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Do regions make a difference? Exploring the role of different regional innovation systems in global innovation networks in the ICT industry

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ABSTRACT

The access to global innovation networks (GINs) has been extremely unequal across regions around the globe. While certain regions are considered knowledge hubs, able to link to global knowledge flow, other still remain marginalized, pointing out to the role of regional innovation systems in the emergence and development of GINs. Using firm-level data collected through a survey and case studies in 2009-2010, this article systematically compares the patterns of global networks in the ICT industry in a selection of European and non-European regions. Contrary to what we expected, the results show that GINs may emerge in regions which are neither too innovative nor institutionally thick (like Tier 1) nor too thin (like Tier 3).

Keywords: globalization; innovation networks; regions; Europe; India China

Do regions make a difference? Exploring the role of different regional innovation systems in global innovation networks in the ICT industry

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Abstract: The access to global innovation networks (GINs) has been extremely unequal across regions around the globe. While certain regions are considered knowledge hubs, able to link to global knowledge flow, other still remain marginalized, pointing out to the role of regional innovation systems in the emergence and development of GINs. Using firm-level data collected through a survey and case studies in 2009-2010, this article systematically compares the patterns of global networks in the ICT industry in a selection of European and non-European regions. Contrary to what we expected, the results show that GINs may emerge in regions which are neither too innovative nor institutionally thick (like Tier 1) nor too thin (like Tier 3).

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1.Introduction

Globalization has come hand in hand with an increased role played by certain regions in the global economy (Amin and Thrift, 1994, 1996; Asheim and Isaksen, 1997; Chaminade and Vang, 2008; Cooke, 1992, 2001). Despite the opportunities opened by information and communication technologies for the transfer of (codified) knowledge and the role that relational proximity may play in link together actors that are geographically distant (Boschma, 2005), some regions remain power houses or knowledge hubs in global innovation networks (Chaminade and Vang, 2008). Global processes are still "pinned down" in certain regions around the globe (Amin and Thrift, 1994) making the access to global knowledge flows still an unequal phenomenon across regions.

While the international business literature has largely contributed to our understanding of the role of firm strategies and capabilities on globalization of research and innovation (Cantwell and Piscitello, 2002, 2007; Dunning, 2001; Narula and Marin, 2005; Zanfei, 2000), economic geographers have studied the role that knowledge bases play in the geography of knowledge flows to explain why certain industries exhibit different patterns of globalization of innovation activities (Asheim and Coenen, 2005).

Observed differences between sub-national regions around the globe could be explained by the different configurations of their regional innovation systems (RISs). RISs can be defined as "wider setting of organisations and institutions affecting and supporting learning and innovation in a region" (Asheim, 2009, p. 28). While the literature has long acknowledge the importance of institutions in RIS and their influence in the geography of knowledge flows (Amin and Thrift, 1994), we are only starting to grasp how different RIS affect the access to global innovation networks and, more specifically, how the institutional thickness of a RIS shapes the access to global innovaton networks. It has been only very recently that some authors have analysed empirically the relationship between regional innovation systems and the geography of knowledge interactions (Blažek et al., 2011; Chaminade, 2011; Martin and Moodysson, 2011; Sotarauta et al., 2011; Tödtling et al., 2011a). While this recent line of literature provides first evidence of the influence of different types of RIS on the geography of knowledge, the existing studies are mainly based on the analysis of cases and European regions. This paper contributes to this last line of research by extending the analysis to regions across the globe.

Using firm-level data collected through a survey in 2009-2010, this article systematically compares the patterns of GINs in different types of RIS from European and not European countries. More specifically, the paper addresses the relationship between different types of RIS –in terms of innovation dynamics and institutional thickness- and the access to global innovation networks across the globe.

The paper is structured as follows. Section 2 discusses the theoretical framework. Section 3 describes the data sources used for the analysis and the method. Section 4 describes the empirical analysis and summarizes the main results. Section 5 concludes with some remarks on policy implications.

2. Main conceptual framework

2.1. Globalization of innovation

Multinational firms have long been locating different functions of the organization in geographically distant places to exploit ownership, location or internationalization advantages (Dunning, 2001). But 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 and to the surge of global innovation networks (Archibugi and Iammarino, 2002; Cantwell and Piscitello, 2002, 2005a, 2005b, 2007; Dunning and Lundan, 2009; Le Bas and

Sierra, 2002; Zanfei, 2000; Chaminade and Barnard and Borras and Lorentzen in this special issue). Global innovation networks are defined here as ‘a globally organized web of complex interactions between firms and non-firm organizations engaged in knowledge production related to and resulting in innovation’ (Barnard and Chaminade in this special issue).

