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Geography of knowledge networks: Case studies of technological capability development of Swiss mechanical and electrical engineering companies with subsidiaries based in China

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Abstract

The generation and circulation of knowledge has become one of the most crucial factors for firms? success in today?s internationalized world. Strategic management literature (resource-based and knowledge-based view of the firm, dynamic capability approach) increasingly highlights learning and innovation in firms as a localized, path-dependent and interactive process; and studies about the national innovation system, regional development or industrial clusters widely acknowledge that learning and innovation processes are highly embedded in local contexts.

However, the existence of transnational production networks suggest that knowledge generation and learning processes may also take place beyond local and national borders at various geographical scales. Moreover, many transnational firms constantly reallocate and renew their knowledge at different locations to build for instance technological capabilities in emerging economies such as China. Whereas a lot of empirical works towards learning and innovation in large multinational companies exist, studies about transnational learning processes in smaller firms with manufacturing operations across borders remain limited. The geography of their knowledge networks are expected to be different from MNCs as they do not have large R&D units, global project teams or globally integrated manufacturing locations.

As proposed in recent debates in economic geography, knowing and learning are relational processes among economic actors in a spatial perspective. Within such a framework, a transnational firm can be conceptualized as an organization in which inter-, intra- and extra-firm interactions within and between different locations are the sources for knowledge to develop or improve products and processes. However, social embeddedness of knowledge exchange and learning limits the boundless transfer, creation and protection of knowledge among employees, work teams and business units, and between customers, suppliers and other external actors at any location.

This ongoing Ph.D. thesis analyses how Swiss mechanical and electrical engineering SMEs transfer, create and protect knowledge within their inter-organizational networks to develop technological capabilities in their Chinese subsidiaries. An initial industry survey about technological competence building covering 150 Swiss mechanical and electrical engineering companies in China has been conducted in 2011. Based on 51 company responses, 6-8 firms with manufacturing operations in China have been selected for in-depth case studies. For the firm studies a mixed method approach has been applied with the following steps: 1. Survey with employees at the case subsidiary in China about intra-, inter- and extra-firm interaction and knowledge exchange; 2. Social network analysis based on the survey results to map, describe and analyze the network structure and identify key actors within each case firm; 3. Interviews with these key actors in China and Switzerland about the case study firm?s knowledge network and an analysis of strategies and challenges to transfer, create and protect knowledge from a relational economic geography perspective.

Preliminary case study results show the sources, flows and resistance within the inter-organizational knowledge networks. A typology of various forms of distance within the different networks has been established and knowledge management strategies to overcome these distances will be presented. The results indicate that the firm specific architecture of the knowledge network is essential to effectively and efficiently transfer, create and protect knowledge. Furthermore, transnational learning in manufacturing operations across borders seems to be more challenging for smaller transnational firms compared to large MNEs.

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Geography of knowledge networks:

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Abstract

This ongoing PhD thesis analyses how transnational companies develop technological capabilities across borders. Based on an initial survey about technological competence building of Swiss mechanical and electrical engineering companies in China, in-depth firm case studies have been conducted to investigate the impact of different dimensions of proximity (cognitive, organizational, social, institutional and geographical) on learning and innovation in and from subsidiary operations in China. Preliminary case study results suppose that companies in China use their subsidiaries to create cognitive proximity to learn from their customers, but at the same time try to maintain a certain distance to protect their knowledge and maximize their competitive advantages. In particular smaller transnational companies seem to be more challenged and limited towards learning in their manufacturing operations in China compared to their bigger multinational counterparts. However, this hypothesis needs to be further tested in the ongoing and planned case studies.

1. Introduction

The generation and circulation of knowledge have become one of the most crucial factors for firms' success in today's internationalized world. Strategic management literature like the resource-based view of the firm or the dynamic capability approach increasingly highlights learning and innovation in firms as a localized, path-dependent and interactive process (Kline & Rosenberg, 1986); and studies about the national innovation system (Nelson & Rosenberg, 1993, Lundvall, 2007), regional development (Scott, 1998, Storper, 1997) or industrial clusters (Porter, 1998) widely acknowledge the importance of geographical proximity and local embeddedness for innovation and learning processes.

However, the existence of transnational production networks with highly competitive firms suggest that knowledge generation and learning processes may also take place beyond local and national borders at various geographical scales (Bunnell & Coe, 2001; Malecki, 2010). Scholars from international business studies for instance have argued that the reason why transnational companies (TNCs) exist lies in their superior ability to organize transactions involving knowledge-intensive assets (Gupta & Govindarajan, 2002). Furthermore, TNCs play a unique role in combining locally embedded capabilities with those that are mobile across borders (Amin & Cohendet, 2005).

However, despite that the world has "shrunk" thanks to new technologies, the geography of tacit knowledge and learning remains complex (Gertler, 2003). Different dimensions of proximity and distance influence learning and innovation and have been discussed in various academic fields including economic geography literature (Boschma, 2005). It has for instance been demonstrated that the efficient integration of remote manufacturing plants is by far not a trivial task and only in certain cases the lack of geographical or institutional proximity could be compensated by organizational closeness (Gertler, 2004). However, firm case studies about the impact of proximity and distance in transnational learning have been limited so far. Whereas multinational companies as for instance described by Bartlett and Ghoshal (1999) have often been the focus for in-depth firm studies, transnational learning and innovation processes within smaller, non-multinational firms have remained a black box.

