different review sessions, several resulting concepts were also reviewed in Europe for further input on implementability. The first session provided a neutral third-party opinion from a dozen invited technology consultants. During the second session, one concept was selected for further development by Pack Tech's distribution equipment experts. The winning university was invited to join Pack Tech's Scandinavian R&D and manufacturing HQ to acquire advanced CAD training focused on further validation and support early implementation of the concept in manufacturing. Also, the Chinese coaching professor was joining this "human knowledge transfer" from China to Sweden. Further collaboration continues in China also with those universities that did not win the first innovation competition.

4.3 Exploration networks as sources of innovation

Med Tech emphasises the importance of enabling scientists to play around with new concepts according to their own interest within working hours:

> "We have a tacit regulation that every employee has 10% to 20% working time to do something that happens to interest themselves and which does not necessarily follow the work plan. Of course they have to do their work first, but when we assign the workload, we keep in mind to leave them some free time. We also encourage our researchers to reach out to peers beyond the company to discuss and get feedback on their new concepts – before presenting them as potential new business opportunities. This is a crucial tool for building a local network of entrepreneurship." (Med Tech, Chinese R&D Department Director, Interview, 05. 26. 2009)

As stated by the Chinese department director, the establishment of the R&D centre has created new networks of scientists who spend up to 20% of their time working on new concepts, which may contribute to external network building and innovation performance. Med Tech has also identified an opportunity to ease the in-sourcing of innovation and knowledge from their Asian suppliers by transferring R&D to China. It was further expected that if the R&D function was made international it would be easier to utilise international partnerships to identify good ideas for R&D project to integrate in the R&D pipeline, early on. Furthermore, they wanted to ease the access to Chinese talent by minimising geographical barriers with the aim of putting the best-suited person on any task. Today, the R&D unit of Med Tech employs close to 60 scientists in China. However, in the beginning, the unit suffered from not reaching critical mass for creativity, which inhibited innovation. An expatriate researcher at Med Tech illustrated this by stating that:

> "Size of the unit matters. You need to be more than 50 people in order really be able to turn creativity into action." (Expatriate researcher A, interview, 2007.03.15)

A local senior scientist found that the new R&D centre offered a valuable global network to other scientists – supporting the innovation output:

> "Innovation is not just sitting there and thinking. You can't make innovation that way. You also need to read and look for new things, exploring new fields by meeting new people. I feel that my global networks are as important as my local resources. Sometimes you get your idea from meetings and conferences. You bring it back, because you get inspiration during your conversation with others. Innovation is the product of the global network, management support and local resources combined." (Local Senior Scientist B, Interview, 2009.05.21)

This approach and attitude is contrasted by Pack Tech, which established strong local knowledge networks to three different universities – before even having 20 people in R&D locally. Pack Tech performed very close exploration collaboration in China – kicked off through joint ideation sessions, followed by an innovation contest where regular coaching and joint reviews secured cross-fertilisation of results. Already after six months of collaboration, several patent applications were made.

None of the case companies have so far encountered IPR-related problems regardless of the level of interaction with the local universities.

4.4 Key enablers to improve innovation performance

Med Tech intends to make the new lab in China a global centre of excellence, but did not transfer many experts from their other R&D labs to the new centre, which instead focused on finding the best Chinese researchers in the field and get them globally networked:

> "All scientists must have the passion to science. Then I think the most important thing is self-motivation. Then the company should provide resources and the right environment. By resource, I mean for us it is important to give our scientists access to what is going on outside: outside our lab and outside China. They should have access to international and domestic meetings and to all journals they can read. They both need the opportunities to network with other

> people and to have time for themselves to do extraordinary work." (Interview, Head of R&D, 2009.05. 27)

The Protein Research Manager at Med Tech believes that this strategy will build unique competence in solving time-intensive research tasks:

