# The changing geography of innovation

## Chinese and Indian regions and the global flows of innovation

Plechero, Monica

2012

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*Chinese and Indian regions and the global flows of innovation*


LUND
UNIVERSITY

by

MONICA PLECHERO

2012

Thesis for the degree of Doctor of Philosophy

To be presented, with the permission of the Faculty of Social Science of Lund University, for public criticism on 11th December, 10 am (10.00) at CIRCLE, Sölvegatan 16
Lund, MNO building, room O104

Opponent: Associate professor Andrea Morrison (Utrecht University, The Netherlands)

| Organization | Document name |
|---|---|
| LUND UNIVERSITY<br><br>CIRCLE and<br>Department of Human Geography<br>P.O. Box 117<br>SE – 22100 Lund | DOCTORAL DISSERTATION |
| | Date of issue<br><br>October 2012 |
| | |
| Author(s)<br><br>Monica Plechero | Sponsoring organization |


Title and subtitle

The changing geography of innovation
*Chinese and Indian regions and the global flows of innovation*


*Abstract*

Despite the recent theoretical and empirical advancements in the geography of innovation literature regarding the role that global sources of knowledge may have for regional growth and development, research in this field remains focused on successful regions and clusters in developed countries. Hitherto there has been limited research on the role of regions located in developing countries and the different types of global flows of innovation that link firms located in those regions with the rest of the world. Furthermore, most of the geography of innovation literature remains at the meso level (regional and sectorial), and almost ignores the interplay with firm-level characteristics. Using an interdisciplinary perspective, the thesis contributes to the literature by combining the geography of innovation studies with international business and innovation studies to integrate the meso dimension with the global and micro dimensions. The thesis investigates how certain regions in emerging economies are changing the geography of innovation. More specifically, this thesis aims to investigate the role of the region as well as of firm level factors, especially resources and capabilities, in explaining and sustaining firms' innovation performances and their possible modes of participation in the globalization of innovation.

The empirical focus is on firms located in the Pune region (India) and the Beijing region (China) which belong to three different sectors: software, green biotech and automotive components. The empirical approach is mainly quantitative and is based on a comparative and econometric analysis of primary data collected through two international projects.

The thesis consists of four articles at different stages of publication, preceded by an introductory section which frames and discusses the theoretical and methodological aspects of the individual articles.



Key words

Economic geography, globalization of innovation, regional innovation system, firm capabilities, Pune, India, Beijing, China

Classification system and/or index terms (if any)

| Supplementary bibliographical information | Language<br>English |
|---|---|
| ISSN and key title | ISBN<br>978-91-7473-399-0 |
| Recipient´s notes | Number of pages<br>255 / Price |
| | Security classification |

Distribution by (name and address): Monica Plechero, Lund University, CIRCLE, P.O. Box 117, 22100 Lund, Sweden




Signature  Date October 10, 2012

MEDDELANDEN FRÅN INSTUTITIONEN FÖR KULTURGEOGRAFI OCH EKONOMISK GEOGRAFI
AVHANDLINGAR VI

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## *Chinese and Indian regions and the global flows of innovation*


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MONICA PLECHERO

This study was made possible by financial support from:

European Union (EU FP7, grant agreement n° 225368)

Lund University

Swedish Research Council (VR)

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ISBN 978-91-7473-399-0

Printed in Sweden by Media-Tryck, Lund University
Lund 2012

## Acknowledgments

My first thanks go without any doubt to my first supervisor Professor Cristina Chaminade, not only because she has been an incredible mentor, but also because she has always encouraged me to trust my own capabilities, she has shared with me many research experiences, and she has pushed me to carry out all those possible stimulating activities that help a Ph.D. student become a researcher.

Thanks also go to my second supervisor Professor Bjørn Asheim, whose works have been important inspiration for my whole research. I am also grateful to Professor Daniele Archibugi, who has taught me how to better understand the complexity of globalization of innovation and who has always encouraged me to "stay over a problem". The energy he puts into everything he does is really contagious.

A special thank you also goes to my two co-authors, Ping Lv (UCAS) and Rakesh Basant (IIMA). From them I have learned fundamental cultural aspects in studying emerging economies and benefited from their stimulating academic discussions. I also need to thank the people I have worked with and with whom I have shared important research experiences during my doctoral period, who have been important in the development of my ideas: Heidi Wiig Aslesen (Norwegian School of Management BI); Helena Barnard (GIBS); Susana Borrás (CBS); Claudia De Fuentes (Saint Mary's University); Stine Haakonsson (CBS); Gouya Harirchi (CBS); Ju Liu (CIRCLE); Balaji Parthasarathy (IIITB); Liu Xielin (UCAS), and not least Jo Lorentzen (HSRC) who unfortunately passed away on February 2011.

I would also like to thank some of my colleagues at CIRCLE who have been a source of inspiration for my work: in particular, Jerker Moodysson, Lars Coenen and Roman Martin, and the Dime and Globelics academic communities for the same reason. Special thanks go also to Claes Alvstam (University of Gothenburg) who helped me in making sense of the international business field I was entering and gave me precious suggestions for improving my thesis. I also gratefully acknowledge the financial support of this work from Lund University, from the European Union's Seventh Framework Programme [FP7/2007-2013] under grant agreement n° 225368 (INGINEUS, Impact of Networks, Globalisation, and their Interaction with EU Strategies), and from the Swedish Research Council with the funding of the project 'Emerging Trends in Asia: from Cost Based Producers to Global Suppliers of Innovations (2007-2010)'. Thanks also to IRPPS (CNR) for hosting me as visiting fellow in this last year.

