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Competences as drivers and enablers of globalization of innovation: the Swedish ICT industry and emerging economies

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This paper explores the relationship between competences and global innovation networks in the Swedish ICT industry. More specifically this paper combines econometric techniques and case study analysis to capture the interplay between firm level competences (competences as *enablers*), the availability of competences in the host country (competences as *drivers*), and the specific strategy of the firm for engaging in global innovation networks. Our results show that for Swedish ICT firms, firm-level competences are an important *enabler* for globalization of innovation, particularly for offshoring. Home regional competences also play an important role for the mode of globalization of innovation that firms engage in. Host regional competences are important *drivers* for globalization of innovation, particularly for offshoring and collaboration. The results suggest that the breadth and depth of competences available in host countries actually determine the type of innovation activities that the subsidiary performs, as well as the role that it plays in the global innovation strategy of the company.

Keywords: global innovation networks; competences as drivers; competences as enablers; ICT

1. Introduction

The objective of this article is to discuss the relationship between competences and global innovation networks (GINs) in the Swedish ICT industry using both survey data and information from a case company. This article portrays the interplay between firm-level competences, the availability of competences in the host country and the specific strategy of the firm for engaging in GINs. GINs are defined in this article as 'a globally organized network of interconnected and integrated functions and operations by firms and non-firm organizations engaged in the development or diffusion of innovations' (Chaminade, 2009). Firms can globalize their innovation activities by engaging in the global exploitation of innovations (exports), global sourcing of technology, global research collaboration and offshoring of innovation (Archibugi and Michie, 1995; Audretsch and Feldman, 1996). This article is concerned with the last two forms of GINs.

This article starts by discussing the interplay between competences and GINs, distinguishing between regional and firm-level competences. Competences may influence GINs in at least two ways: as drivers of globalization and as enablers of globalization. Scholars in international business and innovation studies (Arora et al., 2001; Arora and Gambardella, 2004, 2005) argue that offshoring MNCs pursuing an asset seeking strategy (Howells, 1990) may be attracted

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to a certain region to tap into the specific competences available there (Narula and Zanfei, 2004; Cantwell and Piscitello, 2005, 2007; Lewin et al., 2009). Therefore, competences may play a role as a *driver* for the establishment of GINs, notably, for global research collaboration and offshoring for innovation, as the evidence of knowledge hubs like Bangalore shows (Arora et al., 2001; Saxenian, 2001b; Parthasarathy and Aoyama, 2006; Chaminade and Vang, 2008). That is, firms may be driven to certain locations to access competences available there. In this sense, competences as drivers refer to the role of regional competences attracting innovation activities to a particular region. On the other hand, firm-level competences may also be *enablers* for the establishment of GINs (Nooteboom, 2000, 2004; Nooteboom et al., 2007), that is, firms may need a certain level of in-house competences to engage in global research collaboration or offshoring in faraway locations. Competences define the absorptive capacity of a firm (Cohen and Levinthal, 1990) which in turn, influences the ability of an organization to benefit from engaging in collaboration with other organizations. It also affects the ability of the firm to operate in international environments. Thus, competences are also an enabler for the engagement in GINs.

Through regression analysis using survey data and in-depth interviews with TELEQUIP in different world locations (Sweden, South Africa (SA), India and China), the article explores the interplay between globalization of innovation and competence building, from two perspectives:

(1) Which competences companies need to engage in GINs, particularly in global research collaboration and offshoring? – competences as an enabler
(2) To what extent the access to competences may be the driver for the location of R&D labs abroad? – competences as a driver

This article is structured as follows. First, it introduces the conceptual framework exploring the relationship between firm and regional competences and globalization. The following section presents the method used for this article. Section 4 is centred on the empirical evidence of the relationship between globalization of innovation and competences in the ICT industry in Sweden in general and in multinational firms in particular. The final section of the article concludes with some reflections on the role of competences in GINs, based on the Swedish experience.

2. Conceptual framework

2.1 *Global innovation networks*

It is widely accepted that innovation is the result of the interaction and exchange of knowledge between different individuals and organizations (Freeman, 1987; Lundvall, 1988, 1992). Scholars in the innovation literature have contributed to our understanding of networks of innovators (De Bresson and Amesse, 1991; Freeman, 1991; Powell and Grodal, 2004) particularly with regards to the structure of the network (Burt, 1992; Dickens, 2007), the governance of the networks (Humphrey and Schmitz, 2002; Nooteboom, 2003; Coe et al., 2004; Gereffi et al., 2005) and its impact on knowledge distribution among the actors of the network (Giuliani and Bell, 2005a, 2005b; Giuliani, 2007) but substantially less on its geographical spread.

On the other hand, the geography of innovation networks has been the focus of economic geographers for almost two decades (Cooke, 1992; Asheim and Isaksen, 1997; Mothe and Paquet, 1998). Traditionally, economic geographers have argued that due to its tacit nature, knowledge is sticky and tends to be embedded in certain regions or territories. Local or regional networks of innovators are then considered to be crucial for innovation and competitiveness. Bathelt and Glûckler (2003) argued that the most competitive clusters were those that showed a high degree of local interactions but also strong linkages with international sources of knowledge.

With few exceptions (Fifarek and Veloso, 2010) almost all the scholarly work that has followed on local/global knowledge interactions or the geography of knowledge sourcing (Moodysson, 2008; Moodysson et al., 2008; Martin and Moodysson, 2011) has been mainly treating the international level as a black box, not analyzing whether those international linkages were with countries in close proximity or whether they were globally spread and constituted truly GINs.