Global innovation networks can be formed for the commercialization of new products and services in international markets, for the acquisition of embedded technologies or for the global generation of innovation activities through research collaboration or offshoring (Archibugi and Michie, 1995). The different forms of globalization of innovation reflect different internationalization strategies depending on whether the firm aims at exploiting already existing advantages (asset exploiting) or creating new ones (asset seeking) (Dunning and Lundan, 2009; Castellani and Zanfei, 2006). Asset exploiting commonly refers to the development of new markets for existing products or services (Castellani and Zanfei, 2006) and it is often used in the innovation literature to refer to the export of innovations (Chen et al. 2009). Asset-seeking strategies, on the other hand, usually refer to the acquisition of knowledge and capabilities needed for the innovation process (Castellani and Zanfei, 2006; Dunning and Lundan, 2009; Fifarek and Veloso, 2010). The international business literature has been very firm-focused, mainly looking at firm-based strategies or at the complementarities between firm knowledge bases and capabilities and those searched for and acquired during the internationalization process. The interplay between the region and the internationalization process has been limited to studies on the spillovers of MNCs at regional level (Jaffe et al. 1993; Cantwell and Piscitello 2002; Narula and Marin 2005; Marin and Bell 2006 or the characteristics of the regions as preferred locations for foreign direct investment (FDI) (Cantwell and Santangelo 2002; Cantwell and Piscitello 2007), but the relationship between the dynamics of the regions in which the firm is embedded and the decision to source regionally or internationally has been almost completely neglected.

2.2. Regional – global linkages

For long, economic geographers have argued that due to the tacit nature of knowledge interactions often take place at local level, that is, between organizations that are geographically close (Asheim and Gertler, 2005; Boschma, 2005; Cooke, 1992; Storper and Venables, 2004).

However, in the last decade scholars in this field have been paying an increasing attention to the role of global knowledge flows for the competitiveness of European firms and regions. Concepts like global pipelines or distributed knowledge bases have been recently developed to refer to the interplay between global and local flows of knowledge (Asheim and Gentler, 2005; Giuliani, 2011; Moodysson et al., 2008).

The main argument is that in a globalized economy, regions alone cannot maintain high levels of innovativeness and competitiveness without tapping into global flows of knowledge and that extra-regional interactions are fundamental to avoid lock-in problems in the long term (Amin and Cohendet, 2004; Bathelt et al., 2004; Bathelt, 2008; Tödtling and Trippl, 2005, 2011; Uzzi, 1997). Firms need regular access to knowledge produced elsewhere, especially when their activities require certain knowledge capabilities and knowledge resources that are not present in their regional pools at the quantity, costs or levels that the firm requires (Asheim, 2009; Asheim and Gertler, 2005; Asheim and Isaksen, 2002; Bathelt 2008; Bathelt et al., 2004; Gertler and Levitte, 2005; Owen-Smith and Powell, 2004; Moodysson, 2008;).

According to economic geographers the degree to which innovation activities become globalized depends not only on the strategy of the firm (as scholars in international business argue) but also on the nature of the knowledge prevailing in a certain industry (Asheim and Coenen, 2005). Industries characterized by analytical knowledge bases, like biotechnology, rely often on codified knowledge that is easier to transfer from and to geographically distant locations –thus facilitating the globalization of innovation activities in these industries-. On the other hand, industries characterized by synthetic knowledge bases, like some segments of the automotive industry, are dominated by tacit knowledge and practical skills, which makes their internationalization more difficult. It follows that regions specialized in industries characterized by specific knowledge bases will have a higher or lower tendency to participate in global innovation networks.

Whilst the concept of knowledge bases and distributed knowledge bases has enhanced our understanding of how regions may engage in global innovation networks, it is very limited to explain why the same industry may show very different geographical patterns of knowledge collaboration in different regional innovation systems (Chaminade, 2011). Looking at how different regional innovation systems engage in globalization of innovation in the same industry across the globe may provide some first evidence of the role of sub-national institutional frameworks in global innovation networks.

2.3.Types of regional innovation systems and globalization

Innovation in general, and knowledge sharing in particular, is a social process that is shaped by institutions (Hollingsworth, 2000; Tödtling and Trippl, 2011). Most of the institutions have a very strong regional character and this is particularly the case for soft institutions. The ability to upgrade regional assets using global networks requires the presence of local institutions able to sustain not only innovation but to stimulate the local-global relationship (Bathelt et al., 2004; Coe et al., 2004, 2008).

The same industry, operating in the same country may behave very differently in two sub-national regions, due to the different institutional thickness of the two regional innovation systems in which the firms are embedded (Gertler, 2010). The institutional thickness of a RIS can be defined as a combination of factors, including a strong organizational structure, high levels of interaction, a collective representation by many bodies, a common industrial purpose and shared cultural norms and values (Amin and Thrift, 1994).

The institutional thickness of a RIS may facilitate or hamper the exchange of knowledge (Asheim et al., 2011; Asheim and Isaksen, 2002; Cooke et al., 1997; Gertler, 2010; Morgan, 2007), shape the geography of the knowledge flows of a particular RIS (Amin and Thrift, 1994, 1996; Tödtling et al., 2011) and be the main engine of change within the RIS (Boschma and Frenken, 2006, 2009).

RIS can be institutionally thick or thin according to the combination of different elements (Amin and Thrift, 1994) affecting therefore the quality of the RIS. RIS are institutionally thick when there is a strong organizational infrastructure (i.e. the number and diversity of organizations in that particular RIS, from firms to universities, research centres, financial institutions, chambers of commerce, government agencies), high levels of interaction among the local actors, a culture of collective representation and shared norms and values which serve to constitute the social identity of a particular locality (Ibidem).

According to Cooke et al. (2000) *institutionally thick RIS* are often located in metropolitan areas. Firms in institutionally thick RIS benefit from a dense network of support institutions, interactions take place often and in general, these regions, if not fragmented, show also high levels of innovation dynamics (Tödtling et al., 2011). Therefor, there is a strong relationship between institutional thickness and innovation. We will use the term innovative and institutional thick RIS to refer to these type of RIS.