This ongoing PhD thesis analyses how transnational companies develop technological capabilities across borders. On the basis of a study of Swiss mechanical and electrical engineering companies with subsidiaries based in China, this article examines the role of proximity and distance in transnational learning and innovation processes within TNCs. Based on a survey conducted in 2011 with 150 Swiss mechanical and electrical engineering companies with subsidiaries in China, eight companies have been selected for in-depth case studies. Preliminary results show that companies with business operations in China create different forms of proximity with their subsidiaries, but at the same time maintain a certain distance to exploit and enhance their competitive advantages from their home base. To analyze the different proximity dimensions and its impact on transnational learning, a triadic relationship among the headquarters, subsidiaries and customers in China is proposed for the ongoing and planned case studies.

The paper is structured as follow: it starts with a theoretical analysis of learning and innovation in transnational companies. After a review of proximity and distance dimensions, the framework to analyze the triadic relationship of learning in and from China is proposed. After the section research question and methodology, survey results are presented. The paper is closed by a discussion about further research steps.

2. Learning and innovation in transnational companies

The widely accepted view that knowledge and its creation has become the key competitive advantage of the firm (Nonaka & Takeuchi, 1995; Gibbons, 1994) has led to a shift in strategic management, business and economic literature from the resource-based to the competence-based view (CBV) of the firm. It acknowledges that the firm as a social organization knows how to do certain things, based on competences or coherent sets of routines used in an efficient way. Some competences, which constitute the main sources of competitiveness, are results of a selection process both within and external to the firm (Amin & Cohendet, 2004: 39). The idea that firms learn differs markedly from both neoclassical economics and transaction-cost economics.

Compared to the resource-based view of the firm, knowledge is situated knowledge and not only a simple knowledge stock model, not only codified in nature and not limited to individuals. From this perspective, innovation is fundamentally a localized, path-dependent, and interactive process (Kline & Rosenberg, 1986). Innovation is further considered as an outcome of knowledge production which adds to existing knowledge and expresses its economic value. Firms are seen as as "(…)repositories of capabilities, determined by the social knowledge embedded in enduring individual relationships structured by organizational principles." (Amin & Cohendet, 2004:15).

Scholars from international business studies on the other side have argued that the reason transnational companies exists lies in their superior ability to organize transactions involving knowledge-intensive assets. Furthermore, TNCs play a distinctive role in combining locally embedded capabilities with those that are mobile across borders (Gupta & Govindarajan, 2002).

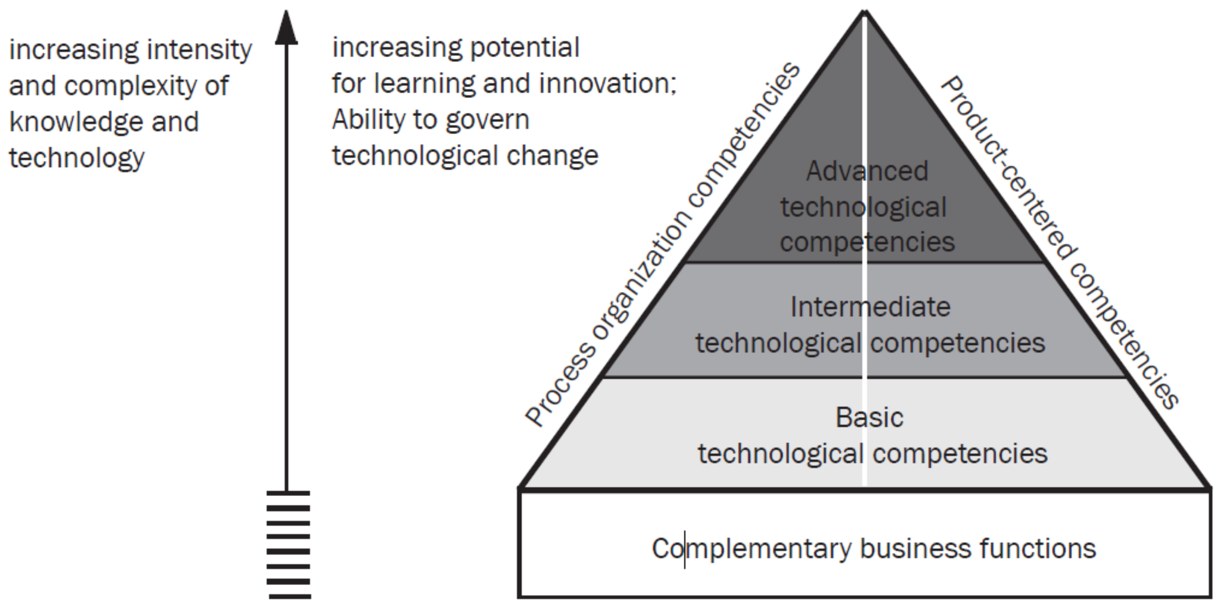
The eclectic paradigm offers some explanations why enterprises engaging in cross-border activities. According to Dunning, a firm must possess unique and sustainable ownership-specific advantages vis-a-vis firms of other nationalities to engage in cross-border investment (Dunning, 2000). Foreign direct investment will take place when the company perceives it to be in its best interest to add value to its ownership advantages rather than to sell or lease them to independent foreign firms. An important aspect of the ownership advantages is that while some of them may be monopolistic in nature, others are characterized as dynamic capabilities: i.e. the ability to coordinate transactions and to reconfigure assets across borders. Being exposed to international competition, and embedded in multiple institutional contexts, in particular multinational enterprises receive ongoing stimuli for the development of new routines (Dunning & Lundan, 2010).