Under the agreement to preserve firms' anonymity I cannot name them, but a special thank you goes to all managers and entrepreneurs for answering the questionnaires and finding room in their calendars for our interviewees. Thanks also to the country and industry experts who were consulted for improving the questionnaires and for clarifying some industrial and regional specificities.

With all my love, I want to thank my family. More than anybody else, I would like to thank my husband Francesco Rullani for having supported me completely during my Ph.D. programme, accompanying me on some of my travels and contributing with his advice and suggestions in order to clarify concepts related to innovation dynamics and econometric analysis. Last but not least, my thoughts go to my daughter Anna, with whom I have missed precious time and who has patiently waited me to return back from trips or late-evening work.

# Table of Contents

# List of articles

| Status | Authors | Paper | Main Research Questions | Main Content | Empirical Material | Main Findings |
|---|---|---|---|---|---|---|
| Conditionally accepted in Industry and Innovation | M. Plechero and C. Chaminade | **1) The influence of micro-characteristics and the region in different modes of globalization of innovation: A comparative study of the Pune and Beijing regions** | Are the Pune (India) and Beijing (China) regions specialized in specific modes of globalization of innovation?<br><br>What can explain the propensities of firms in these two regions to engage in different modes of globalization of innovation? | The paper explores the linkages between different modes of globalization of innovation, firm level factors and the region in which firms are located. It analyzes three distinct modes of globalization of innovation: global exploitation of innovation, global sourcing of technology and global research collaboration. | Sample: primary firm-based survey conducted in 2008 in China and India<br>Regions: Pune and Beijing regions<br>Sectors: automotive components, software, green-biotech<br>Use of data: Econometric analysis | The paper shows that the interplay between the regional location and firm level factors is significant in explaining local firms' propensity to get involved in specific modes of globalization of innovation. In particular, firms in the Pune region are more involved in global exploitation and global collaboration than are firms in Beijing. |
| Submitted to Journal of International Management | P. Lv, M. Plechero and R. Basant | **2) International competitive strategy choices: comparing firms in China and India** | Which are the international competitive strategies of firms located in Chinese and Indian regions?<br><br>Which are the impacts of firms' resources and capabilities on such strategic choices and do they vary between regions? | The paper investigates the types of international competitive strategies followed by firms in the Pune and Beijing regions to compete in the global market. The study analyzes those factors that affect strategy choices and whether they differ between the two regions and among destination markets. | Sample: primary firm-based survey conducted in 2008 in China and India<br>Regions: Pune (India) and Beijing region with an extension to Tianjin and Hebei provinces (China)<br>Sectors: automotive components, software, green-biotech<br><br>Use of data: Econometric analysis | The paper shows that firms in Pune and Beijing regions besides cost leadership strategies, have already developed international differentiation and hybrid strategies, confirming that firms in these regions are moving into international markets not only because of their low cost advantage. Firms' resources and capabilities influence firms' propensity to choose a specific international competitive strategy. Differences are present in terms of sector and region. Differentiation strategies are more often used by firms in Pune. |

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|---|---|---|---|---|---|---|
| R&R in Research Policy | C. Chaminade and M. Plechero | **3) Do regions make a difference? Exploring the role of different regional innovation systems in global innovation networks in the ICT industry** | Can we observe different patterns of global innovation networks in different types of regions around the world?<br><br>What is the role of RIS in explaining these observed differences? | The paper compares the patterns of global innovation networks in the ICT industry in a selection of European and non-European regions (in China and India) with different innovation systems and regional institutional thickness | Sample: firm-based survey conducted in 2009-2010 across 5 countries: India, China, Norway, Sweden and Estonia<br>Regions: 17th regions in three European and two non-European countries (China and India).<br>Sector: ICT<br>Use of data: Statistical and econometric analysis | The paper shows that there are significant differences across regions with regard to the geographical spread of the network and the specific mode of globalization of innovation: research collaboration and generation of innovation. This finding suggests that the regions that are neither too innovative nor too institutionally thick or thin engage more in global innovation networks. Some of the structural characteristics of the firms present in RIS co-occur in determining the capabilities of a system to link with GINs. |
| R&R in Regional Studies | M. Plechero | **4) Effect of geographical proximity and technological capabilities on the degree of novelty in emerging economies** | How do firms in regions such as Beijing and Pune perform in terms of product innovation?<br>How does the geographical proximity of technological sources and of R&D partners in emerging economies affect the degree of novelty of firms' product innovation?<br>How can firm level factors facilitate the transition from new to the firm to new to the market or new to the world innovation? | This paper investigates the role of regions in upgrading firms' capabilities to innovate in emerging economies. By combining economic geography with innovation and business studies, the paper analyzes how the geographical proximity of the network and firms' technological capabilities affect innovation performances. | Sample: primary firm-based survey conducted in 2008 in China and India<br>Regions: Pune and Beijing regions<br>Sectors: automotive components, software, green-biotech<br>Use of data: Econometric analysis | The paper demonstrates that the role of the region in emerging economies may be limited to sustaining firms' innovation performances. In particular, local sourcing of technologies and local research collaboration seem insufficient to help firms move to a higher degree of product innovation. Instead, research collaborations developed at a global level are crucial. In terms of firms' capabilities, the firm's capacity to develop its own patents seems to be important to achieve a higher level of product innovation. Furthermore, firms in Pune perform better than do firms in Beijing. |