As indicated in the introduction section, GINs are defined in this article as a 'globally organized network of interconnected and integrated functions and operations by firms and non-firm organizations engaged in the development or diffusion of innovations' (Chaminade, 2009). This definition highlights the main characteristics of a GIN: its global dispersion, its focus on innovation (and not production) and the combination of both internal and external networks. Following Archibugi and Michie (1995), it is possible to distinguish different forms of GINs (Plechero and Chaminade, 2010): the global exploitation of innovations, global sourcing of technology, global research collaboration and offshoring of innovation. Firms may globally exploit their innovations simply by selling their products abroad; they may innovate by acquiring technology from abroad or by engaging in research collaboration with firm and non-firm organizations located in a different country and, finally, they may also develop innovation through offshoring R&D labs abroad (global generation of innovation). This article is concerned with the last two forms of GINs. The interplay between these two forms of GINs and competences will be discussed in the following sections.

2.2 *Technological competences as an enabler for globalizing innovation activities*[1]

The resource-based view of the firm (Teece, 1980; Wernefelt, 1984) has long argued that the strategy that firms may pursue is contingent to the competences and the capabilities that the firms have (Wernefelt, 1984; Grant, 1991; Barney, 1996; Eisenhardt and Martin, 2000; Barney et al., 2001). The international business literature claims that the success of the internationalization process is also dependent on some firms' competences like the previous experience of the firm in international markets (Sousa et al., 2008) as well as the capability of the firm to organize internally the connections between the headquarters (HQs) and the subsidiaries (Dunning and Narula, 1995; Dunning et al., 1996). Finally, innovation scholars have long maintained that the capability to innovate and engage in interactive learning with other organizations and individuals is highly contingent to the technological competences that the firm has like the qualification of the human resources or the previous investment in R&D (Cohen and Levinthal, 1990; Lall, 1992; Bell and Pavitt, 1995).

Firm-level technological competences in this article are defined not only in terms of human resources but also in terms of technological effort as in Lall (1992) and Cohen and Levinthal (1990). Human resources refer to the skills of the individuals working for the firm and include the formal training as well as experience-based competences acquired on the job (Dantas et al., 2007). Technological effort refers to the investment of the firm in R&D and knowledge creation (Giuliani and Bell, 2005a, 2005b). Technological capabilities are related to the ability of the firm to connect to external sources of knowledge (domestic and international) (Bell and Albu, 1999).

Skills in general and technological skills in particular are the base on which technological capabilities are built (Lall and Pietrobelli, 2005). Qualified human capital is considered to be central for building the absorptive capacity of the firm (Cohen and Levinthal, 1990) and thus is determinant of the ability of the firm to locate, acquire and use information and knowledge from other organizations, such as other firms, users or knowledge providers (i.e. research institutions). Human capital is considered to be crucial for engaging in interactive learning which, in turn, is conducive to innovation. We might therefore expect that the qualification of the human capital is an important enabler of global research collaboration and offshoring of innovation.

Technological efforts or, more explicitly, intramural investments in R&D are expected to serve not only the generation of innovation but also to facilitate the acquisition of knowledge from external sources (Cohen and Levinthal, 1990) and the establishment of partnerships with external suppliers (outsourcing) (Mol, 2005). The more the firm knows, the more it is able to learn and therefore, the more that it will benefit from the interaction with other sources of knowledge. R&D may therefore to be considered directly an enabler of global research collaboration but also of offshoring of innovation. Firms with higher technology intensity are more likely to establish R&D subsidiaries abroad independently of production (Mariani, 2002; Audretsch and Feldman, 2004).

Both the coordination of R&D and innovation activities globally as well as the engagement in research networks requires the introduction of organizational innovations at the firm level (Dunning and Narula, 1995; Knight and Cavusgil, 2004; Sabiola and Zanfei, 2009). As acknowledged by recent international business literature, the advantages of multinationals not only emerge from the technological assets that the firms have in the HQs but also from the ability of the firm to manage international networks, including those with the subsidiaries (Kogut and Zander, 1992; Cantwell, 1995). The coordination of R&D activities between R&D subsidiaries and the HQs is very complex, as it involves the integration of both internal and external networks and requires advanced managerial and organizational competences. Those competences can be considered as enablers or facilitators for the engagement in offshoring and global research collaboration. Firms with higher organizational competences are expected to be related to global research collaboration and offshoring of innovation.

We may therefore expect that firm's level technological competences – such as the educational level, the R&D investment or the organizational innovations – may act as enablers for the engagement in GINs, particularly for global research collaboration as well as offshoring of innovations.

The region in which the firm is located has also an influence of the ability of the firm to engage in GINs. The institutional thickness of a certain region may facilitate or hamper the exchange of knowledge (Cooke et al., 1997; Asheim and Isaksen, 2002; Morgan, 2007; Gertler, 2010; Asheim et al., 2011), shape the geography of the knowledge flows of a particular region (Amin and Thrift, 1994, 1995; Tödtling et al., 2011) and be the main engine of change within the regional innovation system (RIS) (Boschma and Frenken, 2006, 2009).

We may therefore expect that the competences available in the region in which the firm is located may also act as enablers.

2.3 *Competences as a driver for the globalization of innovation activities: offshoring and global research collaboration*

One of the traditional arguments in international business literature explaining the internationalization of production and innovation activities has been the exploitation of existing advantages. The OLI (ownership, location, internalization advantage) framework developed by (Dunning, 1993, 2001) in the early nineties argued that multinational companies expanded their activities abroad to exploit their competitive advantage in terms of ownership, location and internalization. Dunning (1993) refers to four different strategies for internationalization: market seeking, resource seeking, efficiency seeking and asset seeking, being the first three more related to asset exploiting strategies (Knight and Cavusgil, 2004).