But how can knowledge, learning and innovation within companies be measured and conceptualized? Different disciplines have defined and conceptualized capabilities, knowledge and learning differently. One way to describe learning and innovation is the concept of technological capabilities (e.g. Lall, 1992; Bell & Pavitt, 1995). Technological capabilities have been defined as the knowledge and skills that the firm needs to acquire, use, adapt, improve, create, transfer technology (Iammarino, Padillaperez, & Vontunzelmann, 2008: 1980). In my definition, the protection of technology is added to this already existing. Technological capabilities are essential for innovative performance and competitive advantage of the whole TNC.

In this study, technological competencies refer to the ability to apply scientific and technical knowledge to develop or improve products and processes at the subsidiary level independently from the headquarters or other subsidiaries. Rather than the specific identification of certain quantities and qualities of knowledge bases, the concept of technological competencies identifies levels of increasing novelty and significance in terms of subsidiaries innovative activity. Other studies with a similar approach have shown that such different levels of capabilities lie behind the different levels of innovative performance. These levels of technological competencies range from "elementary" to "advanced" and are divided into product-centered and process organization competencies (Iammarino et al., 2008; Figueiredo, 2010)

Technological competencies can additionally be distinguished into process organization and product-centered competencies. The former refers to knowledge and skills which are necessary for an efficient production process and can lead to new or improved processes by means of process innovations. The latter refers to knowledge and skills needed to manufacture already existing products, to improve them or to create new products by means of product innovations (Iammarino et al., 2008). Thus, this classification distinguishes between production resources needed to reproduce existing products and processes, and innovation resources critical to the governance of technological change within the subsidiary, and the whole company respectively (*Figure 1*).

Figure 1: Subsidiary-level technological competencies



adapted from Iammarino et al., 2008

Technological capability development therefore refers to the entire process in which firms not only build technological competencies in their subsidiaries, but also learn and innovate in the entire organization through interactions both within the organization and between external actors like customers, suppliers and other relevant market players.

3. The role of proximity and distance in transnational learning

As proposed in recent debates in economic geography, knowing and learning are relational processes between economic actors in a spatial perspective (Bathelt & Gluckler, 2011). Within such a framework, a transnational firm can be conceptualized as an embedded social network in which inter-, intra- and extra-firm interactions within and between different locations are the sources for knowledge to develop or improve products and processes. However, the social embeddedness of knowledge and learning limits the boundless transfer, creation and protection of knowledge among employees, work teams and business units, and between customers, suppliers and other external actors at any location. The reason is that beside geographical distance, cognitive, organizational, institutional or cultural barriers can hinder knowledge transfer and transnational learning processes (Boschma, 2005).

Various forms of proximity and distance have been defined in the fields of economics, geography, mathematics or sociology. Torre and Rallet (2005) for instance have made a distinction between geographical and organized proximity, whereas the former means the physical distance of two actors within a geographical space (e.g. Km, time, but also individual's perception), the latter the relational proximity which means the ability of an organization to make its members interact. This trade-off, the acquisition of knowledge from various places and regions around the world, and the organizational coherence through corporate expansion, has been named as the expansion-coherence dilemma (Bathelt & Gluckler, 2011). Similarly, the trade-off between external proximity and internal proximity has been described in earlier studies (Blanc & Sierra, 1999).

Based on work of the French School of Proximity Dynamics, Boschma (2005) has proposed different dimensions of proximity which influence learning and innovation in companies: cognitive, organizational, social, institutional and geographical proximity and distance.

The knowledge base in companies is typically dispersed among different business locations, units and individuals. Companies learn and innovate by bringing together diverse, complementary capabilities of heterogeneous agents within and between their organizations (Nooteboom, 2000). Individuals within organizations therefore require *cognitive proximity* in terms of a shared knowledge base in order to communicate, understand and process it successfully. The notion of cognitive proximity is closely related to the tacitness of knowledge and absorptive capacity (Cohen & Levinthal, 1990). However, too much cognitive proximity decreases the potential for learning as it limits the novelty of sources for new knowledge like cognitive lock-in or increases the risk of involuntary spillovers

The organizational dimension of proximity and distance refers to the organizational arrangement in which internal and external relations in organizations are governed. It involves the rate of autonomy and the level of control a company has to coordinate the exchange of dispersed knowledge within and between its own organizations. *Organizational proximity* is closely related to the transaction cost approach of Williamson as new knowledge creation and transfer needs tight relations because of uncertainty and opportunism. However, too much organizational proximity can be harmful for learning and innovation as it inherent the risk of lock-in into specific exchange relations and organizational flexibility, and in an asymmetrical relation, the absence of feedback.

