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Exploring the role of regional innovation systems and institutions in global innovation networks

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ABSTRACT

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Key words: regional innovation systems; institutional thickness; global innovation networks; Europe, China, India, Brazil, South Africa

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1. INTRODUCTION

The access to global innovation networks (GINs) has been extremely unequal across regions around the globe. For certain countries, while the country as a whole may not be playing a role in GINs certain sub-national regions do, pointing out to the role of regional innovation systems and sub-national institutional frameworks in the emergence and development of GINs.

This paper explores the role of the region in the emergence and development of GINs in a selection of European (Norway, Sweden, Denmark, Germany and Estonia) and non-European countries (India, Brazil, China and South Africa).

The starting point of the paper is the literature on economic geography in general and regional innovation systems in particular (Cooke 1992; Asheim and Isaksen 1997; Cooke, Gomez-Uranga et al. 1997; Cooke 2001) which argue that even when economies have become much more globalized, most innovation activity is still concentrated in certain regions around the globe. Agglomeration economies can be explained, among other factors by the tacit nature of knowledge and its sticky character (Asheim and Isaksen, 2002). Tacit knowledge is more likely to be spread among firms and organizations that are located in the same geographical area. This, in turn may facilitate innovation as the success of regions like Third Italy, Baden-Wuttenberg in Germany or the Sillicon Valley has shown (Piore and Sabel 1984; Saxenian 1994; Staber 1996).

However, the rise of internet and the increase in the codification of knowledge may make face to face and inter-personal communication less necessary. Knowledge (codified) can be transferred across large geographical distances without the need of local interaction but it still requires a certain common understanding between the partners involved in the knowledge exchange for that knowledge to be useful for innovation. Relational proximity can link together actors that are geographically distant, thus enabling the transfer of knowledge even when geographical proximity is absent (Amin and Cohendet 2005; Gertler 2008).

While some authors predicted that the increased globalization of economic activities will put a threat to the regions, the reality has shown that globalization has come hand in hand with an increase in the role played by certain regions in the global economy (Amin and Thrift 1994; Amin and Thrift 1994; Amin and Thrift 1996; Demirbag and Glaister 2010). Despite the opportunities opened by information and communication technologies for the transfer of (codified) knowledge, some regions remain power houses or knowledge hubs in global value chains and networks (Chaminade and Vang 2008). In other words, global processes are still "pinned down" in certain regions around the globe (Amin and Thrift 1994).

Hitherto, the literature is very limited when it comes to relating different types of regions with the geography of their knowledge linkages, particularly their international spread. We know very little about how regions influence the way in which firms participate in global innovation networks and

even less about how different regional institutional frameworks may facilitate or hamper the access to global networks of innovation and knowledge. This paper deals with these questions.

Using firm-level data collected through a survey and case studies in 2009-2010, this article systematically compares the patterns of globalization of innovation in regions with different institutional thickness. The paper shows that these patterns differ substantially across regions and discusses relationship between regions, institutional frameworks and different forms of globalization of innovation.

More specifically, the paper addresses the following questions:

1) Do we observe different patterns of globalization of innovation activities in different regions?
2) Do we observe different patterns of globalization of innovation of the same industry in different regions?
3) What is the role of the institutional frameworks explaining the observed differences?

2. MAIN THEORETICAL FRAMEWORK

2.1. Globalization of innovation

There is a general consensus among scholars that the internationalization of production and innovation activities is not a new phenomenon. But the globalization of production and innovation is something new. Globalization implies not only the geographical spread of economic activities across the globe but also a high degree of functional (des)integration (Dickens, 2007). Multinational firms may locate different functions of the organization in geographically distant places to exploit ownership, location or internationalization advantages (**Dunning 2001***)*. It is only recently, that scholars in the international business literature as well as innovation studies have started to pay attention to the globalization of innovation activities (Zanfei 2000; Le Bas and Sierra 2002; Cantwell and Piscitello 2005; Cantwell and Piscitello 2007; Dunning and Lundan 2009).

Already back in the mid-nineties, Archibugi and Michie (1995) proposed to distinguish between three forms of globalization of innovation: the global exploitation of innovation, the global research collaboration and global generation of innovation. The **global exploitation of innovations** refers to the international commercialization of new products or services and has its economic equivalent in the export of new products or services or in the international licensing of patents. The **global research collaboration** alludes to the joint development of know-how or innovations with the participation of partners from more than one country. This collaboration can take a variety of forms, including R&D joint-ventures, R&D alliances, contractual R&D, etc. and can involve a variety of actors, including firms, research centers, universities or the government, among others. Finally, the **global generation of innovations** refers mainly to the location of R&D activities in a different country and it is associated with R&D related foreign direct investment.

In the context of developing countries, there is a forth category of globalization of innovation worth considering (Audretsch and Feldman 1996): **the global sourcing of technology (and innovation)**. More often than not, firms in developing countries depend on technology acquired from the

developed world. Their innovation capacity is often limited and they rely more on the acquisition of technology and its adaptation to the local context than on the development of new technology.

As recent evidence is starting to show, different regions are specialized in different forms of globalization of innovation (Plechero and Chaminade, 2010). For example, firms located in the Pune region in India are more specialized in the three types of globalization of innovation and in particular in the exploitation of innovation more than firms located in Beijing (Plechero and Chaminade, 2010). However, the existing evidence is limited in terms of the number of regions considered in the analysis as well as in providing some useful explanation of why this is so. A deeper look into the innovation systems of those particular regions may provide some insights to why different regions get involved in different forms of globalization of innovation.