Institutionally thin RIS are instead usually to be found in less urbanized regions and are characterized by the strong presence of SMEs, often with limited innovative capacity, lack of support organizations and low level of agglomeration as compared to thick regions. According to Asheim et al. (2011, p. 1137) 'Less urbanized or peripheral regions, (…) are usually characterized by weakly developed RIS subsystems such as a lack of dynamic firms and knowledge-generating organizations. There is often a "thin" and less specialized structure of knowledge suppliers and educational institutions. Also, networks are rather weakly developed, in particular, those to more specialized knowledge suppliers such as universities and research institutes. As a consequence, innovation activities are often at a lower level and of more incremental nature compared with those of a well developed "thick" RIS.

Empirical studies on the institutional thickness of a particular RIS are scarce, largely due to the difficulties measuring most of the intangible elements that define the institutional thickness and thus are based on qualitative information collected on a specific location like Birmingham (Coulson and Ferrario, 2007) or Vienna and Salzburg (Tödtling and Trippl, 2005).

Some very recent evidence suggest that the institutional thickness of a particular RIS influences the geography of the knowledge linkages, i.e. how different regions engage in global, domestic or regional networks[1]. An empirical study of ICT firms in Austria recently conducted by Tödtling et al. (2011) shows that while in innovative and institutionally thick RIS (Vienna) firms will tend to establish more domestic linkages, in not-so innovative and institutionally thin RIS (Salzburg) firms will tend to establish more international linkages, probably to overcome the limitations of the innovation system in which they are embedded, but also because the specificity of the industry and activity involved. We may, therefore,

[1] See the special issue on European Planning Studies 2011, 19(7)

expect that firms located in innovative and institutionally thick regions will engage more in local interactions than firms located in less favoured regions.

Globalization is thus important for both firms and regions. The international business literature has largely contributed to our understanding on the role of firm strategies and knowledge bases on globalization of research and innovation while economic geographers have studied the role that knowledge bases play in the geography of knowledge flows. However, we are only starting to grasp how different regions affect the access to global innovation networks. This has only been done through cases and only in Europe.

In general there are few attempts in the literature to analyse which type of regional system and regional institutional conditions influence the access to global innovation networks. Of those, none deal with regions in emerging economies (Yeung and Lin (2003). Hitherto, the local-global debate has focused on well-known or successful selected clusters and regions in Western developed countries (Owen-Smith and Powell, 2004; Bathelt et al. 2004; Coenen et al., 2004; Genter and Levitt 2005; Moodysson, 2008; Moodysson et al., 2008; Tödling et al., 2011).

The extent to which a relationship between a specific type of RIS in terms of innovation dynamics and institutional thickness and GINs exists, and the positive or negative nature of that relation will be investigated in this paper. This will be done for a variety of regions across the globe and for the same industry (ICT) thus following on the recent work by Tödtling et al. (2011).

3.Methodology

3.1.Sample

This paper is based on a firm-based survey conducted in 2009-2010 across 9 countries: Brazil, India, China, South Africa, Norway, Sweden, Germany, Estonia and Denmark, as well as case studies conducted in Beijing and Cape Town. Although the survey covered three industries ICT, Automotive and Agroprocessing, each country focused on just one industry, which was of economic importance within their national or regional contexts. In all industries and across all countries 1215 responses were collected. The combined 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, 2011). For this specific paper we are considering only the sample in the ICT industry and the regions where the number of answers could be considered at least sufficient for running an empirical analysis.[2] Table 1 below offers a summary of the responses received from ICT industry in each region considered and in each country. Smaller countries have also a lower number of firms representing the specific regions.[3]

Tab. 1 – Sample breakdown by country and regions

Country	Region	No. Firms
Estonia		**14**
	Tallinn	14
Norway		**83**
	Oslo & Akershus	63
	Vestlandet	12
	Nord-Norge	8
Sweden		**90**
	Skåne Region	16
	Stockholm	57
	Göteborg	17
China		**217**
	Shenzhen	35
	Shanghai	35
	Beijing	147
India		**303**
	Bangalore	50
	Trivandrum	20

2 We have excluded regions with only few cases.

3 For more information about the data refer to the methodological annex in the Barnard and Chaminade (in this special issue).

	Mumbai	70
	Pune	20
	Hyderabad	26
	New Delhi	76
	Chennai	41
Total sample		**707**

Source: own elaboration Ingineus data

3.2.Questions and indicators selected for the analysis

3.2.1 The survey questions and the related indicators

The survey questionnaire consisted of 14 questions covering some background information on the main production activities of the firm, organizational type, firm size, market, sales information and R&D activity. The core of the questionnaire focused on the types of innovation, the geographic network and collaborations with customers, suppliers, universities, research institutions, government, the offshoring of production and innovation and the role of the institutional framework (mainly at national and international level) supporting or hampering the access to GINs. All data collected referred to years 2006 to 2008.

For this paper, we built some proxies to capture also the firm's spread of the network (networks)[4] and the firms' innovation performance (Inno_Perform) aggregating some of the survey questions. We used also some structural variables (size and organizational type of the firm) that may affect the capabilities of the firms to develop networks. Table 2 shows the specific questions and relative indicators selected for the statistical and econometric analysis of this paper.