Socially embedded relations between agents at the micro-level based on friendship, kinship and previous experience have been defined as social proximity. The theoretical roots of *social proximity* lie in the embeddedness literature (Granovetter, 1985). Interactive learning, in particular the transfer of tacit knowledge, is facilitated by trust-based social relationships as it reduces the risk of opportunistic behavior. Nevertheless, too much trust can lead to a lock-in at the expense of innovative and learning capacity.

Institutional or cultural proximity refers to the institutional framework in countries and regions like legislative conditions, labor relations or business practices or common cultural background. It is associated with the institutional framework at the macro-level and includes both the idea of economic actors sharing the same institutional rules of the game as well as a set of cultural habits and values. On the one hand, too much institutional proximity can lead to institutional lock-in and may hinder new ideas and innovations; on the other hand, learning and innovation is facilitated by common formal institutions and values, and high social cohesion.

Geographical proximity has been discussed extensively within the field of economic geography. However, co-location may facilitate learning and innovation by stimulating the other forms of proximities as discussed above, but it is neither a necessary nor a sufficient condition (Boschma, 2005).

4. Research questions and methodology

To study the role of proximity and distance in transnational learning and innovation processes, a case study has been conducted on how Swiss companies learn and innovate in and from their subsidiaries based in China. For this investigation, a process-based methodological framework has been applied (Yeung, 2003) with the following research two research questions dividing the inquiry into two phases.

1. What are the developed levels of technological competencies in Swiss mechanical and electrical engineering subsidiaries based in China?

An initial industry survey about the development of technological competences of Swiss mechanical and electrical engineering companies with subsidiaries based in China has been conducted in 2011. The sample consisted of all member companies of the Swiss mechanical and electrical industry association „Swissmem" with at least one subsidiary or representative office in China. The purpose of the survey was to evaluate the relevance of China for the Swiss mechanical and electrical engineering industry, to quantify the developed levels of technological competencies in China, and to determine strategies and characteristics of companies with a high overall level of technological competencies in their Chinese subsidiaries.

The survey was conducted by means of two different questionnaires: the first covered headquarters in Switzerland, the second their respective subsidiaries in China. 150 companies with at least one subsidiary or representative office in China were invited to participate in the survey. Thereof 55 companies returned the headquarters questionnaire (50) and/or the subsidiary questionnaire in China (41). This corresponds to a response rate of 37%. The operationalization of technological competencies in subsidiaries has been done similarly as in previous studies (e.g. Iammarino et al., 2008).

The questionnaires of both surveys were analyzed with the statistical software SPSS regarding possible interrelations within the data. All valid answers were pairwise compared with the Kendall‘s rank correlation coefficient Tau (τ) and tested for significance with a two-tailed technique.

2. How do the technological competencies in Chinese subsidiaries contribute to technological capabilities of the whole transnational company?

Based on survey responses, eight firms with manufacturing operations in China have been selected for in-depth case studies (firm overview in *Appendix 1*). For these ongoing and planned firm studies, a case study method approach (Yin, 2009) has been applied with the following steps: 1. Identify employees at the case firm in China which are key players for intra-, inter- and extra-firm interaction and knowledge sources; 2. Interviews (Schoenberger, 1991) with key employees in China and Switzerland about the case study firm's knowledge network, strategies and challenges of transferring, creating and protecting knowledge according to the theoretical framework.

The qualitative data have been analyzed with MAXQDA according to the theoretical framework of the three dyads (headquarters-subsidiaries, headquarters-customers in China, subsidiaries-customers in China) and the five proximity dimensions (cognitive, organizational, institutional, social, and geographical). The results will additionally be validated by expert interviews.

5. Survey results of technological competence building in China

The mechanical and electrical engineering industry in Switzerland occupy a leading position in the national economy. As the largest industrial employer with approximately 335'000 employees, it contributed in 2010 to 35 percent of total goods exported from Switzerland. Beside of a handful of global multinational companies, most Swiss companies are smaller, often family owned companies. With a high degree of specialization, Swiss mechanical and electrical engineering firms export on average 80 percent of their products and are often technology leaders in their specific fields. Another striking feature is that this industry is primarily an intermediate goods industry (Swissmem, 2012).

The People‘s Republic of China on the other hand has in recent years developed from a low-cost investment place to a location with prospects of increasing knowledge and technology intensive production. An important role in this process has been played by the political leadership which aims to strengthen the domestic innovative capabilities with guidelines such as the national medium- and long-term program for science and technology development (2006-2020). The commitment to modernization and innovation of strategically vital industries has been reinforced by the central government in the current twelfth five-year plan. Expenditures on research and development were 1.75% of the gross domestic product in 2010, until 2015 this ratio is planned to increase to 2.2%. Educational spending is planned to pass 4% of the gross domestic product in 2012 (GTAI, 2012).