2.2. Regional innovation systems and institutional thickness

It is generally accepted that innovation is socially embedded and that it is the result of continuous interactions and exchange of knowledge between organizations (Kline and Rosenberg 1986; Freeman 1987; Lundvall 1992). For long, economic geographers have argued that due to the tacit nature of knowledge those interactions often take place at local level, that is, between organizations that are geographically close (Cooke 1995; Storper and Venables 2004; Asheim and Gertler 2005; Boschma 2005). Thus, geographical proximity may facilitate interactive learning and innovation through the exchange of both tacit and explicit knowledge among the individuals and organizations located in that particular region.

A regional innovation systems (RIS) can be defined as the "institutional infrastructure supporting innovation within the production structure of a region" (Asheim and Gertler, 2004:299). Universities, technological centers and organizations providing funding for technological projects would be, among others, part of the institutional infrastructure while firms will be the main actors in the production structure.

Despite the fact that institutions are at the heart of the very definition of regional innovation systems, there are very few authors that have dealt explicitly with the role of institutions in regional innovation systems (Doloreux and Parto 2005). Among the exceptions are the works of (Amin and Thrift 1994; Amin and Thrift 1996; Cooke, Gomez-Uranga et al. 1997; Asheim and Isaksen 2002; Morgan 2007; Gertler 2010; Tödtling, Lengaver et al. Forthcoming 2011). Innovation in general, and knowledge sharing in particular, is a social process that is shaped by soft and hard institutions like culture, habits, convention and routines but also by laws and regulations. Most of the institutions have a very strong regional character and this is particularly the case for soft institutions. The same industry, operating in the same national institutional framework may behave very differently in two sub-national regions, due to the different regional institutional frameworks in the two regions (Gertler, 2010).

The institutional "thickness" of a particular region is defined as a combination of different elements (Amin and Thrift, 1995): a strong organizational infrastructure, high levels of interaction, a culture of collective representation and shared norms and values which serve to constitute the social identity of a particular locality. Thick regional innovation systems tend to play a more significant

role globally than thin RIS (Amin and Thrift 1996). Institutionally thin RIS are usually to be found in less urbanized regions and are characterized by the strong presence of SMEs with limited innovative capacity, lack of support organizations and low level of agglomeration as compared to thick regions. Institutionally thick regions, in comparison, are often located in metropolitan areas. Firms in this regions benefit from a dense network of support institutions, interactions take place often and in general, these regions show high levels of innovation
The institutional thickness of a particular region also influences the geography of the knowledge linkages, or in other words, how different regions engage in global, domestic or regional networks. In a study of ICT firms in Austria, Tödtling et al (Forthcoming, 2011) show that thin RIS, firms will tend to establish more international linkages while thick RIS will tend to establish more domestic. The extent to which this observed relationship between institutional thickness and internationalization of innovation holds for both developed and developing countries will be investigated in this paper.

3. **METHOD**

3.1. Sample

This paper is based on a firm-based survey conducted in 2009 across 9 countries: Brazil, India, China, South Africa, Norway, Sweden, Germany, Estonia and Denmark, as well as case studies conducted in four emerging regions: Beijing, Bangalore, Cape Town and Gauteng.
For the survey, each country focused on just one industry: ICT, Automotive or Agroprocessing. In all industry there was always at least one European and one non-European country to be able to perform North-South comparisons. Each institute conducting the survey across the nine countries chose a sector which was of economic importance within their national or regional context. In all sectors and across all countries 1215 responses were collected. The combined INGINEUS sample was dominated by ICT responses. This was in part due to the size of the Indian and Chinese market but also due to the nature of the agro processing and Auto industries which tend to be more concentrated (Barnard and Ismail 2010). Table 1 below offers a summary of the results and number of responses received from each sector and each country.

Table 1. Survey results by country and industry

Countries	ICT	Auto	Agro
Brazil		69	
China	243		
Estonia	17		
Denmark			49
India	324		
Germany		53	
Norway	181		
South Africa			84
Sweden	171	24	
Total sector	**936**	**146**	**133**

More than half of the sample are standalone companies (681), about 250 are subsidiaries of a multinational company and only 133 are the headquarters of a Multinational. About 46 % of the firms have less than 50 employees, 30 % have between 50 and 250, and the rest are large companies with more than 250 employees. Only 100 companies have more than 1000 employees.

3.2. Survey and questions selected for analysis

The survey questionnaire consisted of 14 questions covering some background information on productive activities, firm size, market, sales information and R&D activity. Most of the questions were focusing on types of innovation, geographic network and collaborations with customers, suppliers, Universities, research institutions, government etc., offshoring and regional attractiveness and the institutional framework (mainly at national and international level).
This paper is based on the analysis of the four questions capturing the four forms of globalization of innovation:

- Global exploitation of innovation: As a proxy we asked the firm about their largest market, being the options internal to the enterprise, regional, domestic or export.
- Global collaboration for innovation: we use question on the geographical spread of innovation networks which asked the firm "regarding the development of the most important innovation of your firm in the last 3 years, who did you actively collaborate with and in which geographical location?". The question provided different options as partners: clients, suppliers, competitors, consultancy companies, government and universities. Firms where asked to indicate if the partners with whom they collaborated where located in the region (subnational), country or a list of other international locations (North and South America, Western and Central&Eastern Europe, Africa, Japan and Australasia and Rest of Asia). In this paper I have collapsed all international interactions under one category called "International".
- Global sourcing: we use question 5 which asked the firm to indicate which is the most important source of technology for the enterprise. The firms were given 5 options: "we

produce most technological inputs in house"; "we buy inputs from other branches of our own MNC", "we buy from MNCs not formally connected" ; "we buy from non MNC firms" or "we buy from universities and other public organizations".