> "Our Chinese recruits are energetic and intelligent people, and as the society opens up, they will become more and more innovative. Moreover we acquire a good skill base for time-intensive research tasks." (Protein Research Manager, interview, 2008.02.15)

Furthermore, an expatriate researcher at Med Tech put forward that overall innovation performance of the company is positively influenced by transferring R&D to China:

> "We have experienced some times that if a group of Chinese scientists look at the same scientific material, which have already been investigated by scientists at the home base R&D facilities in Europe, they can come up with some inputs which are different even with the same materials. In this way we find something different and we can actually use this to get further and to think about R&D in new ways." (Expatriate researcher B, interview, 2009.01.29)

Earlier, it was recognised that individual initiative lacked in the Chinese units, however, this seems to be subject for change. The outcome of the joint ideation and innovation contest for distribution equipment facilitated by Pack Tech is an indication of this. The newly arrived Western Manager of the Chinese R&D centre stated that:

> "I have used a lot of expert consultants and university researchers in the West and have to admit that I was reluctant when I first heard about the plan to use local Chinese universities for a highly strategic innovation project. After only a few months of collaboration the Chinese university teams convinced me that my reluctance was unjustified. They developed outstanding concepts with very high degrees of innovation."(Expatriate researcher A, interview, 2009.01.28)

4.5 Measuring innovation performance

The data, metrics and approaches used to measure innovation performance differ between the two case companies, partly owing to industrial differences. In particular, medical research has long lead times making innovation performance difficult to measure. Because of this, Med Tech instead focuses on the range of ideas early in the selection process. Figure 6 shows methods of measuring innovation performance used by the case companies.

Figure 6 Measurements of innovation performance

Company	*Measuring innovation performance*
Med Tech	The diversity and selection of ideas to evaluate in the exploration phase
Pack Tech	Time to market from concept to implementation
	Total innovation project cost relative to degree of innovation
	Impact in terms of anticipated increase in sales
	Brand equity increase – as a result of positive differentiation through innovation

Authority respect was experienced by the case companies as a reason for the reluctance of Chinese researchers to take initiative and to express their thoughts and ideas and, hence, inhibiting innovation. Through a stepwise development of the scientist's self-confidence, Med Tech encouraged the Chinese to take independent initiative when doing research. The foundation to make it work was to encourage this rather than forcing the change on the researchers. It was considered a necessary measure to change the Chinese order-driven organisation of research to achieve innovation. Med Tech saw a need to reduce the respect for authorities by breaking it down consecutively and increasing the courage to question routines and orders. This was made to make them convinced that they can, and are allowed to, take own initiative in the innovation process. An expatriate Med Tech researcher linked changes in mentality in the unit to the unit size stating that:

> "They benefit from becoming a bigger unit. It brings along more creative thinking and the management is forced to give more responsibility and freedom to the employees." (Expatriate researcher A, interview, 2007.02.15)

5 Analysis and discussion

5.1 Local networking strategies

In summary, the approaches used to inspire exploration within Chinese networks were:

- expanding geographical coverage for talent sourcing to grow in R&D (Med Tech)
- making their new R&D workers more globally connected and absorbing external knowledge from international partners (Med Tech)
- supporting the building of local networks among researchers to cross-fertilise ideas and concepts (Med Tech)
- collaborating with universities based on joint ideation leading to an innovation contest where regular coaching and joint reviews secured cross-fertilisation of results (Pack Tech)
- bringing the winning university team to Scandinavia to support concept validation and implementation in manufacturing (Pack Tech).

Figure 7 outlines the local networking strategies of the two case companies. Owing to the importance of face-to-face communication, allocation of travelling funding can be an important part of the networking strategy. Also, the location of the R&D unit influences with whom it is possible to network on a frequent basis. It can be seen that Pack Tech was the only company allocating travelling funding for students and universities participating in the innovation contest, which will be further explored later.