# Chapter 1- Introduction

## 1.1 Background

Since the 1990s, the geography of innovation has become an important field of research in the economic geography discipline (Scott, 2000). Research on this topic recognizes that innovation is not uniformly distributed across geographical landscapes (Asheim and Gertler, 2005; Feldman, 1994) and that the locations of activities influence capabilities to innovate (Feldman, 2003). One of the most important streams of literature that has influenced this field of research is the regional innovation systems (RIS) approach (Asheim, 1995 cf Asheim and Gertler, 2005; Asheim and Isaksen 1997; 2002; Asheim and Gertler, 2005; Cooke, 1992, 1996, 1998), which emphasizes the role of geographical proximity and of face-to-face interactions, social ties and shared institutions at a regional level in promoting innovation. Scholars in the geography of innovation field have therefore focused on the role of the region not only as a fundamental key geographical dimension to study innovation, but also as the main scale to study interactions related to innovation. Recent contributions to this field have also been directed to investigate other geographical levels of interaction, in particular the global level as a complement to the local level (e.g. Asheim and Coenen, 2005; Blažek et al., 2011; Coenen et al., 2006; Martin and Moodysson, 2011a b; Moodysson et al., 2008; Tödtling et al., 2011). The reason behind this interest of the complementary role of global interaction in the geography of innovation field can be related to the new globalization trends regarding not only the distribution of production but also innovation activities (Ernst, 2002). The geography of innovation at a global scale has significantly changed since developed countries started to participate in the internationalization (globalization[1]) of innovation activities during the end of the 1990s and the first years of the 21st century (Cantwell and Piscitello, 2002, 2005, 2007; Dunning and Lundan, 2009; Zanfei, 2000). Scholars from the geography of innovation field have therefore focused their empirical investigations on successful

[1] In this thesis, the terms 'globalization/global' are preferred to the terms 'internationalization/international'. Dicken (2011a) defines internationalization as '*simple geographical spread of economic activities across national boundaries with low level of functional integration*'. He defines globalization as a much more complex phenomenon related to a transformation in the nature, degree and speed of different economic qualitative interconnections involving '*both extensive geographical spread and also a high degree of functional integration*' (p. 6 and 7). Dicken's concept of globalization better indicates the recent transformation in the 'where' and 'how' of the economic activities (Ibidem). In this thesis 'where' refers particularly to the inclusion of new emerging economies and 'how' to the qualitative transformation involving these economies (innovation and not only production). Moreover the thesis aims to investigate different modes of interconnections pointing to different directions of the innovation flow from and to these economies by the rest of the world.

clusters and regions in Europe and in North America that were developing local as well as global interactions to sustain innovation.

Recently, some regions in the emerging economies, particularly in China and India, have also started to participate in global flows of innovation. Not only have firms in some of these regions shown in recent years that they are able to attract innovation from the rest of the world, but they have also started to actively export innovation and engage in outward R&D FDI (Bruche, 2009ab; Christensen et al., 2010; Reddy, 2011; UNCTAD, 2005).

The participation of China and India in the globalization of innovation is still discussed and debated in terms of public science, and few scientific studies have analyzed this phenomenon. Moreover, despite emerging evidence of this trend, the specific participation of some regions of these two countries in global flows of innovation and the consequences in terms of changes in the global geography of innovation remain still a black box. In particular, only a handful of these studies examines the role of the region in those economies in shaping innovation and sustaining firms in the globalization of innovation processes. While developed economies may count on well-functioning RIS, emerging economies may not have the same efficient types of RIS that are capable of attracting innovation from other parts of the world as well as pushing firms to explore their innovations in the global market. The fact that some regions in emerging economies may not dispose of well-functioning RIS (Padilla-Pérez et al., 2009) or may have RIS still in formation (Chaminade and Vang, 2008) may increase the important theoretical challenges with respect to how regions in those economies shape firms' participation in the global geography of innovation.

## 1.2 Aim and contribution

The aim of this thesis is to understand how certain regions in China and India are changing the geography of innovation. More specifically, this thesis ***aims to investigate the role of the region as well as of firm level factors in explaining and sustaining firms' innovation performances and their possible modes of participation in the globalization of innovation***.

The economic geography literature has long emphasized the role of regions in sustaining innovation (Amin, 1999; Asheim 1996; Camagni, 1991; Marshall, 1920; Morgan, 1997; Piore and Sabel, 1984; Porter, 2000; Storper, 1997). More recent studies in the geography of innovation field have also underlined how global sources of innovation may complement regional sources to support the innovation performances of clusters and regions (Coenen et al., 2004; Moodysson et al., 2008; Tödtling et al., 2011). Many of these scholars have advanced research

into the geography of innovation field by showing how different knowledge-based activities (analytical, synthetic, symbolic) that characterize a region may require or imply different geographical interactions for innovation (Asheim and Coenen, 2005; Coenen et al., 2006; Moodysson et al., 2008; Martin and Moodysson, 2011b). Other scholars have also contributed to investigating how different types of RIS may link in different ways to global sources of innovation (e.g. Tödtling et al., 2011).