- Global generation: as a proxy, we use questions number 9.1 in which firms were ask to indicate if they were off shoring production or innovation activities.

In order to assess the relationship between different forms of globalization of innovation (and thus innovation networks) and regions, all the cases in the sample were codified as belonging to a region considered as Tier 1, Tier 2 or Tier 3. To define the three Tiers, quantitative information was used to capture the strength of organizational infrastructure and qualitative for the other 3 elements of institutional thickness (levels of interaction, culture of collective representation and shared norms and values). In the project, each country collected data about one particular industry. Statistics broken down at the level of industry and region are scarce or even not available at all for developing countries. Information on the number of firms for the specific industry in a particular region, number of employees and, in some cases[1], the volume of exports was collected if that information was available in the country[2]. The available information is included on page 26-27. Information on the availability of specialized universities, research centres and intermediate organizations in the region was also collected, when available[3]. This information was used as a proxy for organizational infrastructure and it is the only pseudo-quantifiable indicator. Consultation with country experts in the project as well as review of the literature on clusters in those specific industries for each country was used to acquire information on levels of interaction, culture of collective representation and shared norms and values (qualitative).
Basically, regions with the highest concentration of firms and employment in that particular industry in that country, with frequent interactions and a strong identity in that particular industry were considered as Tier 1. Regions with an average or above the average number of firms and employment in the industry and some specialized supporting institutions and with less strong interactions, culture and shared norms were classified as Tier 2. Those regions that have no specialization in that particular industry were classified as Tier 3. The final classification of the regions in Tiers was checked once again with industry experts in the country.

Tier 1 regions can be considered as thick regional innovation systems, usually located in metropolitan areas and that show a strong specialization in that particular industry. For example, Stockholm in Sweden and Bangalore in India are considered to be the most important clusters in the ICT industry, while Baden- Württemberg (Germany) or Sao Paulo (Brazil) are the equivalent for the automotive industry. They are not only considered to be the strongest hub in the country but they are also strong regions globally, for that particular industry.
On the other side of the spectrum, Tier 3 regions are usually institutionally thin regional innovation systems for the particular industry considered. The number of firms specialized in that particular industry is low and there are not so many specialized support organizations. Kwa-Zulu Natal in South Africa or Hasrstad in Norway are examples of Tier 3 regions.
In the middle, we are considering another category, Tier 2 regions. These are usually secondary regions in the country, in which there is a significant number of firms specialized in that industry,

[1] For example in India, as most of the ICT firms
[2] Most of the countries did not have information broken down to both region and industry. Information on the number of employees and number of firms per region was available for Brazil, Germany, Norway and Sweden. Information on the volume of exports on ICT per state was available for India.
[3] In most cases, when information is available it does not refer to a particular industry.

there is also presence of support institutions but that are yet not so well networked, not attracting so many multinationals and in general, do not show the same institutional thickness than those regions considered Tier 1.
Table 2 below summarizes what is considered to be Tier 1, 2 or 3 in each industry and country.

Table 2. Distribution of cases by Tiers

Country	Industry	Tier 1	Tier 2 (example)	Tier 3
Brazil	Automotive	Sao Paulo	Minas Gerais	Porto Alegre[4]
China	ICT	Beijing	Shenzhen	Shanghai
Denmark	Agro-process	Århus, Glostrup, Græsted, Greve, Ishøj København,	Ansager, Bjerringbro, Gråsten, Kjellerup Kolding Ejby, Faxe, Lynge,bRingsted, Slagelse, Sorø and Viby Sj	no
Estonia	ICT	Tallin	Tartu	no
Germany	Automotive	Baden-Württemberg Bayern	NRW, Rheinland Pfalz, Thüringen,	Hessen, Saarland
India	ICT	Bangalore	New Delhi (incl. Noida, Gurgaon) Mumbai Chennai, Hyderabad Pune	Cochin, Trivandrum Chandigarh
Norway	ICT	Oslo, Trollåsen Lisaker, Bergen, Stavanger, Fornebu	Moi, Trondheim, Brumunddal, Sunndalsøra,	Hasrstad
South Africa	Agro-process	Gauteng	Western Cape	Eastern Cape, Free State, Kwa-Zulu Natal Limpopo, Mpumalanga, North West, Northern Cape

[4] Only one case

Sweden	ICT, Auto	Stockholm, Kista and Solna (ICT) Gothenborg (Auto)	Malmö, Gothenborg (ICT) Trollhättan, Södertälje (Auto)	Jönkoping, Helsinborg (ICT) Rest (Auto)

As a result 419 firms were classified as Tier 1, 430 as Tier 2 and 198 as Tier 3. The sample is also quite well distributed by industries. ICT has 308 firms located in Tier 1, 377 in Tier 2 and 156 in Tier 3; Agroprocessing has 32 firms in Tier 1, 64 in Tier 2 and 20 in Tier 3; finally automotive has 44 in Tier 1, 72 in Tier 2 and 31 in Tier 3.
Table 3 next summarizes the distribution by type of firm and size of firm. As can be observed, Tier 1 has more headquarters of multinationals but it is also a region that is dominated by SMEs. Tier 2, in comparison, has the highest proportion of largest companies as well as the higher number of subsidiaries of MNCs. Tier 3, finally, is dominated by standalone companies and also SMEs.