China is therewith following the tradition of other East Asian countries such as South Korea or Taiwan where economic growth came along with the development of research and development capacities in the public and private sector (Ernst, 2009, Ernst, Ganiatsos, & Mytelka, 1998).

As a consequence, China has in the past few years become a prime target of foreign direct investment from Switzerland outside Europe and North America. At the end of 2009, the stock of Swiss capital in China was 7.5 billion Swiss francs (0.9% of the worldwide foreign capital stock), of which 1.2 billion Swiss francs flowed to China in the same year. This corresponds to 3.3% of all foreign investments made by Swiss companies in 2009. Besides, Swiss companies in China employed 125‘938 persons at the end of 2009, corresponding to 4.8% of all employed persons of Swiss companies abroad (SNB, 2011).

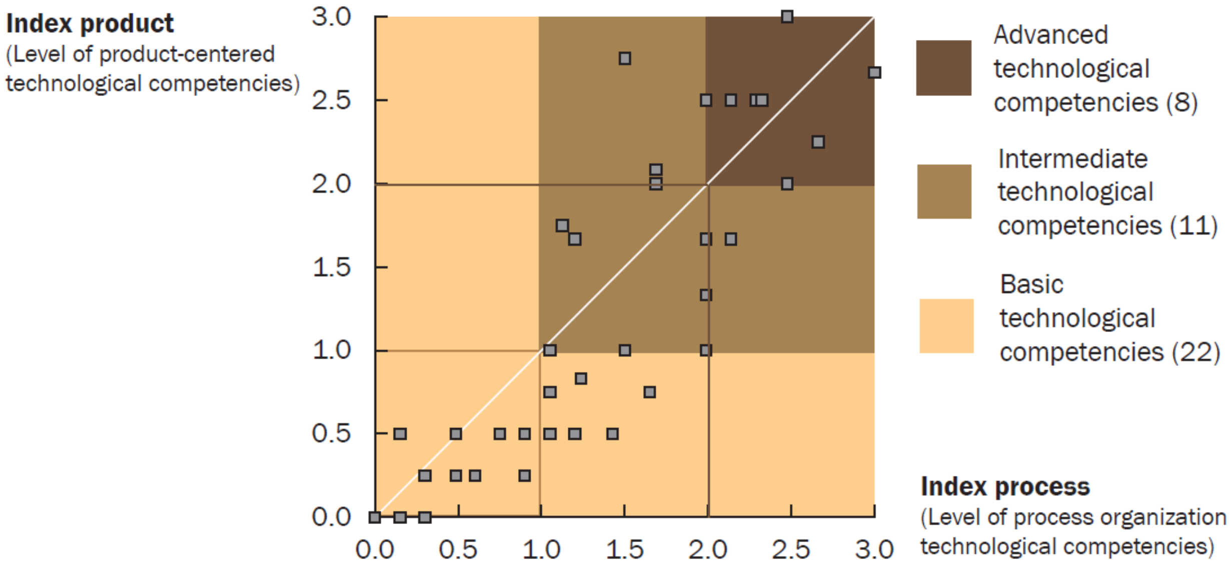
The first Swiss mechanical and electrical engineering companies entered the Chinese market already in the 1980s by means of establishing joint ventures with local companies. In the 1990s, it became additionally possible for foreign firms to establish wholly foreign-owned companies (WFOEs) in China. At the beginning of 2011, all 99 companies with an industry association membership in Swissmem hold together 225 Chinese subsidiaries and employ approximately 40‘000 people in China. The majority has chosen the Yangtze River Delta with Shanghai and Jiangsu Province as a location for their investment.

According to the results of the 50 headquarters questionnaires, the predominant entry mode of Swiss companies in China were greenfield investments by establishing a new unit in the form of wholly owned foreign enterprises (68%), followed by joint ventures with local firms (19%) and acquisitions of existing firms (13%). Some firms, which originally entered China with joint ventures in the early years when foreign investment became possible in China, have in the meanwhile taken over the entire financial control of their subsidiaries. Today, more than three quarters of all Swiss mechanical and electrical subsidiaries in China are so-called wholly foreign-owned enterprises (WFOEs). However, in particular large companies with several subsidiaries in China still hold some shares in joint ventures. Representative offices have conventionally been the first step to an official China entry in a later step.

The subsidiaries in China were asked about 32 different competencies they are able to do independently from their headquarters in Switzerland (detailed results in *Appendix 2*). Among them are four competencies that can be summarized as complementary business functions. The remaining 28 competencies are classified, according to increasing knowledge and technology intensity and complexity, into the three levels basic, intermediate and advanced technological competencies (*Figure 2*).

The index of technological competencies for each surveyed subsidiary was calculated as follows: the share of competencies for every subsidiary at each competence level (basic, intermediate and advanced), separated into process organization and product centered competencies. If a company, for instance, possesses all competencies at the basic product-centered technological competence level, it gets a 1 (as for 100%). The sum of all 6 different levels results in an index which is between 0 and 6. Competencies, which were stated as not applicable in one of the subsidiary responses, were subtracted as a possible competence. In this way, it would still be possible for those subsidiaries to get a maximal score of 6. The result shows a strong interrelation of product-centered and process organization levels of technological competencies.