Despite these contributions, there are still some theoretical and empirical gaps in the current geography of innovation literature. Indeed, the main focus of empirical analysis in this field of research has concentrated on investigating the sources of innovation at different geographical levels (e.g. Martin and Moodysson, 2011ab; Moodysson et al., 2008; Plum and Hassink, 2011; Sotarauta et al., 2011; Tödtling et al., 2011). Scholars belonging to this field have therefore overlooked the existence of other modes besides global sourcing in examining the cross-border linkages of the region related to innovation (e.g. through outbound R&D activities or research collaborations). Moreover, research into the geography of innovation field has focused its empirical analysis on regions in developed countries.

Although the geography of innovation studies very clearly enlightens the meso dimension of the innovation phenomenon (regional and sectorial), they have almost ignored the micro dimension. As a consequence, the role of specific firm strategies and capabilities in sustaining firms' innovation performances and the globalization of innovation activities have been underestimated.

The thesis contributes to filling these gaps in the literature by combining the geography of innovation studies with international business and innovation studies to integrate the regional dimension with the global and micro dimensions exploited in other disciplines. In particular, the thesis analyzes the complementary role of the region and firm's factors in sustaining the participation of firms in specific modes of globalization of innovation besides the global sourcing of innovation.

In this thesis different directions of innovation flow are considered: from the rest of the world to the region and from the region to the rest of the world. Regarding this last point the taxonomy of globalization of innovation developed by Archibugi and Michie (1995) in relation to the global generation of innovation, global research collaboration and global exploitation of innovation is here used and adapted. Empirically, this thesis extends the analysis of regions in developed countries to regions in emerging economies and tests if some of the general assumptions in the literature on the relevance of RIS also apply to regions in emerging economies that have incomplete innovation systems or systems in

formation (Chaminade and Vang, 2008). The focus is on regions and firms located in China and India because of the recent transition of these two countries from production-based to innovation-based activities (Altenburg et al., 2008; Chaminade and Vang, 2008). The sectors considered are software/ICT, green biotech and automotive components since, despite the important differences that exist at sectorial level, in all these industries production and innovation activities are already globally distributed (Altenburg et al., 2008, Gertler and Levitte, 2005; Plum and Hassink, 2011).

## 1.3 Overview of the articles

The thesis is composed of four articles covering the interplay between firm level and regional factors with the aim to investigate the research gaps formulated above. The articles are in different stages of publication.[2]

**Article 1** (co-authored with Cristina Chaminade). **The influence of micro-characteristics and the region in different modes of globalization of innovation: A comparative study of the Pune and Beijing regions**. This paper, conditionally accepted for publication in Industry and Innovation, explores for the first time the linkages between different modes of globalization of innovation, firm level factors and the region in which firms are located, in two regions in China and India. It analyzes three distinct modes of globalization of innovation: the global exploitation of innovation, global sourcing of technology and global research collaboration. The paper shows that the interplay between the regional location and micro-factors turns out to be significant in explaining local firms' propensity to get involved in specific modes of globalization of innovation.

**Article 2** (co-authored with Ping Lv and Rakesh Basant). **International competitive strategy choices: Comparing firms in China and India**, submitted to Journal of International Management**.** This paper shows that firms in China and India are moving into global markets for reasons other than their low cost advantages, related to a greater use of their knowledge-intensive activities. In particular, the paper investigates the types of international competitive strategies followed by firms in two regions (one in China and one in India) with a special

[2] My strategy has been to try to publish all 4 articles in A journals, even when the review process of these journals can be long and thus exceed the time period of 3 years of this thesis. This is why some of the them are still not yet publish as for September 2012. The articles have been presented and discussed in different seminars and conferences: DIME workshop, Utrecht, the Netherlands, 5-7 November 2009; Seminar at UCAS (University of the Chinese Academy of Sciences), Beijing, China, 10 November 2009; Seminar at CIRCLE, Lund, Sweden, 18 May, 2010; The 6th International Seminar on Regional Innovation Policies, Lund, Sweden, 13-14 October 2011; The 9th Globelics International Conference, Buenos Aires, Argentina, 15-17 November 2011.

focus on their micro factors. Specifically, the study analyzes which factors affect the different types of strategy choices and whether these factors differ between the destination markets. Beyond the differences that emerge in terms of region and sector, the paper shows that firms' resources and capabilities influence firms' propensity to choose a specific competitive strategy to explore the global market.

**Article 3** (co-authored with Cristina Chaminade). **Do regions make a difference? Exploring the role of different regional innovation systems in global innovation networks in the ICT industry,** 'revise and resubmit' in Research Policy. This paper compares the patterns of global innovation networks in the ICT industry in a selection of European and non-European regions (in China and India) with different innovation systems and regional institutional thickness. The paper focuses on regional characteristics and shows that there are significant differences across regions with respect to the geographical spread of the network and the specific mode of globalization of innovation: research collaboration and generation of innovation. The paper finds that the regions that are neither too innovative and institutionally thick nor too thin are the ones that engage more in global innovation networks. Moreover, it finds that some structural characteristics of firms present in RIS are important in determining the capabilities of a system to link with global innovation networks.