Table 3. Type of firm and size by Tier

	Region Cluster Tier			**Total**
	First Tier	**Second Tier**	**Third Tier**	
A standalone company	269	270	142	681
A subsidiary of a MNC	74	122	47	243
The headquarters of a MNC	65	61	8	134
Fewer than 10 FTE employees	49	37	42	128
10 to 49 employees	160	114	84	358
50 to 249 employees	113	138	43	294
250 to 999 employees	63	86	18	167
1000 or more employees	34	55	11	100

4. THE ROLE OF REGIONS IN GLOBAL INNOVATION NETWORKS

From the literature review we may expect that firms located in strong innovative regions will innovate more and collaborate more often with domestic and local actors than those located in more marginal regions, as a consequence, they will be more innovative and regionally networked, thus

facilitating the emergence of innovation networks. For example, we would expect ICT firms located in Kista (a knowledge hub for the ICT industry in Sweden) to collaborate more with other actors in Kista than, for example, an ICT firm located in Umeå (a remote region in North of Sweden). Similarly, we would expect firms located in Bangalore to interact more at regional and domestic level than firms located in Maharashtra, just simply because there are more knowledge-intensive firms located in that specific region.

4.1. Regions and the Global exploitation of innovations

The first analysis is to look at the relationship between different regions and the exploitation of innovations. We use the information on the most important market as a proxy, as the question was not asking specifically about market for new products or services. Table 4 shows the proportion of firms targeting the different markets per type of region. The results are significant at 1%. The largest proportions of firms that target international markets are to be found in Tier 2 regions (52,3 per cent of all the firms that export) followed by Tier 1. Firms in Tier 1 tend to commercialize their products mainly in the domestic market.

Table 4. Regions and global exploitation of innovations

4.1 In geographical terms, is your enterprise's largest market?			Internal to your enterprise	A regional market (local region in your country)	Domestic market (rest of your country)	An export market	Total
Region Cluster Tier	First Tier	Count	4	72	247	89	412
		% within Region Cluster Tier	1,0%	17,5%	60,0%	21,6%	100,0%
		% total in that market	22,2%	34,8%	48,0%	27,5%	38,7%
	Second Tier	Count	11	85	182	176	454
		% within Region Cluster Tier	2,4%	18,7%	40,1%	38,8%	100,0%
		% total in that market	61,1%	41,1%	35,3%	54,3%	42,7%
	Third Tier	Count	3	50	86	59	198
		% within Region Cluster Tier	1,5%	25,3%	43,4%	29,8%	100,0%
		% total in that market	16,7%	24,2%	16,7%	18,2%	18,6%

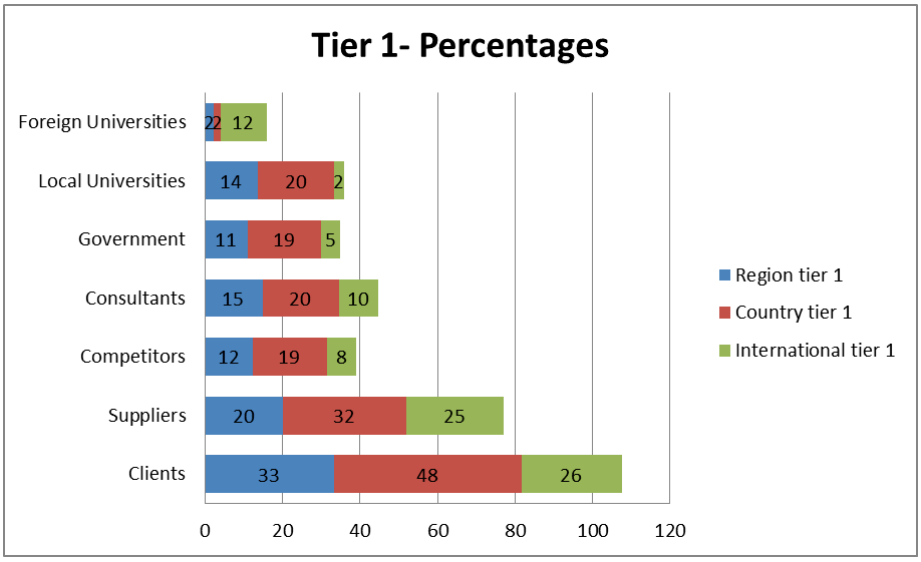
Total		Count	18	207	515	324	1064
		% within Region Cluster Tier	1,7%	19,5%	48,4%	30,5%	100,0%
		% total in that market	100,0%	100,0%	100,0%	100,0%	100,0%

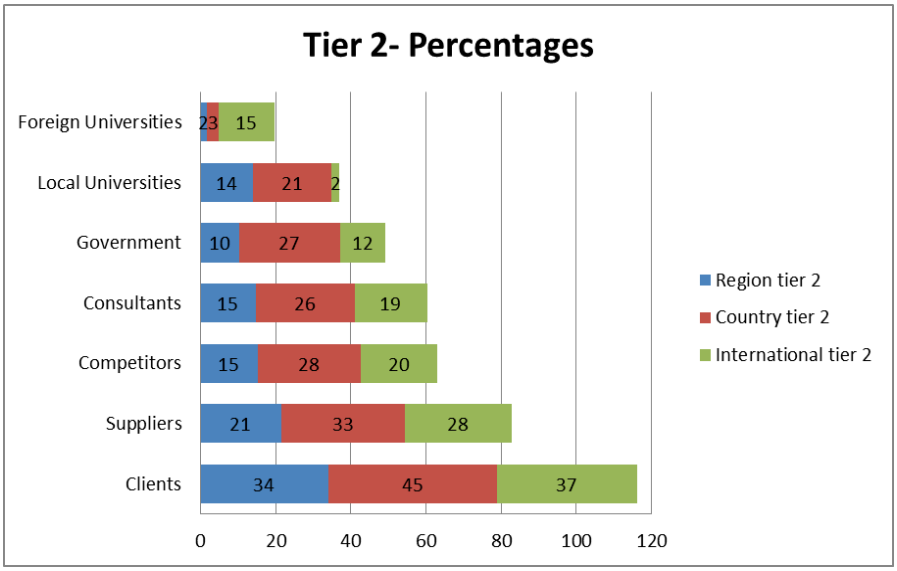
Chi2: 46,891, significant at a 1%.