Table 2. Survey Questions and indicators used in the analysis

[4] The specific variable networks has been used in another empirical analysis based on Ingineus data (De Fuentes and Chaminade, 2011)

Questions	Indicator	Description
q.8 Regarding the development of the most important innovation in the last 3 years, with whom the firm actively collaborate and in which geographical location. The question provided different options of partnership (clients, suppliers, competitors, consultancy companies, government and universities, other) and different options of geographical location (in the region, in the country and in other international locations).	Global collaboration for innovation (capturing only extra-firm networks):	0= no collaboration 1= max regional collaboration 2= max domestic collaboration 3= max international collaboration
q. 9.1 If in the last three years the firm offshored activities. Since from this specific question it was not possible to distinguish firms that have done specifically offshoring of innovation we combined this question to the conditioned question q.9.2 related to identify which were the important regional factors in the decision to offshore distinctly production and innovation into a host region. From the answers we were able to capture all the firms that have offshored specifically innovation activities.	Global generation of innovation (capturing both intra-firm and extra-firm networks)	0=no offshoring 1= offshoring 1a=offshoring innovation
q. 6 The most important source of technology for the firm (including hardware, software and knowledge). The question provided different options: 1 most in-house; .2 most from other branches of own MNC; 3 most from non-MNC firms; 4. most from MNCs not formally connected; 5. most from public-industry organisations q. 8 (see description above) q. 9 If the firm has developed formal/informal linkages (e.g. research relationships) with different kinds of foreign organizations. The question provided different options of partnership (clients, suppliers, competitors, consultancy companies, government and universities)	Networks (capturing firms' spread of network).	Pseudo continuous variable built by factor reduction of the following variables: Internal and external sources of technology (categorical: 1 = internal , sub-questions 1 & 2 if yes =1 ; 2 = external, sub-questions 3,4 and 5 if yes =2); Internal (regional) and external collaboration for innovation (extra-regional). Continuous: own region: 1-7; other region: 1-7; Formal and informal linkages with foreign organizations . Continuous: 1-6. (Min -1.32366 ; Max 2.79244) Factor analysis: VE=46.89
q. 3.3 If firm has significant R&D activity (yes, no) q. 3.3.1 Number of Full time equivalent employees for R&D q. 7. If the firm experienced innovation (new to the world, new to the industry, new to the firm) in the past 3 years (2006-2008) in any of the following: New products; New services; New or significantly improved methods of manufacturing or producing; New or significantly improved logistics, distribution or delivery methods for firm's inputs, goods and services; New or significantly improved supporting activities for firm's processes.	Innovation performance (Inno_Perform) (capturing innovation intensity)	Pseudo continuous variable built by factor reduction of the following variables: R&D activities (Dummy: 1=yes) Full time employees for R&D (continuous) World level innovation (Dummy: 1 =yes). (Min -1.04059 ; Max 2.67445) Factor analysis: VE=61.26
q. 2 If the firm is a standalone company, a subsidiary of a MNC or a headquarter of a MNC	Organizational Form (Standalone; Subsidiary and Headquarter)	Dummy variables Standalone =1 if standalone , 0

		otherwise Subsidiary =1 if MNC subsidiary , 0 otherwise Headquarter = 1 if MNC, 0 otherwise
q. 3.1 The number of full-time equivalent (FTE) employees the firm has	Size (Medium, Large, Small)	Dummy variables Small =1 if FTE ≤49, 0 otherwise Medium =1 if FTE between 50 and 249, 0 otherwise Large = 1 if firms ≥250, 0 otherwise

Table 2. Survey Questions and indicators used in the analysis

3.2.2 The classification of regions in relation to Tiers

In order to assess the relationship between GINs and different types of RIS, all the cases in the sample were codified as belonging to RIS considered as Tier 1, Tier 2 or Tier 3 according to their innovation dynamism and institutional thickness. To define the three Tiers we combined quantitative (when available) and qualitative information about the innovation dynamics of the RIS and their institutional thickness.

The European Regional Innovation Scoreboard 2009 (RIS Scoreboard, 2009), which classifies European regions according to different indicators of regional innovation performance related to enables, firms activities and output can be already a good proxy for evaluating the degree of innovation dynamic of some of the RIS. Unfortunately, the indicators were basically available only for the three Norwegian regions and partially for Stockholm region in Sweden[5]. While the regions Oslo & Akershus, Vestlandet and Stockholm are performing well above the average of other regions in EU, the region Nord-Norge in Norway is, for example, much less dynamic in relation to firms' innovation output[6].

[5] For Sweden, there is not detailed information about Skäne region and Göteborg area. For Tallin in Estonia the RIS is aggregated at the level of the country, so it is impossible to distinguish the regional performance of the firms located in Tallin area respect to other regions in the country.
[6] The indicator for the output is available only for the year 2004.

To capture the organizational structure of the RIS (linked to the institutional thickness) we used the number of ICT firms in a particular region, number of employees and, in some cases the volume of exports compared, for example, to the average of the country when that information was available. This latter information was used as a general proxy for assessing the organizational infrastructure of the region and together with the innovation dynamic indicators are the only pseudo-quantifiable measure we can consider. In general statistics broken down at the level of the industry are scarce or even not available at all for the regions in developing countries.

Qualitative information was also collected through literature review, cluster reports and consultation with country experts involved directly in the project. The qualitative information used in the analysis referred to the:

- Availability and quality of specialized universities, research centres and ICT specific intermediate organizations in the region[7].
- The degree of ICT specialization in the regions also in comparison with the country average.
- Other elements related to assess the institutional thickness (levels of interaction, culture of collective representation and shared norms and values).