In line with March (1991), Penrose (1959) and later Wernefelt (1984) argue that the strategy of the firm is based on both the exploitation of existing resources and the exploration of new ones. The distinction between asset exploiting and asset seeking strategies is particularly relevant for offshoring and global research collaboration and has important implications for the role of competences as a driver for the engagement in GINs. While it is true that some companies may locate

R&D labs abroad to adapt existing products to the specific market needs (asset exploiting) (Verspagen and Schoenmakers, 2004), there is growing evidence of the increasing importance of asset seeking strategies in the localization of R&D abroad (Howells, 1990; Zander, 1999; Zanfei, 2000). Firms are attracted to certain regions or engage in research networks to tap into specific competences and knowledge available in that particular region or network (Lewin et al., 2009) and, in doing so, they increase the geographical concentration of innovation activities in certain knowledge hubs around the world (Fifarek and Veloso, 2010). Competences in the host region are therefore considered as drivers for offshoring of innovation.

Country or regional technological competences are defined here as the skills, knowledge and institutions that make a country or region's capacity to generate and manage change (Bell and Pavitt, 1995). Traditionally technological competences have been concentrated in a handful of developed countries and regions (Archibugi and Coco, 2004, 2005; Li et al., 2010). But the technology clubs of the world are slowly changing (Castellacci and Archibugi, 2008). In 2006, the UNCTAD published a report on R&D Foreign Direct Investment which pointed, almost for the first time, to the changing role of developing countries in the global flows of innovation-related investments (UNCTAD, 2006). It showed how R&D investments to and from developing countries had increased dramatically in a few years. Innovation had become truly global, involving organizations and regions outside the high-income countries.

One of the most often cited arguments explaining this global shift is the accumulation of competences in certain regions around the world, like Bangalore in India (Arora et al., 2001; Saxenian, 2001; Arora and Bagde, 2006; Parthasarathy and Aoyama, 2006) or Beijing in China (Altenburg et al., 2008; Athreye and Prevezer, 2008). Thus, some regions in developing countries have become knowledge hubs in global value chains (Castellacci and Archibugi, 2008), particularly in ICT industries (Chaminade and Vang, 2008).

We may therefore expect that the knowledge or technological competences available in a certain host region is an important *driver* at least for the offshoring of innovation activities.

3. Method

This article combines the analysis of survey-based data with a case study to illustrate with more detail the complex relationship between competences and GINs from a managerial perspective.

3.1 *Survey*

The survey was conducted in 2010 and was directed to the entire ICT population in Sweden. Firms were contacted by email and asked to conduct the survey online. The dataset used for the survey contains all the Swedish companies that according to Statistic Sweden operate in ICT in the following NACE 2 codes: (26.30 manufacture of communication equipment; 62.01 computer programming activities; 62.02 computer consultancy activities; 62.03 computer facilities management activities; 62.09 other information technology and computer service activities). The size of companies in the database is small, medium-size and large organizations. We excluded in the survey the firms with less than five employees.

The final number of companies contacted by mail was 1662. The final number of responses (complete questionnaires) was 171. The response rate was therefore 10.28%. The distribution of responses by firm size and sub-industry is representative of the total population of the industry (using statistics from statistics Sweden).[2]

The survey captures information about the different dimensions of the globalization of innovation for each firm, such as global technological collaboration (R&D strategy, sources of technology, establishment of networks for sourcing/developing technologies or innovations), and offshoring of production and innovation. The survey also captures information about structural characteristics of the firm, such as size, industry, specific activities and the main functions performed by the firm. Finally, it also captures information on technological competences at firm level such as qualification of the human resources, investments in R&D and organizational management techniques, etc.

3.1.1 *Dependent variables*

Global research collaboration. In the survey firms were asked who they actively collaborated with for the development of their most important innovation in the last 3 years. The firms were also asked to indicate the geographical location of the partner – the region, the country and a list of regions around the world (Western Europe, Eastern and Central Europe, North America, South America, Africa, Japan and Australasia and rest of Asia). The options available included clients, suppliers, competitors, consultancy companies, government and universities. We created two variables that capture collaboration within Europe, and truly global collaboration (grouping North America, South America, Japan and Australasia, Africa and rest of Asia). These two numerical variables are based on the number of partners that the firm collaborates with.

Global offshoring of production and innovation. In the survey, the firms were asked if they had offshored production and R&D activities. The firm could only answer yes/no. Although the survey did not explicitly ask the geography of offshoring, we checked their websites to investigate where the firm was offshoring. For the analysis we consider two cases, offshoring within Europe and those firms that have global offshoring (i.e. outside Europe) to destinations like India, China, Malaysia, Hong-Kong, Dubai or Bangladesh. Therefore, the two variables of offshoring of innovation are dummy variables that take the value 1 when the firm has offshored production or R&D activities and 0 otherwise.

3.1.2 *Independent variables*

3.1.2.1 *Competences as enablers*. *Firm's technological competences – skills*. We use two variables to capture the qualification of the human capital in the firm. In the survey, we asked the firms to indicate the estimated proportion of the employees by level of education. The three options were technical education/training, university degree and postgraduate degree. We created two dummy variables 'employees with university degree' and 'employees with postgraduate degree' that takes value 1 if the firm responded affirmatively to each of the categories, respectively.

Firm's technological competences – technological effort. We use three variables to capture the R&D activities of the firm. The first one is a dummy 'R&D activities' that takes the value 1 if the firm had answered Yes to the question 'do you have any significant R&D activity?'. The second one is a numerical variable with the number of full time equivalents employed in R&D. The third one captures whether the firm had engaged in intramural R&D and is derived from the question 'did your company engage in any of the following innovation activities in 2008' – being the options intramural R&D, extramural R&D, design, training and acquisition of machinery and equipment.