Key aspects of the I–U collaboration of Med Tech:

- Main-focus on recruiting for internal build-up of future exploitation capabilities.
- No scientific university collaboration owing to perceived insufficient exploration capabilities of the universities.
- Scholarship fund established in 2007 to enhance goodwill and support the development of global scientific networks.

Figure 7 Local networking strategies of the case companies

	Med Tech	*Pack Tech*
Target for R&D networking activities	Universities for recruiting, and Governmental bodies for approvals	Universities for enhanced creativity and innovation
Goal for networking activities	Recruitment (minor in China – mainly overseas Chinese) Good relations with governmental bodies in order to maintain a leading position in China	Recruitment New ideas and innovations through innovation competitions
Allocation of travelling budget	Employees only	Employees Students from Chinese universities get funding for visiting the main R&D unit of the company in Europe in order to support implementation of their new innovation
Location of R&D unit in China	Beijing area (Tianjing)	Shanghai
Advantages of location from a networking perspective	Relative closeness to governmental bodies in Beijing	Closeness to industrial centre of China and to universities strong in mechanics and mechatronics
Drawbacks of location of from a networking perspective	The travelling time within Beijing can be several hours	Travelling drawbacks minimised by inviting university researchers to the company rather than going to the universities

Key aspects of the I–U collaboration of Pack Tech:

- Research, design and sourcing divisions of Pack Tech China teamed up with the local universities to utilise their exploration abilities for innovation purposes.
- Joint ideation was done with several universities followed by an innovation competition.
- Proximity to important universities was a key criterion for the R&D unit – to support frequent and fluid communication.
- Winning university team invited to come to Scandinavia to support validation and implementation of the winning concept.

5.2 Innovation networks influencing organisational learning

The underlying learning processes and different mental models of how to organise and perform R&D activities in Pack Tech changed fundamentally when the newly established R&D centre organised an innovation competition between three different universities. This approach fostered new patterns of learning both between the universities and with the new R&D centre. The external networks replaced the need for internal critical mass – while generating higher innovation output at far lower cost than internal recruitment. The three university teams worked on competing approaches in parallel and the R&D centre secured a proper balance between joint learning and individual competition to optimise both individual motivation and joint knowledge creation.

The learning capability of the company as a whole improved not only by establishing new knowledge networks and patterns of collaboration in China, it also improved in the home-base by inviting the winning university team to Sweden to support implementation of the winning innovation. In this sense, the new patterns of joint learning from China were brought back to the home-base to further enhance corporate knowledge creation and innovation performance.

Pack Tech established a unique creativity network in China based on three competing university teams, and then brought the winning creativity network to Scandinavia for incorporation into the corporate process network to secure validation and implementation of the concept (the networks are described in Figure 4).

5.3 R&D and innovation outsourcing-related inhibitors to and drivers of innovation performance

If R&D units are not allowed to interact closely with the environment to get inspired, it may reduce their innovation output. R&D unit personnel may be restricted by corporate policies focused on preventing leakage of intellectual property. In the university competition initiated by Pack Tech, however, the young Chinese engineering students proved highly capable of coming up with 'out of the box' ideas on how to solve existing problems in new ways. By teaming up local students with more process-oriented Pack Tech engineers and sourcing experts, the joint creativity – process network – could secure rapid transformation of exploration into innovation. The student teams created radical ideas, which were continually linked to manufacturing realities for seamless transformation into radical innovation. In this sense, the competitive collaboration network took the role of interconnecting exploration and exploitation thereby enhancing innovation performance. Two patent applications were filed by Pack Tech based on the creativity network's results – with the university researchers as inventors.

Interesting differences can be found in the two case companies. Instead of transferring R&D and innovation-related activities to China with the pure purpose of responding to local needs and wants, Pack Tech immediately reached out to local knowledge networks in terms of universities to also enhance the potential of creating new breakthrough innovations. An immediate and dedicated focus on increasing radical innovation seems to have been important to make it happen for Pack Tech in China.