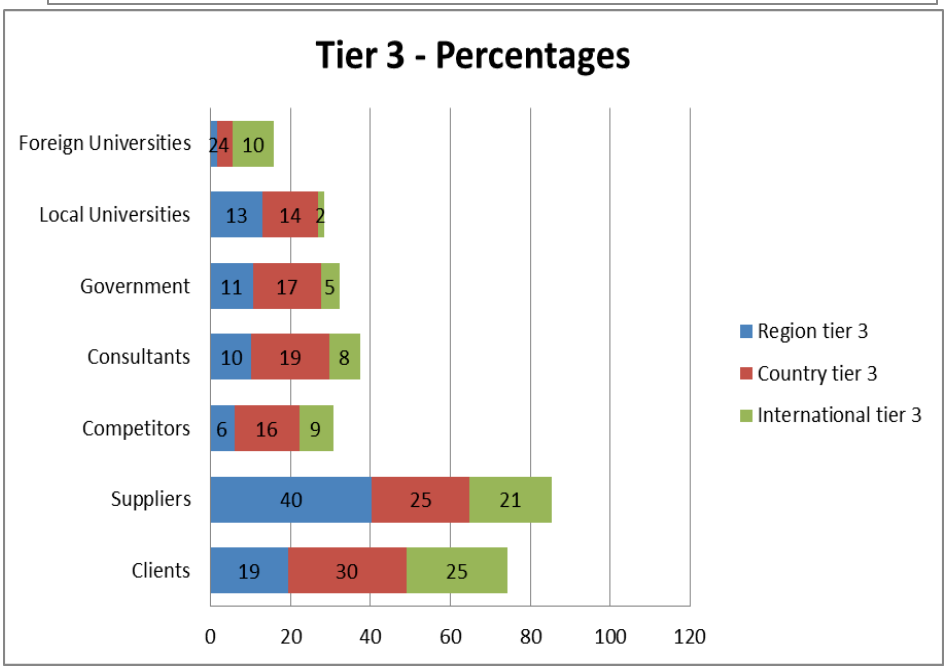
4.2. Regions and the Global collaboration for innovation

To investigate if firms in stronger regions collaborate more at regional level, we calculate the percentage of firms, in that particular region, that collaborate with each of the potential partners for innovation. The results are plotted next, one graph per region.

Graph 1. Collaboration for innovation







Contrary to what we would have expected, it is firms located in Tier 2 regions tend, in general to collaborate more with partners not only at regional level, but also at international levels. They are more networked than firms in Tier 1. The only exception is the collaboration with regional suppliers in Tier 3 regions, which is higher than in Tier 1 and 2.

So, while Tier 1 regions tend to concentrate a larger number of innovative firms, they are less prone to participate in international networks. It is firms in Tier 2 that collaborate with a larger variety of international networks. Although a deeper analysis of the data is needed, preferably in a more quantitative way, the descriptive analysis suggests that it is firms in Tier 2 regions that are more internationally networked, that is, they participate more often in global innovation networks.

4.3. Regions and the global sourcing of technology

There is a significant relationship between the type of region and the global sourcing of technology. In terms of sourcing of technology, the majority of firms in all three tiers produce their own technological inputs in house. However, in Tier 1 we find the higher concentration of firms that acquire their inputs from other branches of their own MNC. This is coherent with the fact that it is in this Tier 1 that we find more headquarters of MNCs.
In Tier 2 we find the higher proportion of firms that acquire the inputs from non-multinational firms or from MNCs that are not formally connected to the firm. This reflects the external character of the networks of firms in Tier 2, as compared to the more internal character of the networks in Tier 1.

Table 5. Regions and global sourcing of technology

5. Which is the most important source of technology for your enterprise (including hardware, software and knowledge)?			We produce most technological inputs in-house	We buy most of our inputs from other branches of our own MNC	We buy most of our technological inputs from non-MNC firms	We buy most of our inputs from MNCs with which we are not formally connected	We buy most of our inputs from public-sector organizations, e.g. research institutes, universities etc	Total
Region Cluster Tier	First Tier	Count	258	48	30	60	8	404
		% within Region Cluster Tier	63,90%	11,90%	7,40%	14,90%	2,00%	100,00%
		% over total number in that source	42,20%	44,90%	24,60%	39,00%	34,80%	39,70%
	Second Tier	Count	241	34	69	80	11	435
		% within Region Cluster Tier	55,40%	7,80%	15,90%	18,40%	2,50%	100,00%
		% over total number in that source	39,40%	31,80%	56,60%	51,90%	47,80%	42,80%
	Third Tier	Count	112	25	23	14	4	178
		% within Region Cluster Tier	62,90%	14,00%	12,90%	7,90%	2,20%	100,00%
		% over total number in that source	18,30%	23,40%	18,90%	9,10%	17,40%	17,50%
Total		Count	611	107	122	154	23	1017
		% within Region Cluster Tier	60,10%	10,50%	12,00%	15,10%	2,30%	100,00%
		% over total number in that source	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Chi2: 30,761 significant at 1%

4.4. Regions and the global generation of technology

We take as a proxy for the global generation of technology the question on whether the firms has offshored production or innovation (we cannot distinguish which one). As can be observed in Table 6, Tier 2 hosts a higher proportion of firms offshoring production and innovation than Tier 1 and 3. The Chi2 tests are, however, not significant, pointing out to a weak relationship between different tiers and the globalization of production and innovation.