Firm's technological competences – organizational competences. The variable 'service innovation' captures whether the firm has introduced any service innovation in the last 3 years; the variable 'support innovation' captures whether the firm has answered positively to the question 'has the firm introduced new or significantly improved supporting activities for your processes (e.g. purchasing, accounting, maintenance systems, etc.) in the past 3 years (2006–2008)'? or to the question 'has the firm introduced new or significantly improved logistics, distribution or delivery methods for your inputs, goods and services in the past 3 years?'. These two variables are categorical variables that indicate the degree of novelty of the innovations (new to the firm, new to the country and new to the world). The variable 'advanced production systems' is a numerical variable that captures the number of systems of production organization that the firm employs. The available options were quality control systems, just in time production, continuous improvement, quality circles, internal manual and others. We use this variable also as a proxy for firm technological competences, related to organizational competences. We also asked the firms to estimate the percentage due to products 'manufactured by your unit according to design specifications provided by external buyers' (original equipment manufacturing – *OEM*), 'developed and designed by your unit according to performance requirements of buyers' (original design manufacturing – *ODM*) and 'developed and designed by your unit and sold under your own brand' (original brand manufacturing – *OBM*). We created three dummy variables that take the value 1 if the firm has performed any of those activities, respectively.

To capture the level of competences in the home region, we created the variable 'Home region Tier'. Home Region Tier is an original categorical variable that represents the dynamics and importance of the ICT in different regions in Sweden. We assigned the Tier level based on information about employment, economic dynamism and industrial activities for the ICT sector in Sweden. We have categorized regions where the firms are located in Tier 1, Tier 2 and Tier 3. Tier 1 regions are the most dynamic in the particular industry. Firms located there can have higher level of technological capabilities, also networks among agents and knowledge flows are more mature than in Tiers 2 or 3. Tier 2 regions present a medium level of interaction among the members of the network, and firms located in Tier 2 have a medium level of technological capabilities. Tier 3 regions are the least dynamic and interactions among the members of the network are weak (see Table 1).

3.1.2.2 *Competences as drivers (for offshoring of innovation only)*. *Regional competences*. If the firm offshored production and innovation, they were asked to indicate 'what were the important regional factors in the decision to offshore production and innovation into a host region'. The different options available captured market, costs and knowledge drivers *separately* for production and innovation. For the variable 'Host-region competences' we use only the ones regarding the offshoring of innovation activities. The variable takes the value 1 if the firm has marked the 'availability of specialized knowledge in the host region', the 'availability of qualified human

Table 1. Home region tiers.

Tiers	Description
Tier 1	Stockholm (including Kista and Solna) and Skåne. The Stockholm area employs around 100,000 people in the ICT industry and it is considered a leading region in the EU in ICT. Skåne (together with Copenhagen area – the Oresund region) employ around 93,000 people in ICT. The innovation performance of these two regions is high, according to the regional innovation scoreboard. Furthermore, Skåne is the region in Sweden with the highest number of ICT-related patents
Tier 2	Göteborg. Göteborg grew recently in the ICT industry with Ericsson and Volvo IT driving innovation. There are around 4700 ICT companies with 22,000 employees. The innovation performance of this region is also high, according to the regional innovation scoreboard
Tier 3	Rest

Sources: Hollanders (2009), Transform (2006), Hansen and Serin (2010) and Franzén and Wallgren (2010).

capital at a lower cost than in your own country' or 'access to knowledge infrastructure and services in the host region (R&D infrastructure, technical support services, etc.)' as important factors explaining the decision to offshore innovation.

3.1.3 *Control variables*

Additionally, we include a variable capturing the type of firm (standalone, subsidiary and HQ) and another one for the size of the firm. Of the firms in the sample 15% offshore production or innovation activities, but only 6% offshore at a global level (outside Europe). Regarding collaboration for innovation, 85.3% have established collaboration activities with different organizations, but only 35% collaborate at a global level. Most of the companies in the sample are standalone companies (88%), while subsidiaries and HQs represent only 12%. In terms of the region Tier, 42% of the firms are located in Tier 1, 19% in Tier 2 and 39% in Tier 3 regions. Table 2 provides the descriptive statistics of the variables used in the regression models.

3.2 *The model*

The analysis of the effect of competences on GINs can be analysed with a linear regression model. We estimate two different equations for the types of GINs; thus we have a set of equations for global research collaboration and a second set of equations for global offshoring. For the case of global research collaboration, we differentiate by collaboration within Europe ($CEUR_i$), and global collaboration (excluding Europe) (GC_i) and the dependent variables ($CEUR_i$ and GC_i) are continuous variables indicating the number of different types of organizations the firm collaborates with. The independent variables (x_i) are a set of dimensions that predict the engagement on global collaboration.

$$\mathrm{CEUR_i} = \mathrm{x_i}\beta + \varepsilon_\mathrm{i}, \tag{1}$$

$$\mathrm{GC_i} = \mathrm{x_i}\beta + \varepsilon_\mathrm{i}. \tag{2}$$

Regarding offshoring, we differentiate by offshoring within Europe ($OEUR_i$) and global offshoring (excluding Europe) (GO_i). Thus, we estimate two equations for offshoring. The dependent variables ($OEUR_i$ and GO_i) are dummy variables indicating whether or not the firm offshores production or innovation activities. The independent variables (x_{ii}) are a set of dimensions that predict the engagement on global collaboration.

$$\mathrm{OEUR_i} = \mathrm{x_{ii}}\beta + \varepsilon_\mathrm{i}, \tag{3}$$

$$\mathrm{GO_i} = \mathrm{x_{ii}}\beta + \varepsilon_\mathrm{i}. \tag{4}$$

3.3. *Case*

To illustrate the complex relationship between competences and the offshoring of innovation we use a case study in the ICT industry. The firm selection is based on three criteria, namely the firm's global presence (particularly presence in China, India and SA), production and innovation capabilities, innovation leadership and headquartered in Sweden. Due to the request of anonymity of the firm, we use TELEQUIP instead of the real name of the company.