Figure 2: Developed levels of technological competencies in Swiss mechanical and electrical engineering subsidiaries in China



Source: 41 survey respondents

The key messages of the study can be summarized as follows: First, in the past years, Swiss mechanical and electrical engineering companies have successfully developed numerous technological competencies in China. A quarter of the surveyed headquarters stated that they carry out research and development activities in China and that different basic technological competencies exist in the majority of surveyed subsidiaries. In addition, larger companies and older subsidiaries in China tend to have developed higher and more complex local competencies.

Second, despite difficulties regarding knowledge and technology protection, all surveyed companies are going to develop more competencies in China in the next two years. These competencies will further contribute to local knowledge and technology related activities and can be distinguished into the levels: basic, intermediate and advanced technological competencies. Existing technological competencies in Chinese subsidiaries turn out to be complementary to competencies developed at other business locations outside China and are, therefore, not displacing them.

Third, two thirds of the investigated companies report that they are applying scientific or technical knowledge to develop and improve products and processes in China. In doing so, the transfer of existing knowledge - compared to knowledge protection and creation of new knowledge - was rated by the headquarters and subsidiaries as the most critical knowledge management strategy. However, companies with a higher level of competencies evaluate knowledge creation as significantly more important than their counterparts with less advanced competencies. This means that local sources of knowledge and skills are becoming more crucial with more advanced competencies. The protection of knowledge is relevant for headquarters and subsidiaries equally, but has compared to the transfer and creation of knowledge, a lower priority.

6. Conclusion for the ongoing and planned case studies

The generation and circulation of knowledge have become one of the most crucial factors for firms' success in today's internationalized world. Therefore, transnational companies constantly need to find efficient organization and integration strategies to learn and innovate in their dispersed global business networks. This ongoing PhD thesis analyses the impact of different dimensions of proximity (cognitive, organizational, social, institutional and geographical) on learning and innovation by means of a case study of Swiss mechanical and electrical engineering companies with subsidiary operations in China. Based on first exploratory results, three preliminary conclusions shall guide the ongoing and planned case studies:

First, technological competence building of Swiss mechanical and electrical engineering companies in China not only reflect the development of China from a low-cost investment location to a more knowledge and technology intensive production base, but also demonstrates the increasing importance for transnational companies to deal with geographical complexities and challenges. The shift in the global manufacturing industry forced suppliers of intermediate goods to expand into the Chinese market. Firstly, because of new potential Chinese customers, and secondly even more important, because their long-term customers in Europe, the US or Japan also relocated production to China. By establishing a subsidiary in China, extra-local linkages are established and the company may benefit of spatial externalities in China, learn and innovate in and from its local business operations and may enhance its competitive advantage. As a consequence, if co-location is beneficial for learning and innovation because it facilitates other dimensions of proximity as demonstrated in various studies, then transnational learning in TNCs needs the capacity to deal with various dimensions of distance and create the necessary proximity where needed. In other words, technological capability is the knowledge and skills that the firm needs to acquire, use, adapt, improve, create, transfer and protect technology across borders.

Second, the established subsidiaries in China play an important role for local learning and innovation processes for the whole TNC. The development of technological competencies in China seems not to be driven by cost advantages, but much more by the necessary cognitive proximity to learn and innovate in and from the Chinese market. When companies establish subsidiaries in China, they must first familiarize themselves with various different ways of acquiring knowledge, in order to learn how to undertake production and to engage in innovation activities at a basic level. Because the subsidiary is dependent on its parent company, the deployment of capabilities to undertake different degrees of innovation is mobilized in a sequential and interactive learning process between the subsidiary and the parent company. Only what is learned in the subsidiary can also be learned from the subsidiary, and vice versa.

Third, smaller transnational companies seem to be more challenged and limited towards learning in their manufacturing operations in China compared to their bigger multinational counterparts. The reason for this higher chalenge lies in their limited capacity to create organizational proximity. It is therefore hypothesized that transnational learning in smaller TNCs is most efficient in a strong triadic relationship between the headquarters and subsidiaries, headquarters and customers in China, and subsidiaries and customers in China as it has been observed in preliminary case study results.