Table 6: Regions and global generation of technology .

9.1 Regarding internationalisation, does your firm offshore (or has your firm offshored) production or any R&D activities?			No	Yes	Total
Region Cluster Tier	First Tier	Count	283	114	397
		% within Region Cluster Tier	71,3%	28,7%	100,0%
		% within firms offshoring	39,4%	37,6%	38,8%
	Second Tier	Count	290	141	431
		% within Region Cluster Tier	67,3%	32,7%	100,0%
		% within firms offshoring	40,3%	46,5%	42,2%
	Third Tier	Count	146	48	194
		% within Region Cluster Tier	75,3%	24,7%	100,0%
		% within firms offshoring	20,3%	15,8%	19,0%
Total		Count	719	303	1022
		% within Region Cluster Tier	70,4%	29,6%	100,0%
		% within firms offshoring	100,0%	100,0%	100,0%

Chi2: 4,347, not significant

4.5. Illustrative cases[5]

Tier 1 – Beijing

Beijing is considered to be a Tier 1 region in China, both in general but also with regards to the ICT industry. Beijing regional innovation system is composed both by a large number of multinational companies as well as a dense network of small and medium size enterprises (90% of the firms in Beijing are small). In terms of MNCs, Beijing has become the second largest cluster with headquarters of MNCs in the Fortune Top 500. At the end of 2007, there were approximately 280 R&D labs of MNCs located in Beijing (Lv and Liu, 2011). In 2010, Beijing hosted around 20000 high tech enterprises. There are around 39 Universities located in Beijing, including some of the best in China and worldwide like Tsinghua University, Peking University or the Graduate University of the Chinese Academy of Management (CAS). The R&D personnel at higher education institutions (HEIs) is around 25000 full time equivalent. CAS is one of the most important actors in the regional innovation systems and some of the most important Chinese ICT

[5] This section relies heavily on the intermediate reports produced by GUCAS, HSRC and IIITB for this work package. The full reports are included as annexes to this research paper.

enterprises, like Lenovo, were spin-offs from CAS. Beijing is responsible for almost a third of all R&D by R&D institutes in China. There are several high-tech parks in Beijing, concentrating a large amount of firms, being one of the most important ones the Zhongguancun Science Park. IBM China research laboratory, Microsoft R&D Center, Intel China Research Center, Motorola China R&D institute or Bell Labs research China are located in Zhongguancun Science Park (Lv and Liu, 2010:17). The Zhongguancun science Park collectively represents the firms located in the Park, which is another issue contributing to the thickness of the RIS. There are a number of Government promoted initiatives to increase the number of alliances between firms located in Beijing. Hitherto, initiatives like the software alliance, the IGRS (Intelligent Grouping and Resource Sharing) Industrial Alliance or the Zhongguancun Cloud Computing Industry Alliance have supported the establishment of more than 100 industrial alliances involving more than 5000 members (Lv and Liu, 2010).

In terms of networks, the analysis of the INGINEUS survey shows that although local interactions are important, most collaboration for innovation take place at domestic level and with clients. This is not surprising. The most important reason why MNC companies locate in Beijing is to access the domestic market, followed by accessing knowledge infrastructure. They collaborate with the domestic clients in order to develop products that suit the domestic market. They also source domestically, to take advantage of the lower costs of production in China as well as the knowledge infrastructure. There is, of course, a strong international linkage between the subsidiaries and the headquarters of the firms, particularly for the sourcing of technology; about 75% of the firms in the survey indicated that they produce their technological inputs inhouse (internal sourcing of technology). This is not the case for the exploitation of innovation. Only 1,7 % of the firms indicate that their main market is internal to the firm. 60% indicate that it is the domestic market. From this data, we can infer that MNCs locating in Beijing source technology internally, but sell their new products to the domestic market. In terms of collaboration of innovation, firms also collaborate mainly with domestic clients and domestic suppliers, although some collaboration at regional level also exists. Some of the Beijing-based firms have engaged in the global generation of technology. The survey indicates that as much as 10% of the firms have engaged in offshoring of R&D. For example, Lenovo has an R&D center in USA and another in Japan (Lv and Liu, 2011)

Two cases can help illustrate the interactions of the firms with the regional innovation systems, one of a Chinese-based firm and another from a MNC located in Beijing. VOICE[6] is a high-tech company spin-off of a research institute of the Chinese Academy of Sciences. VOICE develops speech recognition engines and Audio Signal Processing Modules, which are sold in three ICT markets: telecom services; embedded services (MP3; MP4; learning machines); and speak control systems (e.g. interface to control telematic system in the cars). - The company is global leader for speech recognition technologies but it is mainly targeting the domestic market. The main partners for innovation are their customers- for example a Chinese mobile company that is a leader in the market as well as the Government. As a spin-off of the Chinese Academy of Sciences, they still keep very strong linkages with CAS. This partnership, provides them with access to a large pool of researchers as well as R&D funds. The sourcing of technology is internal to the company and the exploitation of innovation as well as the collaboration takes place at national level. One significant

[6] The names of the two firms are finctional. The real name is kept confidential.

local interaction is with CAS, which supplies all the R&D resources needed to develop the innovation.