In terms of locations, TELEQUIP has important R&D facilities in European countries North America and China. The research conducted in TELEQUIP R&D centres worldwide can be both

Table 2. Descriptive statistics.

Variable	Type	Obs.	Mean	Std. dev.	Min.	Max.
Dependent variables						
Collaboration Europe	Numerical	171	0.485	0.821	0	4
Collaboration global (excluding Europe)	Numerical	171	0.333	0.553	0	2
Offshoring Europe	Dummy 1 = yes	171	0.047	0.212	0	1
Offshoring global (excluding Europe)	Dummy 1 = yes	170	0.059	0.236	0	1
Independent variables						
(a) Competences as enablers						
Employees with university degree	Dummy 1 = yes	171	0.924	0.266	0	1
Employees with postgraduate degree	Dummy 1 = yes	171	0.468	0.500	0	1
R&D activities	Dummy 1 = yes	166	0.458	0.500	0	1
R&D employees	Numerical	165	5.200	7.420	0	33
Intramural R&D (local, regional, global)	Dummy 1 = yes	171	0.304	0.461	0	1
Service innovation	Categorical 1 = firm level 2 = country level 3 = world level	171	1.035	0.880	0	3
Support innovation	Categorical 1 = firm level 2 = country level 3 = world level	171	0.585	0.734	0	3
Advanced production systems	Numerical	171	1.637	1.458	0	5
OEM	Dummy 1 = yes if OEM > 50	171	0.094	0.292	0	1
ODM	Dummy 1 = yes if ODM > 50	171	0.158	0.366	0	1
OBM	Dummy 1 = yes if OBM > 50	171	0.386	0.488	0	1
Host-region competences	Dummy 1 = yes	171	0.035	0.185	0	1
(b) Competences as drivers						
Region TIER	Categorical 1 = Tier 1 2 = Tier 2 3 = Tier 3	171	1.971	0.904	1	3
Control variables						
Standalone	Dummy 1 = yes	170	0.876	0.330	0	1
Subsidiary	Dummy 1 = yes	170	0.100	0.301	0	1
MNC	Dummy 1 = yes	170	0.024	0.152	0	1
Size	Categorical 1 = less than 10 2 = 10–49 3 = 50–249 4 = 250–999 5 = more than 1000	169	1.840	0.782	1	5

for the development of a completely new product or service for the whole corporation as well as for the adaptation of an existing product to a local market.[3]

Interviews were conducted in 2010 and 2011 with several CEOs of the company in the HQs as well as in the subsidiaries in SA and China: the Vice-president and head of R&D at HQs, the Chief director of TELEQUIP China, the CEO for Commercial management of TELEQUIP sub-Saharan Africa, the Strategy and Marketing director of TELEQUIP sub-Saharan Africa and the CEO of

Innovation and partnering of TELEQUIP sub-Saharan Africa. We used the information collected in the different sites to check the validity of the statements (for example, between the HQs and the subsidiaries). Interviews were semi-structured and lasted 2–3 h. All interviews were recorded and transcribed. A document summarizing the most important issues raised in the interview was also produced within 24 h after the interview. Additional information was collected from the annual reports, website and other public information of the firm.

4. Globalization of innovation and competences in the Swedish ICT industry

4.1 *Results of the survey*

The results of the regression equation given in Table 3 show that both firm-level competences as well as regional competences matter for firms engagement in globalization of innovation, but they relate differently for global research collaboration than for global offshoring.

In the case of global research collaboration, firm-level competences and regional competences seem to matter almost equally, while for the case of offshoring of innovation regional competences seem to matter most. Results are also consistent with the two levels of geographical offshoring analysed in this article (Europe and Global).

Regarding *global collaboration for innovation*, the results confirm that skills and the technological effort are related to research collaboration, both in Europe and globally. Indeed the number of employees with postgraduate degree, the number of employees in R&D and the engagement in intramural R&D activities are positively correlated to global research collaboration in both geographic levels. This result suggests that firms with higher levels of absorptive capacities in terms of their human capital and R&D activities identify and collaborate for innovation with organizations located abroad, which is consistent with Cohen and Levinthal (1990). However, the level of organizational competences is not related to the propensity of the firm to engage in research collaboration neither with geographically close nor distant partners.

The competences available at the regional level in Sweden (captured by the variable Region Tier) are significantly related to research collaboration only within Europe; however, no significant results were found for global research collaboration. This result is consistent with the discussion brought by Chaminade and Plechero (2012), as firms located in Tiers 2 and 3 regions will tend to establish more research collaboration with external partners to compensate for lower level of capabilities in their regions.

The type of firm is also another important determinant. Standalone and MNCs seem to be keener to establish more collaboration networks at both geographic levels than subsidiaries of MNCs. This result was expected, as standalone firms and MNC need to establish extramural collaboration networks with other agents, in order to compensate for knowledge not available in their internal networks (Castellani and Zanfei, 2006; Barnard and Chaminade, 2011).

Interestingly enough, size does not seem to matter for the propensity of Swedish ICT firms to engage in global research collaboration, but it shows to be important in research collaboration within Europe. This result seems to be in line with data from the Swedish innovation survey which also shows a very high proportion of small (and medium-size firms) that report to collaborate for innovation with distant partners such as Indian or Chinese (Eurostat, 2009). The international orientation of the Swedish business sector (Marklund et al., 2004) is also reflected in their propensity to engage in global research collaboration, independent of the firm size or the location of the unit in Sweden.

Both firm-level and regional competences are related to the propensity of Swedish ICT firms to engage in *offshoring of innovation* (offshoring of production and innovation activities). At the

Table 3. Competences as drivers and enablers of GINs.