**Article 4** (single author paper). **Effect of geographical proximity and technological capabilities on the degree of novelty in emerging economies**, 'revise and resubmit' in Regional Studies**.** This paper investigates the role of regions in upgrading the firms' capabilities to innovate in emerging economies. Combining economic geography with innovation and business studies, the paper analyzes how the geographical proximity of the network and firms' technological capabilities impact on the innovation performances of firms in the Pune (India) and Beijing (China) regions. The results show the limited role of the region in supporting the move from 'new to the firm' to 'new to the world' innovation: local sourcing of technologies and research collaboration are insufficient to help firms move to a higher degree of innovation. The importance of the global sourcing of innovation and of global research collaboration and the role of specific resources and capabilities for sustaining the global competitive position of firms in emerging economies are confirmed. Differences emerge between the two regions: Pune performs better in terms of innovation than Beijing.

# Chapter 2 - Theoretical Framework

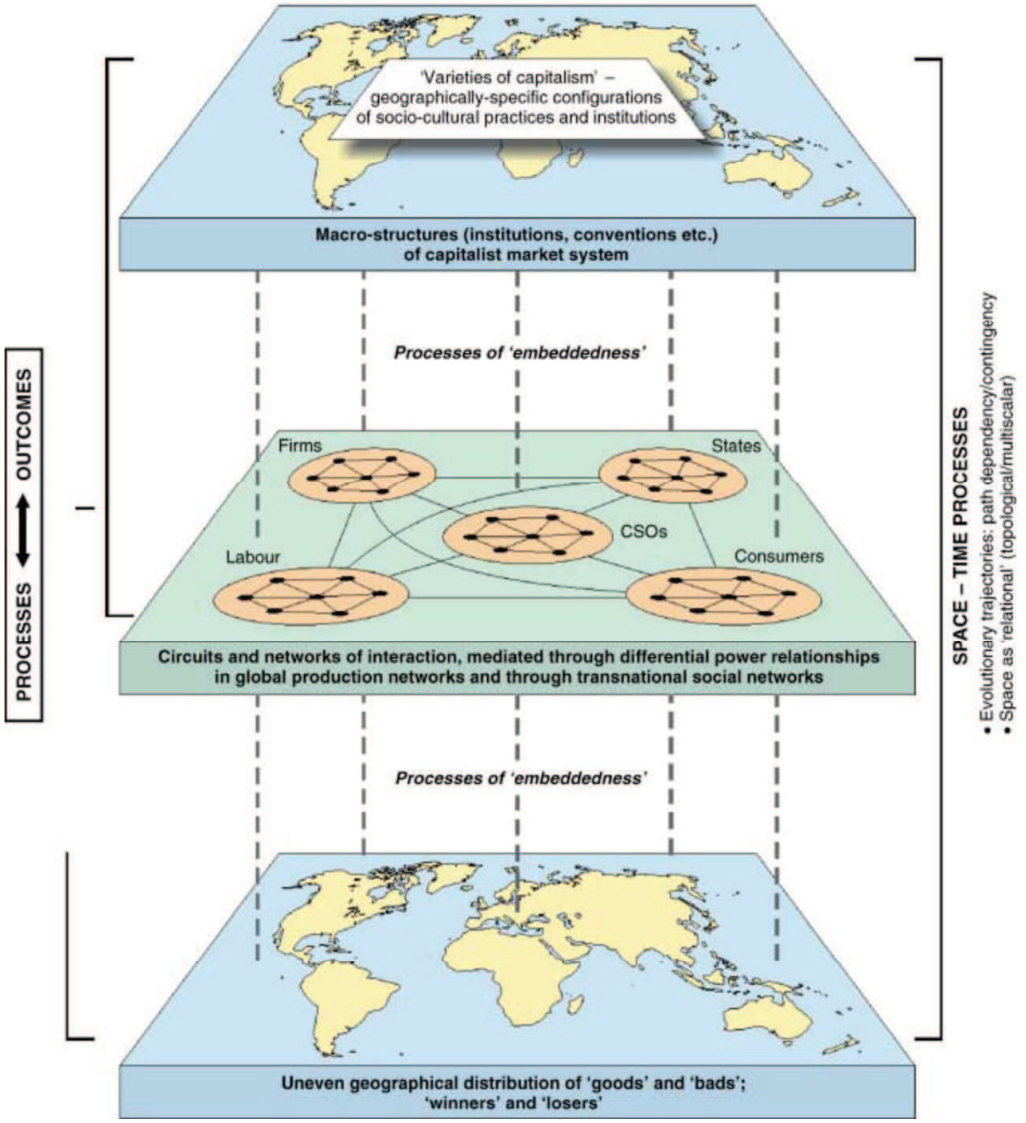
## 2.1 The geography of production vs. the geography of innovation (a second missing train?)

When globalization started to become an important research topic addressed in many different academic disciplines, Dicken (2004) pointed out how the contribution of geographers and economic geographers on the globalization debate was indeed so small that, with only a few exceptions, studies in the discipline of geography were missed as important references for the globalization literature. Therefore, at the beginning of the 21st century, while other disciplines such as economics, political science and jurisprudence were making important advancements in understanding the globalization of the economy, geographers were maintaining only a marginal role in the analysis of the processes and outcomes of globalization (Ibidem).