All the sources of information used for the classification in Tiers are included as an appendix.

Basically, regions with the highest regional innovation dynamics, highest concentration of educational facilities, firms and employment in the ICT industry, with frequent interactions and a strong identity in that particular industry in that country were considered as Tier 1 RIS.

[7] In most cases, when information is available it does not refer to a particular industry.

Regions with an average number of firms and employment in that industry respect to the country, with some specialized supporting institutions and with less strong interactions, culture and shared norms were classified as Tier 2 RIS. Those regions that have no specialization in that particular industry, and/or with a weaker institutional setting or weaker innovation dynamic compared to other regions in that country were classified as Tier 3 RIS. The final classification of the regions in tiers was checked once again with industry experts in each country.

Table 3 below summarizes which regions have been classified as Tier 1 RIS, 2 or 3.

Table 3. Classification of regions by Tiers

Type of RIS tier	Country	Region	No. of firms
	Sweden	Stockholm	57
	Norway	Oslo & Akershus	63
		Vestlandet	12
	Estonia	Tallinn	14
	India	Bangalore	50
	China	Beijing	147
Total First Tier			**343**
	Sweden	Göteborg	17
		Skäne Region	16
	India	New Delhi	76
		Mumbai	70
		Chennai	41
		Hyderabad	26
		Pune	20
	China	Shenzhen	35
Total Second Tier			**301**
	Norway	Nord-Norge	8
	India	Trivandrum	20
	China	Shanghai	35
Total Third Tier			**63**
Tot Sample			**707**

Source: own elaboration Ingineus data

Tier 1 RIS are considered as thick RIS. They are usually located in metropolitan areas with strong specialization and innovation in the ICT industry. For example, Stockholm in Sweden and Bagalore in India are considered to be the most important clusters in the ICT industry not only in their specific country, but also globally since these regions count also on strong organizational, institutional and infrastructural support in that industry (Hansen & Serin, 2010; Ptak and Bagchi-Sen, 2011).

On the other side of the spectrum, Tier 3 RIS are usually thin (peripheral) RIS for the ICT industry (Tödtling and Trippl, 2005). The number of firms specialized in the ICT is low and/or there are not so many specialized support organizations in ICT, as it is the case for Trivandrum in India, Shanghai in China[8] and Nord-Norge in Norway.

In the middle, we are considering another category: RISs Tier 2. These are usually secondary regions in the country, in which there is a significant number of firms specialized in ICT, there is also presence of support institutions, but that are yet not so well networked and in general, do not show the same institutional thickness or innovation dynamic than those RIS considered Tier 1. One example could be the Skäne ICT cluster around Malmö and Lund, which employs around 23000 people, but that is still far away from the more than 100.000 people employed in ICT in the area of Stockholm (Tier 1), which is considered as the hub for the ICT industry in Sweden. Moreover, although the organizations supporting firms are performing very well, there are not so many organizations supporting specifically ICT as in Stockholm since the region have other more developed clusters like the life science or the food industry (Martin and Moodysson, 2011). Some examples for India are Chennai, Hyderabad and Pune that had recently an increase in ICT cluster development and some

[8] China is a very dynamic country. At the time that this research was conducted, Beijing and neighboring provinces were considered to be Tier 1 RIS for ICT while Shanghai, being the automotive hub, was considered only a peripheral region for ICT. This may be changing very rapidly as more and more ICT companies are establishing subsidiaries also in Shanghai.

metropolitan area such as New Delhi and Mumbai. Even though these regions are performing well in terms of ICT, they are still below the large ICT specialization and performance of Bangalore (Grondeau; 2007; OECD, 2010; Ptak and Bagchi-Sen, 2011) in terms of number of indigenous and multinational firms, employment, innovation or exports.

Table 4 shows specific characteristics of firms located in different RIS in terms of innovation performance, organizational form and size.

Tab. 4 – Structural characteristics and innovation performances of firms in regions classified by Tier 1, 2 and 3 RIS

Tier	**Size** (% on total answers)			**Organizational form** (% on total answers)			**Innovation performance** Inno_Perform (mean)
	Small	**Medium**	**Large**	**Headquarter**	**Subsidiary**	**Standalone**	
Tier 1 RIS	50.79	30.91	18.30	20.66	15.74	63.61	0.241969
Tier 2 RIS	26.12	33.58	40.30	16.27	31.86	51.86	0.101619
Tier 3 RIS	48.39	29.03	22.58	6.67	45.00	48.33	0.004852
Total	40.34	31.84	27.82	17.42	25.61	56.97	Sample mean 0.159043

Source: own elaboration Ingineus data

In relation to the innovation performance (Inno_Perform), firms in Tier 1 RIS are in the average the most innovative, while firms in Tier 3 RIS the least. In terms of organizational type firms in Tier 1 RIS have more headquarters of multinationals (20.66% of all the firms in that Tier) than firms in Tier 2 and 3. Tier 3 RIS have a very low percentage of MNC headquarters, but a very high percentage of subsidiaries. Tier 2 RIS represents something in between the two Tiers because there are is good presence of MNCs headquarters but also of subsidiaries.