	Collaboration Europe	Collaboration global	Offshoring Europe	Offshoring global
Competences as enablers				
Human Capital				
Employees with university degree	0.231	0.024	0.033	**−0.099***
	(0.263)	(0.184)	(0.064)	(0.076)
Employees with postgraduate degree	**0.316****	**0.139***	−0.006	−0.039
	(0.129)	(0.090)	(0.032)	(0.038)
R&D activities				
R&D activities	−0.117	−0.079	**−0.083***	−0.027
	(0.204)	(0.143)	(0.051)	(0.061)
R&D employees	**0.025***	**0.015***	**0.005***	0.004
	(0.014)	(0.010)	(0.003)	(0.004)
Intramural R&D	**0.276***	**0.191***	0.041	0.001
	(0.158)	(0.111)	(0.039)	(0.046)
Other organizational competences				
Service innovation			**0.026***	0.015
			(0.019)	(0.022)
Support innovation			0.014	−0.015
			(0.022)	(0.026)
Advanced production systems	0.042	0.039	**0.014***	**0.017***
	(0.044)	(0.031)	(0.011)	(0.013)
OEM	−0.116	−0.075	−0.054	0.039
	(0.215)	(0.151)	(0.053)	(0.062)
ODM	**−0.257***	0.015	**−0.064***	**−0.068***
	(0.181)	(0.127)	(0.044)	(0.052)
OBM	−0.040	−0.037	−0.017	0.019
	(0.144)	(0.101)	(0.035)	(0.042)
Host-region competences			**0.144***	**0.416*****
			(0.082)	(0.097)
Competences as drivers (Offshoring)				
Region TIER	**0.107***	0.029	0.004	−0.030*
	(0.072)	(0.051)	(0.018)	(0.021)
Other firm characteristics				
Standalone	**0.367***	**0.231***		
	(0.212)	(0.149)		
Subsidiary				
MNC	**0.367***	**0.231***	−0.138*	0.006
	(0.212)	(0.149)	(0.105)	(0.125)
Size	**0.127***	0.060	−0.014	**0.047***
	(0.092)	(0.064)	(0.022)	(0.026)

Note: Standard errors in parenthesis.
*Significance at 10% level.
**Significance at 5% level.
***Significance at 1% level.

firm level, the skills or qualification of human capital, the engagement in R&D activities and the existence of other organizational competences are positively related to offshoring of innovation, although with different degrees in terms of the geography of networks.

The skills of the employees in the firm seem to be relevant only for global offshoring and R&D activities and more specifically, the number of employees performing R&D activities is significant only when the firm offshores in Europe. Organizational competences are important for

Table 4. Competences as enablers and drivers of globalization of innovation in the Swedish ICT industry.

	Competences as enablers	Competences as drivers
Research collaboration in Europe	Employees with postgraduate degree (**) R&D employees (*) Intramural R&D (*) ODM (–) (*) Standalone (*) MNC (*) Size (*)	Region Tier (*)
Global research collaboration	Employees with postgraduate degree (*) R&D employees (*) Intramural R&D (*) Standalone (*) MNC (*)	
Offshoring of innovation in Europe	R&D activities (–) (*) R&D employees (*) Service innovation (*) Advanced production systems (*) ODM (–) (*)	Host region (*)
Global Offshoring of innovation	Employees with university degree (–) (*) Advanced production systems (*) ODM (–) (*) Home region (–) (*)	**Host regions (***)** Region Tier (–) (*)

offshoring, no matter at which geographical level. Our results suggest that firms that have implemented advanced production systems are more prone to engage in European and global offshoring.

The size of firms is an important determinant for global offshoring as could be expected, suggesting that large firms tend to establish routines to coordinate global activities, results consistent with those by Cantwell (1995) and Kogut and Zander (1992).

The results also confirm that regional competences are a very important driver for the offshoring of innovation, particularly for global offshoring. The availability of knowledge in the host region is highly correlated to this form of GIN, and the Region Tier is also correlated in a lesser extent, thus pointing out to the importance of asset seeking strategies in the process of globalization of innovation of Swedish ICT firms. The case presented in the following section will provide some insights into the relationship between host-region competences and the decisions of the firm to offshore innovation activities. Table 4 summarizes the main findings of the econometric analysis for the ICT industry.

4.2 *Host-region competences and the offshoring of innovation to emerging economies: the case of TELEQUIP*

The analysis of the ICT industry in Sweden points out to the importance of the competences in the host region as important drivers for the globalization of innovation activities, particularly offshoring of innovation. When offshoring globally, the skills of the staff and the organizational competences are important enablers while the competences in the host region is the most important factor shaping the decision of the firm to locate innovation activities abroad.

The case of TELEQUIP is interesting to illustrate how different competences accumulated in specific regions in emerging economies are shaping the decision of a multinational company to locate innovation activities.

TELEQUIP is an R&D intensive company. The level of skills of the human capital is also very high. The R&D personnel represent around 22% of the total work force. Of the total R&D employees, 28% are in Sweden, 14% distributed among the five centres in China, 5% in USA, or 2% in India, among others (Ujjual and Tunzelmann, 2011).

In the last decade or so, TELEQUIP has followed a clear strategy of reducing the number of R&D sites worldwide while increasing the size of the remaining sites (less sites but larger ones). This has occurred in parallel with the increasing technological complexity of ICT products and services, which demands a larger variety of skills (from software developers, to radio experts, computer engineers, etc.). While the number of sites in Europe has decreased, the presence in USA remained unchanged while new R&D sites within the emerging economies, like India and China, were opened. The reason for this move towards large Asian economies is related to their proximity to the local market and adaptation of the products to the local demands and standards as would be expected, but the access to competences and more explicitly, the access to 'domain competences'[4] is regarded as the second.

Different subsidiaries play a very different role in the global innovation strategy of the company depending on their competence level. Each of the largest R&D sites of TELEQUIP sites has specialized in a particular knowledge domain. For example, the site in the Silicon Valley (USA) has the R&D site for radio products, as the site in India is strong in IT which is related to TELEQUIP business support systems and the ones in China are providing global solutions in different knowledge domains and for a variety of business segments like networks (radio networks, core networks and service networks), global services (consulting), power modules and consumer and business applications for the multimedia business.