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Appendix 1: Overview case study firms

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
Industry	Mechanical and electrical enginnering	Mechanical and electrical enginnering	Mechanical and electrical enginnering	Mechanical and electrical enginnering	Mechanical and electrical enginnering	Mechanical and electrical enginnering	Mechanical and electrical enginnering	Mechanical and electrical enginnering
Related industry	Machine tool industry	Machine tool industry	Machine tool industry	Plastic industry	Plastic industry	Automation industry	Textile industry	Textile industry
Establishment	1943						1887	1935
Worldwide employees	485	1400	600	1000	900	400	1000	250
Employees in Switzerland		490						30
Production plants	CH	CH, CN, D, RO	CH, USA, GB, CN, TW, Turkey	CH, CN, US, Malaysia, F		CN, CH, HU	CH, CN, ??	CH, CN, ??
China establishment	2005	2001	2007	2002	2001		1997	
Type	WOFE	WOFE	WOFE (Aquis)	WOFE	WOFE	JV	WOFE	WOFE (ex JV)
China employees	22	300	100	40	380		250	120
Competencies in China	Sales and Service Sub-assembly	Sales and Service Purchasing (Sub-)Assembly Production Engineering R&D	Sales and Service Purchasing (Sub-)Assembly	Sales and Service Purchasing (Sub-)Assembly Engineering R&D	Sales and Service Purchasing (Sub-)Assembly Production		Sales and Service Purchasing Assembly or Sub-Assembly Engineering	
Sales Share	10%	25%	14%	30%	15%		28%	
China production	5%	22%	14%	10%	18%		25%	
Import	85%		10%	30%	30%		15%	10%
Domestic Sourcing	15%		90%	70%	70%		85%	90%
Export							3%	
Semi-structured interviews in China	GM China Plant Manager Customer Service Engineer	President APAC GM China Engineer CN	CEO, Asia Synergy Team Leader Asia COO Asia Sales Manager Ex. VP China VP China	GM China Electrical Engineer	Managing Director Tooling GM Tool Design Manager Project Manager Tool Engineer	GM	GM China Plant Manager Marketing China	GM China Electrical Engineer Project Manager
Semi-structured interviews at HQ	CEO VP/Head R&D Sales Manager Asia Technical Advisor/Instructor	CEO Head Development Head Operations Ass. President APAC	CEO Group CMO	CEO VP Sales Head R&D	CEO CTO-TQM	CEO	CEO Head Sales Asia Head Marketing	CEO Ex GM China Engineers

Appendix 2: Results on technological competencies developed in Chinese subsidiaries (N=41)