The exceptions to this 'missing train' have been the theoretical contributions on the changing geography of production through the development of the global production networks (GPN) perspective by geographers from the school of Manchester (Coe et al., 2004, 2008; Dicken et al., 2001; Dicken and Henderson, 2003; Henderson et al., 2002). The contributions of these academics have mainly been an attempt to further develop the global value chain (GVC) concept (Gereffi, 1996; Gereffi et al., 2001; Humphrey and Schmitz 2000, 2002) to understand the global distribution of production. The GVC studies in the 1990s aimed at investigating how firms active in global markets (particularly multinational corporations (MNCs) organize the transfer of information and the coordination of labor with other firms (Saliola and Zafei, 2009). More specifically, with particular attention to the governance structure and power position of each actor in the GVC, they aimed at understanding how firms in different geographical locations inter-relate and co-ordinate production activities to bring the product to the end market and end use (Gereffi, 1996; Gereffi et al., 2001, 2005).

With respect to early GVC studies, GPN studies (see fig. 1) have focused on a more complex idea of structures and relations (i.e. circuit processes rather than chain process) for studying the global division of labor in production activities (Coe et al., 2008; Dicken, 2011b; Dicken et al., 2001; Henderson et al., 2002). GPN is indeed defined '*as the globally organized nexus of interconnected functions and operations by firms and non-firm institutions through which goods and services are produced and distributed*' (Coe et al., 2004, p 471).

**Figure 1. GPN perspective**




Source: Dicken (2004)

The GPN concept particularly underlines the multi-actor and multi-scalar characteristics of transnational production systems (Coe et al., 2008; Dicken, 2011b; Dicken et al., 2001; Henderson et al., 2002).

First, the GPN approach takes account of the multiple types of actors (firms, research organizations, universities, governments) that are involved in global production systems, how they connect in the network, and how they interrelate in asymmetric power relationships (Dicken et al., 2001; Henderson et al., 2002). Second, it considers the social, institutional and geographical environments in which the different actors are located (*territorial embeddedness*) (Henderson et al.,

2002; Coe et al., 2004, 2008). This is particularly important for the changing geography of production involving actors from different regions in the world (i.e. from developed and developing economies) who belong to different contexts, institutions and cultural traditions. Third, it makes clearer the effect that the global distribution of production activities may have on regional development and underlines the strong relationship that exists between the regional level and the global level in terms of interactions and flows of information (Chaminade and Liu, 2012; Coe et al., 2004, 2008). Fourth, it aims to map the linkages of the network at different geographical scales (e.g. regional, national, global) and show heuristically the interdependence that exists between them in terms of the nature of the actors and of the intra-firm relations (Coe et al., 2004).

The contribution of the GPN framework has been fundamental in understanding the spatial and social dynamics of global production systems in a globalized economy. In the geography of production, this framework has certainly assisted in the process of grasping the complex dialectic between local and global interactions and analyzing the dynamics of production relations and the division of labor at a global level in terms of micro (actors) and meso dynamics (e.g. the regional and sectorial embeddedness of actors) (Henderson et al., 2002). It helped also to grasp the uneven distribution of power among agents and among locations in the appropriation of the value generated in the network (Hess, 2008).

Even though the GPN framework has conceptually brought about an important insight into the dynamics and outcomes related to the global geography of production, the model considers only the international production of goods and services. Indeed, one might also have expected this framework to be a natural point of departure for studies related to the geography of innovation (despite the different nature of the activity), since it takes account of the multi-scalar conditions and relations that link the single actors more heuristically to regional and global frameworks. Moreover, it may give an idea of the geographical distribution of those who among the regions and actors may be winners or losers in the innovation activities. The geography of innovation literature, and in general the recent conceptual debate on the local and global flows of knowledge/innovation has instead failed to follow up the original conceptual framework of GPN[3].

One of the explanations for this may be that many of the economic geographers involved in the discussion related to the geography of innovation belong to the regionalist school of thought. This school has often ignored the

[3] A basic tentative to point out the relevance of the GVC/GPN framework to investigating the local – global distribution of innovative activities have been carried out by Eraydin (2005).

micro dynamics that may influence the decision, the actions and the position of single firms and other organizations within global innovation networks. The main idea remains that innovative activities, even more than production activities, tend to remain concentrated in clusters and regions because of the sticky, intangible and embedded nature of knowledge (Audretsch and Feldman, 1996; Maskell and Malberg, 1999). This may partially explain why the development of the concepts of global innovation networks and the general debate related to the globalization of innovation derive mainly from the contributions of scholars in innovation and business studies (e.g. Archibugi and Michie, 1995; Barnard and Chaminade, 2011; Chaminade, 2009; Chaminade and Liu, 2012; De Prato and Nepelski, 2012; OECD, 2008) and, with few exceptions, not from scholars in economic geography.

As we will see in the following sections, the discussion that has been framed about the geography of innovation studies has been delinked from the discussion and theoretical conceptions developed in the geography of production through the GPN perspective. The direction of investigation that scholars, for example, of the RIS approach, have been taking to discuss the geography of innovation is indeed prone to maintain the regional level as the most important level of investigation, both as the object of analysis and as the main scale to assess innovation linkages. This has underestimated the roles of specific agents involved and their degree of participation in these processes, as well as the 'broader' nature of global linkages for innovation. Is this another missed train?