In general, the R&D activities and the most specialized competences (in the internal network) remain concentrated in the sites located in Europe and the USA but, according to the Vice-president R&D China has upgraded rapidly as an important R&D site inside TELEQUIP.

4.2.1 *China*

Accessing domain competences is one of the main drivers for TELEQUIP to locate one of the largest corporate R&D sites in China. In 2009, China represented 14% of the R&D personnel of TELEQUIP. The Chinese R&D labs develop solutions for the whole corporation and not only for China. More than 25% of the employees in the Chinese subsidiaries of TELEQUIP are working on products in different fields and solutions, developing on an average 100–150 products for the global market each year (Ujjual and Tunzelmann, 2011).

The location in particular regions also facilitates close interactions with universities and research centres. The interviewee with the Operation Development Director of TELEQUIP in China regards the large pool of skilled people coming from various Chinese universities as a main reason for locating the R&D sites in this country and in particular regions. For example, the Nanjing centre has been started due to the presence of regional actors, such as universities and colleges, as well as TELEQUIP's biggest manufacturing unit. In his view, there are not many differences between the Chinese market and markets in the rest of the world which makes it easier for the subsidiary to provide solutions for the entire company. In his words:

> Our market strategy is to provide global solutions, and solve problems in terms of network smooth and call quality, whether what we face is high-end markets or low-end markets.

The division of labour in terms of innovation between the HQ and the subsidiary is better explained by the CEO of TELEQUIP in Sweden. He indicates that

> For the activities related to Radio based stations the most important innovations are the ones that are developed in Sweden, Canada and China but Sweden does mainly core innovation while in China the activities are mainly related to the implementation of idea. The Chinese subsidiary can be often relevant, for example, for incremental innovation (e.g. reducing cost and adapting the product to the specific profile of Chinese operators). But some of those innovations also have a global effect. An example of incremental innovation with a 'global' effect is the production of a play station adapted to the local context; this idea is starting now to be spread worldwide.

This possibility of the Chinese R&D subsidiaries to develop solutions potentially useful for the entire corporation puts an additional emphasis on the competences in the subsidiaries. They are not merely adapting the products to the local market, but developing products or services (sometimes brand new) that are potentially useful for the entire corporation.

4.2.2 *India*

TELEQUIP has three subsidiaries in India, employing basically 2% of the R&D staff of TELEQUIP. According to the Vice-president R&D the Indian subsidiary can be regarded as an extension of the multimedia business unit at TELEQUIP and strong in IT competences. But the Chinese have a broader range of domain competences in many different areas and thus conduct research for different business of TELEQUIP. R&D in India is narrower than in China not because the Indian market demands fewer or less sophisticated products, but because they do not have all the requisite competences. Especially since TELEQUIP – as a group – benefits from what goes on in its Chinese operation in that it generates knowledge and equipment for global markets, competences rather than market proximity seem to matter more.

So, it is the breadth and depth of skills available in China that makes the Chinese site a more interesting location for R&D for TELEQUIP than India.

4.2.3 *South Africa*

The subsidiary of TELEQUIP in SA aims at adapting TELEQUIP products for the African market. The subsidiary does not have its own R&D department. The interviews done by one of our partners in SA may provide some insights[5] into why this is so. A CEO of TELEQUIP sub-Saharan Africa explains that the reasons behind a lack of R&D site in SA are related to size of market (smaller than that of China and India, for example) and the lack of skilled labour or specific expertise in certain competences. He emphasizes the lack of engineers as a main hindrance for TELEQUIP in SA. Table 5 provides an overview of the enrolment in tertiary education in China, India and SA in comparative perspective. As can be observed, although the proportion of students enrolled in tertiary education in Science and Engineering fields in SA is higher than in India and China, their numbers are way below these two Asian countries.

The Commercial Management of TELEQUIP in sub-Saharan Africa also talks about reasons for choosing India and China as the R&D sites, he mainly refers to the issue of a large pool of skilled labour at a reasonable price. In his words:

> R&D price is still quite high and to do it we have to look at the centres that provide engineering expertise and efficiency. And also at a very low cost. And India and China provide those fundamentals.

Further on he refers to the fact that in the case of China the products can also be supplied at a global level, thus confirming what the interviewee in the HQ said.

Table 5. Enrolment in tertiary education in China, India and SA (total and by field).

Countries	Tertiary education enrolment Gross (%)	Technical enrolment at tertiary level: Science Number	Science %	Engineering Number	Engineering %	Total for science and engineering Number	Total for science and engineering %
China	24	128,350	4	1,516,611	5	1,644,961	9
India	16	2,056,675	10	1,490,618	7	3,547,293	17
South Africa	16	135,505	15	71,172	8	206,677	23

Sources: South African statistics from the Department of Higher Education and Training South Africa, Statistic on India from National Indian Bureau Publication 2011 and China data from UNESCO and from National Statistics Bureau of China.

The role of the South African subsidiary in the global strategy of TELEQUIP is related to the adaptation of the products to the African market. For doing so, knowledge of the local languages is essential. As one of the interviewees in SA indicates 'as more and more people get into the mobile arena with handsets and so on, the local languages become more important'. Therefore in order to penetrate the whole of Africa it is a necessity to have skilled people from African regions. He indicates that even though the HQs have the knowledge on networks they need to have a better understanding of the local consumers.

The interviews held in Sweden, China and SA point out to a kind of division of labour of offshoring sites in TELEQUIP according to competences. It also shows the interplay between firm-level competences and regional competences as enablers and drivers of innovation (Table 6).