SOFTSERV, on the other hand, is a MNC company established in Beijing. They provide R&D services (where they develop, test and localize the product) and IT services (e.g. enterprise solutions that require more business domain knowledge than technical expertise). Although they started as an internationally oriented company, developing products for international clients (mainly US), currently they are shifting their focus to the domestic market. When the interview took place (2009) their objective was to increase the revenues from the Chinese Market to 50% (when it was 30%). In terms of collaboration for innovation, the company develops its open standard processes to share and to use as a base to construct later the services in collaboration with their customers. Therefore the 'innovation' is done also in cooperation with their clients, which are international, domestic and also local. Sourcing of technology is also done domestically, tapping on the expertise of the different branches around the country.

As the two examples illustrate, both firms are located in Beijing to serve the domestic market (SOFTSERV also the international market). They benefit from the pool of qualified human capital in Beijing, as well as some clients, but the bulk of their technological sourcing, exploitation of innovation and collaboration for innovation takes place at domestic level. The strong institutional framework supports innovation in the sense of providing human capital and proximity to competitors and some clients, but when the objective is the domestic market and the client is the main source of innovation (together with the internal employees), interactions take place domestically.

Tier 1- Bangalore

Bangalore is considered to be the most important ICT hub in India and, for many, also in the world. It is an interesting case as Bangalore firms, in contrast to Beijing firms, have traditionally been more oriented to the international market than to the domestic one. Bangalore can be considered an institutionally thick regional innovation system. In terms of organizational infrastructure, there are about 2100 software firms registered in Bangalore, which are responsible for a third of the national exports (Parthasarathy and Rabganathan, 2011:6). According to the INGINEUS survey, about half of the firms are standalone companies, 16% subsidiaries and 28% headquarters of MNCs. Whereas there are many large firms (about 40% has more than 250 employees. While Bangalore started as a low-cost provider of software services, it has been upgrading gradually and currently is an important provider of high-added value services. The industrial structure combines both a large pool of SMEs with a large number of MNCs, many of which have located also R&D centers in Bangalore. In terms of research infrastructure Bangalore is home of the Indian Institute of Science and the International Institute of Information technology (IIIT_Bangalore) and has branches of some international universities like Chicago as well as other well-known HEIs like the Indian Institute of Management. Some MNCs have also opened their own campuses of firms like Hewlett Packard, Infosys, Siemens and Wipro (Parthasarathy and Rabganathan, 2011:12). As many scholars have pointed out, one of the main reasons why MNCs started to locate in Bangalore was the availability of highly skilled human capital (Arora et al, 2001). According to the INGINEUS survey, accessing specialized knowledge, qualified human capital and other knowledge

infrastructure and services continues to be the main reason for firms to offshore production and innovation activities in Bangalore (Parthasarathy and Rabganathan, 2011:16).

Networks in Bangalore have evolved reflecting the evolution in the strategies of the firms: from strong linkages with MNCs during the outsourcing wave to more complex alliances for the provision of embedded systems which forces chip vendors to develop alliances with service providers, both at regional, domestic and international level. While regional networks are not still fully developed, Bangalore shows a higher propensity to collaborate with regional actors than firms in other parts of India. As indicated by Parthasarathy and Rabganathan, 2011:23 "Bangalore stands out as much higher percentage of firms have worked with every type of regional collaborator than firms in other regions", and this differences are particularly higher with regards to the collaboration with universities and consultants. So, regional networks are very significant in Bangalore and, in contrast to other Tier 1 and other regions in India, regional networks for innovation are even more important than domestic[7]

In Bangalore there is a strong culture of collective representation and collective action. In 1997 Karnataka took the initiative to developed its own information technology policy, being one of the outcomes of that policy the establishment of the IIITB mentioned before. The Government has been very active in developing the institutional framework supporting the IT industry in Bangalore. Additionally, the India semi-conductor association was created in Bangalore in 2004 to represent the interests of the emerging embedded system industry centered in Bangalore (Parthasarathy and Rabganathan, 2011:20).

Using the INGINEUS survey data, one can see that sourcing of technology is mainly internal to the firm, although the proportion of firms that source from their own MNC or from other MNCs is higher than in other Tier 1 regions (like Beijing). In terms of exploitation of innovation, half of the Bangalore firms are targeting export markets (global exploitation of innovation) while other half are targeting domestic. However, the international orientation of the clients may change in the future as the number of firms that develop innovation (for the poor) in interaction with local customers increases (Parthasarathy and Rabganathan, 2011:23). Firms like HP, Microsoft, Motorola or Siemens have opened R&D labs in Bangalore precisely to develop "innovations for the poor".

A case that can illustrate this shift towards domestic market and the development of innovation for the domestic market and in collaboration with local and domestic actors is Hewlett Packard. As Parthasarathy and Rabganathan (2011:24) account, HP became involved in the development of an affordable and easy to carry solar powered digital camera with a small printer. The innovation was developed to serve one particular purpose (help woman report their social events) but it has the potential to be further developed into a product that can be commercialized for India and elsewhere. The development of this innovation was done through the interaction with domestic clients, although it may be exploited internationally.