Concerning the size of the firm while the distribution of size for Tier 1 RIS and 3 is similar, for Tier 2 RIS we can notice that there is a much higher percentage of large firms (around

40% of the all firms in that RIS) while in Tier 1 and 3 the majority are small enterprises with less than 50 employees.

The structural characteristics of the RIS in terms of the size and organizational form of the firms predominant in that region will have an impact on the propensity to engage in global innovation networks in general and in asset seeking strategies in particular. In order to disentangle the role of the region from all these other factors, we control for them in the econometric analysis presented next.

4.The role of RIS in global networks

4.1.Types of RIS and the geographical spread of the networks

To see if there is a relation between the different type of RIS (Tier 1, 2 and 3) and the probability of developing research networks that are geographically spread we run an econometric analysis using as dependent variable a categorical variable (TIER) indicating with 1 all the Tier 1 RIS; with 2 all Tier 2 RIS and with 3 all the Tier 3 RIS. The tiers are ordered on the basis of their RIS thickness, where Tier 1 has the highest level of institutional thickness and innovation dynamics and Tier 3 the lowest. We can exploit this information using an ordered logit model. However, the Brant test certifies that the effect of the regressors on the probability to move from one tier to next depends on the tier of origin, violating the proportional odds assumption. We thus applied the generalized form of the ordered logit model, which allows for estimating different coefficients for different categories.

The main independent variable is *Networks*, a proxy capturing firm's spread of the network. We control for size, organizational form and innovation performances of the firms (Inno_Perform). Table 5 plots the results.

Table 5 - Generalized ordered logit model

From First_Tier to Second Tier	
Networks	0.288***
	[0.092]
Inno_Perform	-0.352***
	[0.098]
Medium	0.712***
	[0.218]
Large	1.186***
	[0.258]
Headquarter	-1.133***
	[0.278]
Standalone	-0.800***
	[0.222]
Constant	0.205
	[0.223]
From Second Tier to Third Tier	
Networks	-0.458***
	[0.169]
Inno_Perform	-0.015
	[0.160]
Medium	-0.055
	[0.349]
Large	-0.357
	[0.421]
Headquarter	-1.743***
	[0.551]
Standalone	-1.472***
	[0.335]
Constant	-1.297***
	[0.305]
N	579
Ll	-482.706
LR χ^2 (12)	108.69
P	0
Pseudo R2	0.1012

*p<0.10, **p<0.05, ***p<0.01. Standard errors in parenthesis

As the table shows, the coefficient of *Networks* is significant and positive for the passage from Tier 1 to Tier 2, and significant and negative for the passage from Tier 2 to Tier 3. This means that firms in Tier 2 collaborate with a larger number of geographically spread networks than firms in Tier 1 and 3. Moreover, the results show also that while a larger number of innovative firms tend to concentrate in Tier 1 RIS (as the significant and negative coefficient of Inno_Perform for the passage from Tier 1 to Tier 2 shows), they are less prone to participate in geographically spread networks respect to firms in Tier 2. We also observe that the specific structural characteristics of the firm (size and organizational form) do matter in placing the firm in a specific Tier. Appendix C present the main statistics related to the variables and the correlation between the variables.

This first analysis shows only that a relationship between different types of Tiers and spread of the network exist. To assess if these networks are not only spread, but global and innovative we look specifically at the relation between Tiers and two types of GINs related to asset seeking strategies ad specifically to global collaboration for innovation and global generation of innovation. To test if difference among the firms in the three RIS Tiers are significant in terms of GIN we use a χ^2 test.

4.2.Types of RIS and global collaboration for innovation

As we can observe from table 6 all the Tiers show a good involvement in global collaboration for innovation, but firms in Tier 2 show the highest percentage of involvement[9]: 51.16 % of firms in these RIS are involved in international collaboration, against the 42.27% in Tier 1 RIS and the 34.92% in Tier 3 RIS. Tier 1 RIS show instead the highest percentage of collaboration for innovation that is not international (approximately 40% of firms in this RIS type have collaborated for innovation only at regional or maximum domestic level, against the

[9] Even when we tried to separate the international collaboration for innovation done with other firms and related specifically to the insertion in GVC (e.g. suppliers, clients) from the collaboration for innovation done with other organizations (consultancies companies) or knowledge providers (universities and research organizations) the results do not change. Tier 2 remains with the highest percentage of involvement in global collaboration for innovation.

22.6% in Tier 2 RIS and 23.31% in Tiers 3 RIS). Tier 3 RIS are also the ones that have fewer firms involved in any type of collaboration for innovation (41.27 % of the firms in this Tier did not develop any type of collaboration in the years 2006-2008). The differences among the 3 Tiers in terms of collaboration for innovation are robust since the $\chi2$ test is significant at 1% level ($p < 0.01$).