## 2.2 The insertion of a global perspective into the geography of innovation

### *2.2.1 The role of the region in innovation*

For many years, economic geography literature has considered the region to be one of the most fundamental dimensions to study innovation phenomena[4] (Asheim et al., 2003; Cooke, 2001; MacKinnon et al., 2002). The historical roots for this can be found in the industrial districts and cluster literature, as there was an initial recognition of the relevance of the impact of the locality and geographical context in terms of knowledge spillovers and firm innovation (Marshall, 1920; Becattini, 1978, 1990; Piore and Sabel, 1984; Porter, 1998, 2000). Studies during the 1990s explored the role of the region in sustaining innovation in a globalized world (Amin, 1999; Asheim, 1996; Camagni, 1991;

[4] As underlined by Cooke (2001, p. 953), the region represents a *'meso-level political unit set between the national or federal and local levels of government that might have some cultural or historical homogeneity but which at least had some statutory powers to intervene and support economic development, particularly innovation'*.

Morgan, 1997; Storper, 1997). This research focused particularly on the mechanisms of learning and interacting at a social and at a systemic level in order to lead the region and the firms located therein to develop a competitive position in the global arena (MacKinnon et al., 2002).

The stream of literature that has very much influenced research in this field is the regional innovation system (RIS) approach (Asheim, 1995; Asheim and Isaksen 1997; Cooke, 1992, 1996, 1998). This approach found its inspiration in the National Innovation System studies, which was developed at the end of the 1980s and the beginning of the 1990s by scholars such as Freeman (1987), Lundvall (1988) and Nelson (1993). The National Innovation System (NIS) and RIS approach aims at understanding the technological development and innovation of nations/regions through '*all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring'* (Lundvall, 1992, p. 12). Following this idea, innovation from a RIS perspective is the result of a complex set of interactions between public and private actors at a regional level (e.g. enterprises, universities, research institutes, agencies, departments of the government, suppliers, users). Cooke et al. (1998, p 1581) define RIS as those '*in which firms and other organizations are systematically engaged in interactive learning through an institutional milieu characterized by local embeddedness*'. Innovation is seen therefore as a socially embedded process (Moodysson, 2008; Lundvall, 1992) where firms and organizations located within short proximity share network relations of a (mainly) tacit and informal nature that are crucial for innovation (Bathelt et al., 2004). The RIS concept underlines not only that geographical proximity among actors may help the development of relations sustaining innovation through face-to-face interaction, but also that this effect is strengthened by the natural embeddedness of the economic ties in a specific institutional setting[5] (Steiner, 2011). These mechanisms of cooperation and interaction between local players are fundamental to support firm and regional competitive advantage (Asheim et al., 2007; Asheim and Isaksen, 2003). In fact, earlier RIS studies focused on the endogenous capacity of the region to sustain innovation treated external to the region linkages often as residuals (Eraydin, 2005). By studying the dynamics of regional development through the analysis of local interactions, RIS research has thus become an important part of the conceptualization of the geography of innovation field.

[5] An institutional setting can be defined as a context of shared institutions such as culture, habits, convention and routines, laws and regulations.

### *2.2.2 The development of the local-global debate*

At the same time as the development of the GPN perspective by the geographers of Manchester, some economic geographers interested in the geography of innovation field started to take into consideration that innovation can also be generated by a combination of close and distant interactions (Asheim and Gentler, 2005; Bathelt et al., 2004; Eraydin, 2005; Gentler and Levitte, 2005; Owen-Smith and Powell, 2004; Park, 2005).[6]

Bathelt et al. (2004) is recognized having theoretically contributed to opening the formal debate on local-global interaction, drawing the attention of geography of innovation scholars to the existence of the specific factors and mechanisms needed for exchanging knowledge at the local and global levels. These authors underline that some types of knowledge (e.g. tacit knowledge) remain local, while other types of knowledge (e.g. codified knowledge) can be transferred through the construction of long distance interactions (defined by the authors as global pipelines) that are important for the generation of 'non-incremental' innovations and the entrance in the region of new knowledge/innovation flows (Owen-Smith and Powell, 2002).[7]

In relation to this last contribution, new research has demonstrated empirically and theoretically that firms need to cross the borders of their local geographical agglomerations to access knowledge produced elsewhere, especially when their activities imply certain knowledge capabilities and resources that are not present in their regional pools (Coenen et al. 2006, Cooke, 2005; Gertler and Levitte, 2005; Giuliani and Bell, 2005; Moodysson, 2008). This mirrors the fact that, in the globalized economy, regions cannot pretend to continue self-sustaining their innovativeness and competitiveness capacity (Amin and Cohendet, 2004; Bathelt et al., 2004; Bathelt, 2008; Tödtling and Trippl, 2005, 2011; Uzzi, 1997). Belussi et al. (2010) show, for example, that the degree of the openness of a region influences positively the firm's innovative performances. Increasing at regional level the interactions with foreign partners also increases the probability of firms performing better in terms of innovation. These recent studies in the geography of

[6] Nevertheless, the globalization of innovation with respect to the globalization of production has focused its theoretical framework on different aspects. In particular, the theoretical framework of the geography of innovation has been much more focused on the *conditions* that make possible the interactions for innovation at local and global levels and far less on the heuristic relationships that exist among different geographical levels and types of actors.

[7] Indeed, the concept of global pipelines remains mainly a generalized concept. It provides no information about which types of extra local linkages are more suitable for developing regional assets that sustain learning and innovation (Tödtling and Trippl, 2005) or about which types of RIS and type of knowledge and activities (beyond the dichotomy of tacit and codified knowledge) may be more suitable for the development of global networks.

innovation have contributed to a view of the region as an open system in which firms may have different degrees of integration with global partners and global sources of innovation (Asheim et al. 2011; Gertler, 2008).