None of the investigated cases provides evidence that it is dangerous from an IPR protection perspective to perform R&D and innovation-related activities in China. Recent research presented in this paper – suggesting that such concerns are seldom relevant – triggers us to ask whether it is not about time to loosen up on the strict knowledge management and IP protection policies and, instead, allow employees to share knowledge for instance with innovation partners such as universities to make it possible to harvest new radical innovations, which are not captured when applying more closed innovation approaches?

It is particularly interesting to note how Pack Tech managed not only the enhancement of innovation performance in China by taking a more networked and open approach to university collaboration, but also the transition from exploration to exploitation of innovation by transferring the winning team including their coaching professor to the home-base in Scandinavia. The mixed team of university researchers and regular employees in R&D, procurement and manufacturing are now working together in a way that leverages the know-who (Harryson, 2006) of the coordinators to interconnect creativity and process networks – as introduced and visualised in Figure 3. The R&D offshoring process of Pack Tech offers a good illustration of this theoretical framework. First of all, the new R&D offspring makes use of consulting services to acquire the required relationships to build optimal local knowledge networks supporting exploration of innovation through open networks with loose ties to a multitude of university researchers. Once a winning innovation had been defined, the coaching professor and his network of key researchers were transferred to Scandinavia to take active roles in the process networks that support exploitation of the winning innovation. Through this transfer, Pack Tech migrated from maintaining a multitude of weak ties in an open network to a few strong ties in a closed network that was transferred to Sweden to support the full exploitation of innovation. By using the innovation competition as a tool for coordinating and managing the momentum, the local networks to leading universities in China seem to have enhanced the innovation performance quite significantly. Bringing the winning team to Sweden supported a more immediate transformation from exploration to exploitation, which further enhanced the innovation performance in a dual sense – both in China and in Sweden. Here, we summarise how this compares with the outcomes of Med Tech.

5.4 Diverse I–U interaction foci and related results

As outlined in Figure 8, both case companies experienced benefits in relation to industry–university (I–U) collaborations. It is, however, only Pack Tech that has been able to capture a significant immediate increase in innovation performance as a result of the exploration-oriented open I–U interaction strategy.

Figure 8 I–U interaction strategy and captured benefits

Main strategy of I–U interaction	*Captured I–U benefits*
Exploitation oriented strategy	Med Tech:
	Lower-cost and lower-risk test of medicine for wider exploitation across China and other emerging markets
	Brand building by marketing the R&D investment
	Improved recruitment opportunities – also for exploration-focused functions
Exploration and Exploitation oriented strategy:	Pack Tech:
	New implementable concepts for the distribution equipment R&D pipeline
	Goodwill and brand building without marketing the local R&D investment
	Reduced time to market of higher performance lower cost equipment by interconnecting creativity and process networks through transfer of researchers

The R&D transfer of Pack Tech was to a greater extent than R&D transfer of Med Tech, pervaded by creativity and innovation already from the beginning, expressed particularly by the joint ideation and innovation contest, which showed that the Chinese students indeed can increase innovation performance in terms of ground-breaking concepts.

Partly, this is enabled by the open collaboration Pack Tech facilitated. Figure 9 outlines main barriers and corresponding key enablers benefiting innovation performance, which have been presented throughout the case studies.

Figure 9 Summary of barriers and corresponding enablers to enhance innovation performance