[7] See Table 8 in Annex 2 paper « The role of regions in supporting the emergence and development of GINs : the case of Bangalore »

Tier 2 – Cape Town

The Western Cape, is considered to be a Tier 2 region. The RIS is dominated by small and medium size enterprises (Kaplan et al, 2010) which are not specialized in high-added value activities. There are four universities in the Cape Town region, accounting for about 2200 research staff. One of them, the University of Cape Town is considered among the top 200 Universities in the world and the highest ranked in Africa (Lorentzen and Muller, 2010:7). Although the Cape Town has some specialization in agro-processing, it is not so strong in ICT. There is a considerable amount of ICT firms and the desire of the government to make this industry a landmark in the region, but it has not crystalized yet. There are also a number of sector associations and initiatives, like the Cape IT Initiative, the Bandwidth Barn and the Silicon Cape.

In terms of networks, there is a certain degree of collaboration between university, industry and the government, but firms report that interactions with local knowledge producers are marginal (Lorentzen and Muller, 2010:10).

How this RIS affects the insertion of firms in Global Value Chains can be illustrated with a case. DCM[8] is a Cape Town based firm specialized in high speed digital signal processing technologies for radar and sonar applications. DCMs principal customer is a South African engineering company based in Gauteng (domestic link) that, in turn, sells both domestically (second domestic link) and internationally (insertion in global innovation networks –global exploitation of innovations- through the node of the client) and has two large European defense companies as shareholders (Lorentzen and Muller, 2010: 18). DCM sources from international sources, as the quality of the domestic and local sources is considered low (global sourcing of technology). So, DCM has not very strong linkages in the Cape Town region. Its clients are domestic (with further international linkages) and its suppliers are international. The only strong linkages with the regional innovation systems are for the recruitment of staff, which is done locally (Lorentzen and Muller, 2010: 19).

The RIS in Cape Town can be considered as neither too strong institutionally nor too weak. It is clearly a Tier 2 region. There is some organizational infrastructure both in terms of firms as well as strong universities (especially Cape Town University), some initiatives and support from the government. There is some interaction taking place between firms, government and universities, but collaborations work sub-optimally and they seem to be only marginal to innovation. There is an emerging culture of collective representation in the form of initiatives to create an ICT hub in the Cape Town region and there seem to be a strong Cape Town identity, reported in the cases. Yet, the technological capabilities of the local firm are not strong enough and firms tend to source technology internationally and sell their products to domestic or international clients.

[8] DCM stands for Defense Components Manufacturer. The real name of the firm is confidential (Lorentzen and Muller, 2010)

5. FINAL REMARKS

When taking all the industries together, the data shows that there are significant differences across regions with regards to three out of four forms of globalization of innovation: global exploitation of innovation, global research collaboration and global sourcing. In general, firms located in Tier 2 regions participate more often of global innovation networks that firms in Tier 1 and Tier 3. Tier 1 firms seem to be more engaged in intra-firm networks rather that extra-firm. Transactions take place more often between different units of the same organization rather than with external firms or knowledge providers.

Tier 1 regions, like Stockholm, Beijing or Bangalore could be considered *Globalized regional innovation systems* (Cooke et al, 2007). They are characterized by a large presence of multinationals and in general large corporations, surrounded by a network of SMEs. They host a number of research institutes, providing qualified human capital and research to the productive system. Although innovation is higher in these regions, collaboration for innovation is not as high as in Tier 2 regions, despite the high density of their institutional environment. Our results seem to confirm that research is rather internal to the firm than external (Cooke et al, 2007) and more confined to the domestic arena rather than the regional or international one (Tödtling et al, forthcoming).

Tier 2 regions, like Shenzhen, Western Cape or Malmö could resemble what Cooke et al call *Interactive regional innovation systems*. The productive structure is a mix between large and small firms. They network with a variety of actors for innovation, at all three geographical levels (regional, domestic and international). Firms in Tier 2 regions are more integrated in global flows of innovation, particularly the global exploitation of innovation, global sourcing of technology and global research collaboration.

Finally, Tier 3 regions, like Pune, Easter Cape or Jönkoping could resemble a *Localist innovation system*, dominated by small firms and with limited research capabilities. Interactions take place within the value chain, with suppliers and clients for example. It is in this region where we find that interactions with regional suppliers are higher. It is also in this region where we find also collaboration with international clients. The picture that emerges is of firms that collaborate regionally with suppliers and internationally with clients.

Following this, we may expect that firms located in Tier 2 regions may be more prone to participate in global innovative networks (GIN). Firms in Tier 3 may have linkages with global clients but there are not so innovative and not so networked (gin). Finally, firms in Tier 1 regions, may be more innovative, but they are not so global (at least not with regards collaboration for innovation) and not as networked as firms in Tier 2 (gIn).

It is interesting to link these findings with the institutional thickness of the different regions. What these results seem to suggest is that, contrary to what we expected, GINs may emerge in regions which are neither institutionally too thick (like Tier 1) or too thin (like Tier 3). Regions that are institutionally thick are better networked domestically than internationally. They may have reached some form of institutional congestion that hampers instead of promoting the kind of networking that characterizes less institutionalized regions. Regions that are too thin institutionally may force firms to collaborate with international clients or suppliers, thus supporting the emergence of global value chains (not so much networks).

It is regions that are neither too thick nor to thin institutionally -like Tier 2 regions- that are more supportive for the emergence and participation of GINs. This could also explain why most of the

firms that are truly innovative, networked and global are located in non-european regions (institutionally less thick), rather than in European ones (Barnard and Chaminade, forthcoming).

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