Core R&D seems to be conducted barely in three sites worldwide in Sweden, USA and China. These centres provide complex R&D solutions for the different business and for the entire corporation which requires a combination of a wide arrange of skills. A second tier of centres are those that provide very specific competences in certain domains, like, for example, the R&D centre in Bangalore which provides very deep expertise in software. They are also global, in the sense that they provide solutions also to the entire company, but only on specific domains. A final tier of centres are those that conduct mainly development for the local markets. Finally, there are locations in which there are not yet any R&D centre, but only production and sales, with small adaptations to local markets.

Table 6. Competences as a *driver* for offshoring of TELEQUIP and the role of different sites in the global innovation strategy of TELEQUIP.

Sites	Competences	Role
Sweden (HQ)	Advanced R&D competences in a variety of domains	Core innovation
China (Beijing)	Broad domain competences in radio communication	Provide solutions for the entire company (e.g. play station) Implementation of core innovations developed at the HQ
India (Bangalore)	Strong competences in internet protocol business (specific competences in certain domain)	Provide solutions for the entire company but only in the specific domain of IP
South Africa (Gauteng)	Local languages	Simple adaptation of services to local market

5. Conclusions

By distinguishing between competences as an enabler and competences as a driver this article contributes to our understanding of the role of firm and regional competences in the globalization of innovation.

For Swedish ICT firms, the level of competences in the region where the firm is located (home region) and the level of the competences in the host region are related to the propensity of the firm to engage in offshoring. The level of competences at the firm level is related to both global research collaboration and global offshoring of innovation. The involvement of the firm in R&D activities is correlated with both global research collaboration and offshoring of innovation, as it increases not only the innovative capability of the firm but also the capacity to tap into and absorb knowledge from external sources (Cohen and Levinthal, 1990). Global research collaboration is also related to organizational competences particularly the level of flexibility and quality of the processes within the firm. Engaging external sources in the innovation process is necessary but also costly. Having advanced production systems in place may help to standardize some of the processes thus reducing the transaction costs involved in open innovation. Thus, firm-level competences are an important *enabler* for the globalization of innovation, particularly offshoring of innovation. Home-regional competences are important for global research collaboration and offshoring of innovation, but in different directions, suggesting that firms located in Tiers 2 and 3 will tend to establish global research collaboration to tap into knowledge produced externally, while firms in Tier 1 regions are more prone to establish global offshoring of innovation.

The results of the survey also confirm that competences accumulated in the host region are an important *driver* for the globalization of innovation and in particular for the offshoring of innovation, as the recent literature on the role of emerging countries in R&D offshoring has pointed out. What the literature has been lacking is a comparison between competences in different locations vis-a-vis the decisions of the multinational company to locate different innovation activities in the different subsidiaries. In other words, the BICS countries are treated more often than not as a relatively homogeneous block of countries.

What the case illustrates is how the breadth and depth of the competences available in three of the BICS countries actually determine the type of innovation activities that the subsidiary performs as well as the role that it plays in the global innovation strategy of the company. While some subsidiaries may be able to play a double role adapting existing products to the local market and developing new solutions for the global markets, others may only play a limited role.

The case of TELEQUIP also points out that there is not one single reason why a company decides to engage in GINs. It is a combination of factors that include firm strategy, firm-level competences and the characteristics of the potential locations in terms of markets and skill supply. In terms of the strategy, TELEQUIP's selection of the sites seems to respond to a double strategy: some of the sites have been selected because they excel in very specific competences (like Bangalore in India) while some others are a combination of the willingness to position themselves in a larger market (also in India) while accessing a broader base of domain competences (Beijing).

It is interesting to see that some of the factors that the literature has traditionally considered as influencing research collaboration and offshoring, like the engagement in R&D activities (Cohen and Levinthal, 1990), are only important when the partners of the collaboration or the destination of the offshoring are in close proximity to regions or countries and presumably with a similar level of technological capabilities. When research collaboration or offshoring takes place at the global level, other factors like organizational competences take over in level of importance, which points out to the challenge of engaging in innovation at a global scale in organizational terms (Barnard and Chaminade, 2011).

Finally, the results of the survey point to some interesting future venues of research. Sweden is a small economy with strong international linkages (Marklund et al., 2004). The innovation system is highly dominated by multinationals which have been the focus of extensive analysis by Swedish researchers in international business. What the analysis presented in this paper suggests is that small and medium-size enterprises are also active players in GINs, particularly in global research collaboration. But these firms are traditionally characterized by limited competences and resources. Understanding the drivers and enablers of these firms to engage in globalization of innovation could provide some insights into the current literature which is highly dominated by MNCs' perspective.

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Notes

1. This section is based on Plechero and Chaminade (2010).
2. The distribution of the respondents/non-respondents by size is the following: 5–9 employees (42/40%), 10–49 employees (45/45.9%), 50–199 employees (9.7/10.8%), 200–999 employees (1.5/2.6%) and more than 1000 employees (1/0.5%). The proportion between respondents and non-respondents per sub-industry is 1.8/2.3 for manufacture communication equipment (NACE code 26.30) and 98.2/97.7 for information technology and computer services (NACE code 62.10–62.90).
3. An example of the development of a local solution for local needs could be the development of radio equipment in rural areas in India that would be conducted completely by TELEQUIP India. Another example of a development in which the subsidiaries will be involved could be a technology developed in the USA that needs to be adapted to the standards and requirements of the market in which TELEQUIP is commercializing that technology.
4. Domain competences refer to the skills needed for the supply of different business solutions for the clients, which includes, among others, knowledge on radio networks, core networks, service networks, consultancy, TV and media applications (software development), etc.
5. Interviews were conducted by Tashmia Ismail and Helena Barnard, Gordon Institute of Business Studies, Pretoria University, South Africa. The authors of this article had access to the transcription of the interviews.

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