Table 6 – Maximum geographical spread of collaboration for innovation by Tiers

	First Tier	Second Tier	Third Tier	Total
No collaboration				
No. firms	61	79	26	166
% row	37.75	47.59	15.66	100
% column	17.78	26.25	41.27	23.48
Regional collaboration				
No. firms	33	25	5	63
% row	52.38	39.68	7.94	100
% column	9.62	8.31	7.94	8.91
Domestic collaboration				
No. firms	104	43	8	157
% row	66.24	27.39	6.37	100
% column	30.32	14.29	15.87	22.21
International collaboration				
No. firms	145	154	19	321
% row	45.17	47.98	6.85	100
% column	42.27	51.16	34.92	45.40
Total				
No. firms	343	301	63	707
% row	48.51	42.57	8.91	100
% column	100	100	100	100

Pearson χ^2 (6) = 38.8719   Pr = 0.000

Source: own elaboration Ingineus data

Regarding the structural characteristics of the firms located in a particular region and their impact on the results, we checked what type of firms in each Tier performs better in global collaboration of innovation. While in Tier 1 are mainly the MNCs headquarters that are engaged in global collaboration (around 52% of all the headquarters in Tier 1), in Tier 2 and Tier 3 the global collaboration is done mainly by the subsidiaries, (around 70% of the subsidiaries in Tier 2 and around 44.5% of the subsidiaries in Tier 3 are involved in global collaboration). In terms of firm's size in all the Tiers large firms are the ones performing better, in particular in Tier 2 around 68.5% of the large firms collaborate for innovation at global level. In Tier 1 and 3 the percentage is instead lower: respectively 53.5% and 43% of large firms .

4.3. Types of RIS and the global generation of innovation

As a proxy for global generation of innovation we consider the firms that in our sample have done offshoring of innovation activities. We defined offshoring as activities both internal and external to the firm for the purposes of serving home country or global markets in a location outside the firm's home country. As it can be observed in Table 7, Tier 2 RIS hosts in general a higher proportion of firms offshoring production and/or innovation activities abroad than region Tier 1 and 3 (around 37.16% of firms in Tier 2 against, 26.80% of firms in Tier 1 and 32.79% of firms in Tier 3). Unexpectedly firms in Tier 3 offshore more than firms in Tier 1, but this is valid only if we consider offshoring of production and innovation together. If we look specifically to the offshoring of innovation activities Tier 3 RIS are the ones with less percentage of firms involved in offshoring (around 18.03% against the 20.59% of firms in Tier 1 and 28.38% of firms in Tier 2).

The differences among the 3 tiers in terms of generation of innovation are robust since the χ^2 test is significant at 5% level ($p < 0.05$).

Table 7 – Global offshoring by Tiers

	Offshoring				Only Offshoring of innovation			
	First Tier	**Second Tier**	**Third Tier**	**Total**	**First Tier**	**Second Tier**	**Third Tier**	**Total**
None								
No. firms	224	186	41	451	243	212	50	505
% row	49.67	41.24	9.09	100	48.12	41.98	9.90	100
% column	73.20	62.84	67.21	68.02	79.41	71.62	81.97	76.17
Global offshoring								
No. firms	82	110	20	212	63	84	11	158
% row	38.68	51.89	9.43	100	39.87	53.16	6.96	100
% column	26.80	37.16	32.79	31.98	20.59	28.38	18.03	23.83
Total								
No. firms	306	296	61	663	306	296	61	663
% row	46.15	44.65	9.20	100	46.15	44.65	9.20	100
% column	100	100	100	100	100	100	100	100

Pearson χ^2 (2) for offshoring = 7.4514 Pr = 0.024; Pearson chi2(2) for offshoring of innovation = 6.2745 Pr = 0.043

Source: own elaboration Ingineus data

As for collaboration of innovation we checked for the structural characteristics of the firms located in each region. In Tier 1 and Tier 2 RIS are mainly the MNC headquarters involved in the generation of innovation (around 35% of the MNC in Tier 1 and 48% of MNC in Tier 2 RIS are offshoring innovation abroad), despite that Tier 2 RIS hosts more subsidiaries than headquarters. In region Tier 3 are instead the subsidiaries that are involved (probably indirectly with their MNC headquarters) in this type of network (33% of subsidiaries in Tier 3). As for collaboration of innovation in terms of size in all the three tiers the large firms are performing better respect to SME, but in particular in region Tier 2 (50% of large firms in Tier 1, 31% of firms in Tier 1 and 28.5% of firms in Tier 3).

Table 8 summarizes the results. Different RIS show different patterns of engagement in GIN, at least with regards to global research collaboration and global generation of innovation. It is in particular firms in Tier 2 RIS that engage more in global innovation networks than firms in Tier 1 or 3. Our results confirm those by Tödtling et al. (2011) for a selection of RIS across the globe. Firms located in innovative and institutionally thick regional innovation systems tend to interact more often with partners located in the region or in the country than abroad. They can basically find the resources that they need in their proximity and thus do not need to go abroad. It is basically the MNCs located in those RIS that are more prone to participate in GINs. Firms located in Tier 3 RIS, on the other hand, show the smallest propensity to engage in networks but once that they do, they may do so at international level. It is firms located in Tier 2 RIS – not too thin, not too thick- that are more prone to engage in GINs. In line with Barnard and Chaminade in this special issue, these results seem to point out to the fact that the engagement in global innovation networks may be a compensation mechanism for the absence of a strong innovative milieu. But what the analysis of the types of firms located in that region suggests is that not all firms in the region have equal possibilities to engage in GINs. It is mainly large firms and multinationals (either HQ or subsidiaries) that have the competences to engage in GINs.