Figure 3: Complementary business functions

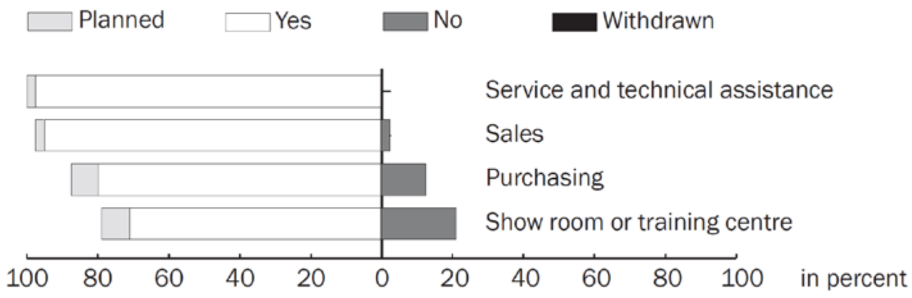

Figure 4: Basic *process organization* technological competencies

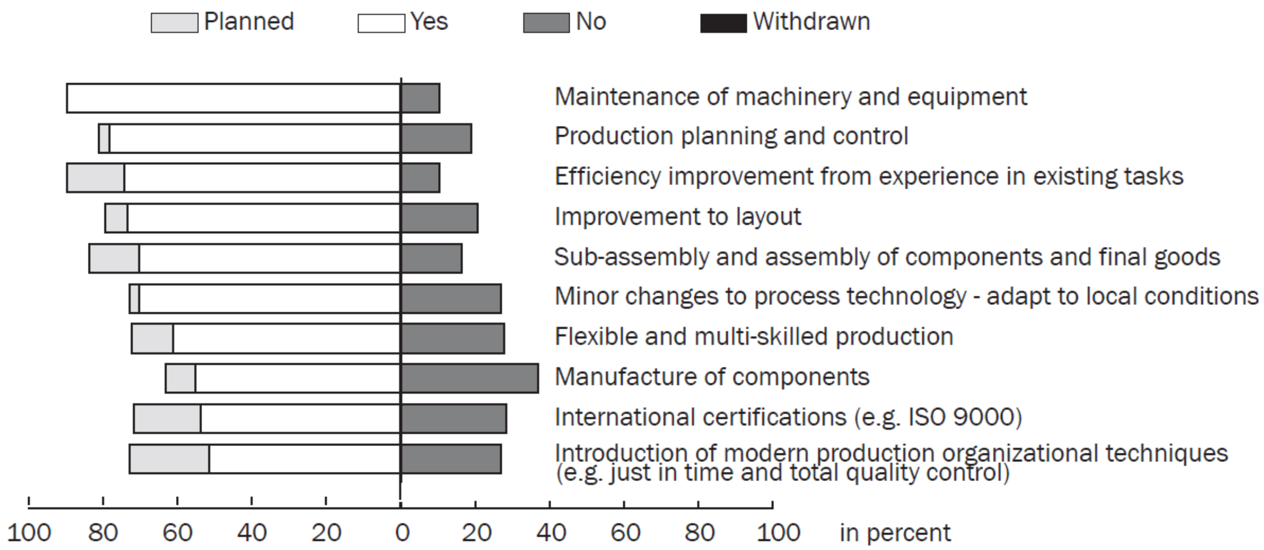

Figure 5: Basic *product-centered* technological competencies

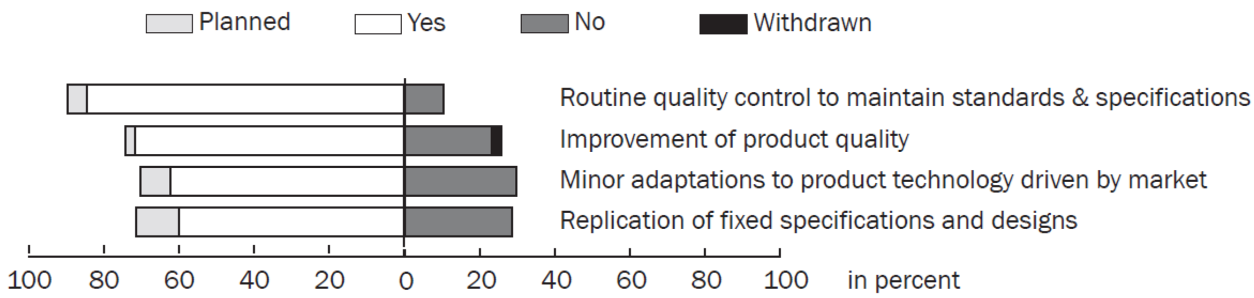

Figure 6: Intermediate *process organization* technological competencies

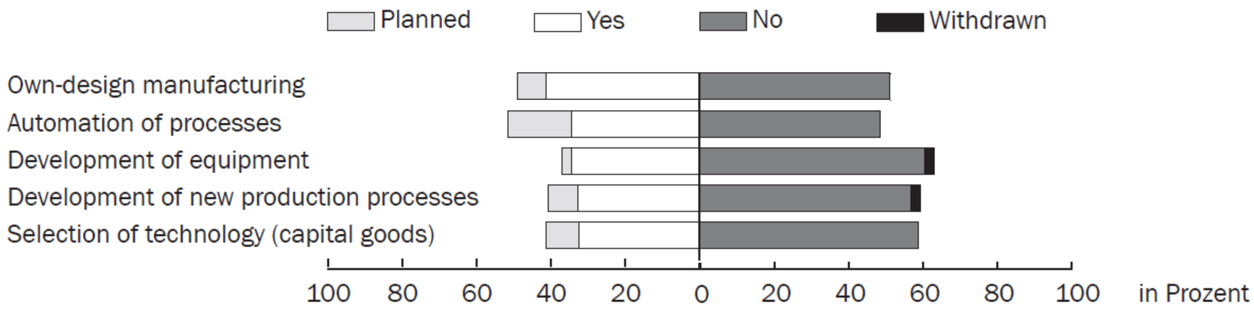

Figure 7: Intermediate *product-centered* technological competencies

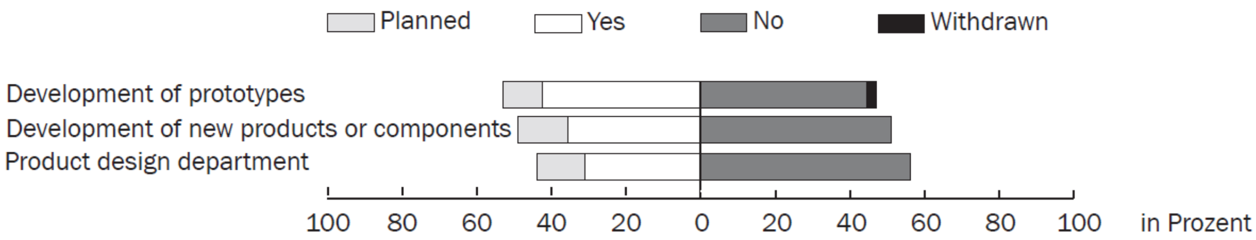

Figure 8: Advanced *process organization* technological competencies

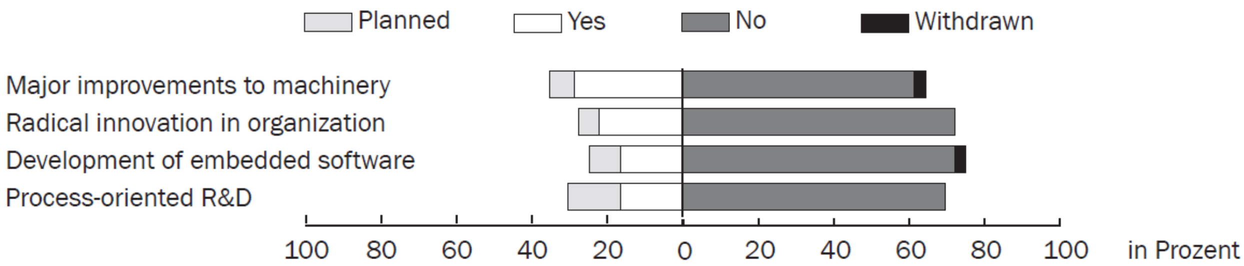

Figure 9: Advanced *product-centered* technological competencies