Main barrier	*Corresponding key enabler*
Reluctance to share innovation-relevant knowledge from home-base R&D unit, and fear that the transfer would lead to undesired deviations from product portfolio standards	Inviting sceptic employees in Scandinavia to join and support the transfer process (Med Tech)
Focus on exploitation as opposed to exploration generally inhibits radical innovation	Focus on increasing initiative willingness among Chinese researchers by introducing them to take an active role in coaching the university competition (Pack Tech)
High (excessive) respect of top management – leading to passive obedience of top-down orders as opposed to own initiative	Successive break-down of excessive authority respect in Med Tech
	Med Tech helped the Chinese researchers to take initiative and to get locally and globally networked to other corporate researchers
	Increasing the size of the R&D unit forces the management to give more responsibility and freedom to the researchers (Med Tech)
The educational system inhibits creative thinking	When Pack Tech challenged and stimulated the Chinese university teams to be creative they developed several concepts containing radical innovation
	Med Tech initiated a process aimed at growing self confidence among the Chinese researchers

6 Conclusions and contributions to theory

In conclusion, the case companies captured very different results from their R&D offshoring from Scandinavia to China – both in general terms and in relation to each of the companies' approach to measure innovation performance – as summarised here in Figure 10:

Figure 10 Measurements of innovation performance and results accomplished through R&D offshoring to China

Company	*Measurement of innovation performance*	*Result*
Pack Tech	Time to market from concept to implementation	Shorter
	Total innovation project cost relative to degree of innovation	Lower
	Impact in terms of anticipated increase in sales	High
	Brand Equity Increase – as a result of positive differentiation through innovation	High
Med Tech	Diversity of ideas to evaluate in the exploration phase	Higher
	Time to market through local testing of new medicine	Shorter

By relieving the shortage of research competencies within Western companies, R&D and innovation outsourcing promotes innovation instead of inhibiting it. Our theoretical framework suggests a generic framework to distinguish and analyse the interrelated activities of exploration and exploitation that jointly contribute to innovation. Our two cases suggest that if R&D offshoring involves steps that bring R&D closer to selected universities and other relevant knowledge networks, innovation performance can increase further depending on the relative openness in interaction with the universities and the resulting knowledge flows.

The network perspective developed and applied in this paper enhances our understanding of performance-driving modes of interaction between and across actors such as individual researchers, academic research teams and R&D units. From a formal perspective, we could also include networking at the inter-organisational level of company–university collaboration, but in reality, the interaction was with the professor and his/her students – not with the university per se. The performance-enhancing contacts were social between individual and teams rather than institutional between company and university/universities.

Our case studies from China suggest that transfer and transformation from exploration to exploitation can be addressed through new and more extreme social networks combining science-driven academic researchers and business-driven corporate practitioners – thereby spanning the well-known ambidexterity gap – illustrated in Figures 1–3 – to enhance innovation performance.

7 Managerial implications

The managerial implications of our study are that R&D and innovation outsourcing can enhance innovation performance – provided that the foreign R&D unit is allowed to interact openly with local knowledge networks. The openness can consist of: physical closeness of collaboration, open sharing of strategically relevant knowledge, joint ideation and close coaching of innovation competitions, joint reviews of results – with every interaction opportunity supported by social events for relationship building. R&D managers will be able to apply this approach to their own company context both to reduce possible internal barriers against the establishment of new R&D centres, and to make more proactive use of local sources of exploration to enhance innovation performance. It is also important to note that allowing local employees in the newly established R&D centre to take leading roles in collaborations with universities typically makes them grow. This individual growth has a significant impact on personal motivation, talent retention and the overall innovation performance of the new R&D centre.

8 Limitations and possible future research directions

The limitations of our study are that only two cases are covered – although there have been more than 600 R&D centres established over the past nine years. A logical next step will be to design a quantitative study exploring the degree of openness to local collaboration and relate this to the impact on innovation performance. Furthermore, it would be valuable to compare the university collaboration patterns in China with equally important emerging innovation markets like India. For both regions, it would be highly relevant to study how the collaboration patterns between the new R&D subsidiaries and local universities underly the development innovation performance – both of the newly established R&D centre, and of the MNC as a whole. It would also be of great interest to explore how the importance of human interaction may differ depending on the nature of the business, the difference in product – and/or process-architectures (Sanchez, 2008) and the relative language and communication challenges across the different countries.

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