Table 8 - Summary of results

	Characteristics of firms in the Tier	**Insertion in Global Innovation Networks**
Tier 1 – Innovative and Institutionally thick RIS	The higher proportion of MNCs headquarters is located in this Tier but also of SMEs. Tier 1 firms are on average the most innovative.	Local and domestic collaborations for innovation are more important for firms in this region. It is the large number of MNCs that sustain in particular the GIN: 52% of MNCs are engaged in global collaboration and 35% in global generation of innovation. Firms in this Tier are somehow global, very innovative and networked, but not so global (gIN)[10]
Tier 2 – Neither innovative and institutionally too	The higher proportion of large firms is in this Tier 2. Good distribution of both	Firms located in Tier 2 show the higher propensity to engage in geographically spread networks and in GINs related to collaboration for innovation and

[10] We use normal or capital letters here to refer to high or low degree of globalness, innovativeness and networkedness. See Barnard and Chaminade in this special issue for more information.

thick or too thin RIS	subsidiaries and MNCs headquarters in the Tier. Firms in Tier 2 are in the average less innovative than firms in Tier 1, but more than firms in Tier 3.	generation of innovation. Larger firms in these RIS perform better in GIN than SME. They also perform better than the large firms in Tier 1 and 3 RIS. 68.5% of large firms in the Tier are engaged in global collaboration and 50% in global generation. Subsidiaries are performing well in global collaboration for innovation, while MNC headquarters in global generation of innovation. Firms in this Tier are global, innovative and networked, although not as innovative as in Tier 1 (GiN and GIN)
Tier 3 – Innovative and institutionally thin RIS	Small proportion of MNC headquarters, but larger proportion of subsidiaries and standalone firms. Half of the firms are also small. Tier 3 firms are on average the least innovative	Firms in Tier 3 show the smaller propensity to engage in geographically spread networks. A very high percentage of firms in this Tier are not involved in collaboration for innovation at all. Even though the proportion of firms engaged in global collaboration are less than in Tier 1 and 2, the firms engaged in international collaboration are more than the ones engaged only in domestic and local collaboration. The firms in this Tier are also more engaged in offshoring activities than firms in Tier 1. It is the subsidiaries located in these RIS that engage (mainly indirectly) in GINs in this Tier: 44.5% of the subsidiaries are engaged in collaboration for innovation and 33% in global generation. In comparison with the other two tiers, firms in Tier 3 are mostly not networked, not innovative and not global (gin)

5. Conclusions

Our paper shows that there are significant differences across RIS with regards to the geographical spread of the networks, the global research collaboration and global generation of innovation. The paper discusses relationship between different type of RIS and GIN. We found that are the RIS that are neither too thick nor too thin that engage in more geographically spread networks and in particular in asset-seeking forms of GINs. What the results seem to suggest in line with Barnard and Chaminade (in this special issue) is that engaging in GIN is costly and hard to maintain and only when the firm cannot find the resources they need to innovate in their close proximity, they will engage in different forms of GINs. Firms that are located in thick regions, as Tier 1 RIS, they tend to network for innovation with other firms and organizations that are in close proximity or with domestic actors, so they may not have a strong need to develop asset-seeking strategies at global level. This is in line with Bode (2004, p. 51) that sustains how innovative and well-functioning RIS will have a tendency to exploit knowledge resources in close proximity since the knowledge from abroad is subject to transactional cost or distance decay. Even when the need for extra regional asset seeking strategies exists (like in Tier 3 RIS) firms may not have the capabilities and the absorptive capacity to engage in GINs. As the data show the firms in Tier 3 RIS are the less innovative and a large percentage of them (around 41%) are not involved at all in any type of collaboration. The firms in this type of RIS that are involved in global generation of innovation or global collaboration are mainly subsidiaries of MNC located abroad and therefore probably involved only indirectly by the MNC's headquarters in the GIN participation.

Tier 2 RIS been neither too thick nor to thin in terms of innovation and institutions have instead the need but also the possibility to engage in GINs. Indeed, firms located in Tier 2 show the higher propensity to engage in geographically spread network and in GINs for collaboration of innovation and global generation of innovation.

This paper is a first attempt to assess the role of different RIS around the world in global innovation networks. Our data suggests that the different quality of RIS matter for GINs and more precisely, that the institutional thickness and the innovation dynamic of the RIS have an impact on GINs. We also observe that the structural characteristics of the firms present in the RIS are very important in determining the capabilities of a system to link with GINs.

These results have important policy implications. Tier 3 RIS may need extra effort to support and stimulate the system both in terms of absorptive capacity and in terms of global but also domestic and local linkages (for example creating incentive sustaining in general networking and the presence of foreign MNC in loco). Policy makers in Tier 1 RIS need instead to pay attention to possible situations of lock-in derived by a too strong system of endogenous development that may require more government initiative related to open the region to external global knowledge flows.

The extent of the analysis is limited in several respects. First, the lack of available quantitative data on the institutional thickness, the type of questions used in the survey and the different distribution of firms in the three Tiers (i.e. smaller sample for Tier 3) limits the possibilities for a more sophisticated econometric analysis. Second, due to the difficult in running the same survey in different countries the sample may not be completely representative of the population in the RIS under analysis in terms, for example, of size and organization form which may be influencing the results of the analysis.

Due to these limitations, the paper is of exploratory nature. Further research is needed in order to explore the network related to the third mode of globalization of innovation, i.e. exploitation of innovation and the differences between Tiers and level of development, i.e. to investigate if Tier 1, Tier 2 and Tier 3 RIS in developed countries differ from Tier 1, 2 and 3 in developing countries. It will be also interesting to investigate if the observed differences in Tiers are consistent across different industries and not only for ICT.

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