Further research has demonstrated that the geography of innovation is influenced and characterized by the knowledge base prevailing in an industry, region or cluster (Asheim and Coenen, 2005; Coenen et al., 2006; Moodysson et al., 2008; Martin and Moodysson, 2011a, b).[8] This point of view stresses that localized sources of innovation, where tacit knowledge and face-to-face interaction occur among customers and suppliers, are more important for synthetic and symbolic knowledge-based activities. Since a consistent amount of tacit knowledge and practical experiences are exchanged here, it may be more difficult to rely on long distance interactions for innovation (Martin and Moodysson, 2011b). By contrast, analytical knowledge-based activities that characterize, for example, biotech clusters (Owen-Smith and Powell 2004; Moodysson et al., 2008) are less sensitive to proximity effects and social interaction and are instead more prone to codification processes through, for example, the sharing of formal models. Consequently, in this last type of activities, global interaction devoted to innovation becomes easier to achieve (Asheim and Gentler, 2005; Moodysson et al., 2008). These recent studies confirm that sectors or activities characterized by analytical knowledge bases link more often and better to global sources of innovation. This research contributes to highlighting that to sustain global-local linkages it is necessary to take into account the specific activities that are involved in the innovation process[9] (Moodysson et al., 2008).

The local-global nature of interactions can also depend very much on the types of RIS where firms are located according to the degree of innovation and RIS specific local and embeddedness structure of relations (Eraydin, 2005; Park, 2005). In general, different RIS have different ways of engaging in knowledge

[8] Analytical knowledge characterized by scientific knowledge and rational processes represents strategic knowledge in sectors such as biotechnologies and nanotechnologies and is devoted to the discovery and application of scientific laws. Synthetic knowledge is defined as having originated by the application of or through the new combination of existing knowledge and its construction and is often triggered by the need to solve specific problems or to answer the specific needs of customers or suppliers (one example is the engineering industry). With respect to symbolic knowledge, this is principally built on aesthetic and design attributes, and on the symbolic value of the product (Asheim et al., 2007). This last type characterizes, for example, regions and clusters oriented to fashion production.

[9] Many industries draw upon a combination of synthetic, symbolic and analytical knowledge, but the dominance of one mode in an industry or in stages of specific innovation projects has different spatial implications for the knowledge interplay between local and global actors (Asheim, 2009). Studies such as that by Gertler and Wolfe (2003) show indeed that clusters characterized by a synthetic knowledge basis (such as the Ontario Steel cluster) can draw from local but also global sources of knowledge.

linkages, developing seeking strategies for innovation at different geographical level (Asheim et al., 2011). As some recent evidence suggests (e.g. Tödtling et al., 2011), this may depend on the specific institutional framework existing within a region (Gertler, 2010; Asheim et al., 2011)[10]. Tödtling et al. (2011), conducting a study of ICT firms in Austria, show that while firms in institutionally thick RIS tend to establish more domestic linkages, firms in institutionally thin RIS[11] tend to establish more international linkages, probably to overcome the limitations of the innovation system in which they are embedded.

This underlines that differences exist not only at a sectorial level, but also at a regional level. In some regions the sources of innovations remain fundamentally local (Martin and Moodysson, 2011a; Blažek et al., 2011), while in other regions important innovation sources are also found at the global level (Chaminade, 2011; Plum and Hassink, 2011; Sotarauta et al., 2011; Tödtling et al., 2011). Other types of conditions for explaining the different tensions in the geography of innovation between local and global forces have also been analyzed. Eraydin (2005) tentatively defines how RIS and global networks are connected to each other, indicating that this may also depend on the type of partners found in vertical and horizontal relationships, the type of power relations between agents and types of specific network (e.g. value chain, academic excellence networks, technology transfer networks, global business services). The work of Fifarek and Veloso (2010), related to rare earth technologies, shows that innovation activities are concentrated in clusters or become more global depending on the type of innovation activity and on the role of the firm within a value chain in the production of technological knowledge.

By applying a 'distance to innovation' approach (Doloreux and Shearmur, 2012), other researchers have shown that it is not only geographical proximity per se that may be relevant[12], but rather the potential access to resources in that specific geographical space (McCann, 2007; Shearmur, 2011). According to these studies, the potential for innovation will be affected by the presence of specific key determinants of innovation (Shearmur, 2011).

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[10] See in particular the European Planning Studies special issue 19, no. 7 (2011).

[11] Regions can be institutionally thick or thin according to the combination of different elements (Amin and Thrift, 1994). Regions are generally institutionally thick when there is a strong organizational infrastructure (i.e. the number and diversity of organizations in that particular innovation system, high levels of interaction among local actors, a culture of collective representation and shared norms and values that serve to constitute the social identity of a particular locality (Ibid.). RIS are institutionally thin when these elements are missing and there is a lack of institutions that support innovation (Tödtling and Trippl, 2005).

[12] Boschma (2005) has contributed to downplay the role of geographical proximity for innovation and to enlighten the possibility of developing geographically distant interactions for innovation through other types of proximities (cognitive, social, organizational and institutional).

### *2.2.3 The empirical and theoretical limitations of the geography of innovation in relation to the global perspective*

The most recent contributions related to local-global interactions have partially changed the earlier perspective of geography of innovation studies. This more recent research has slightly scaled down the role of the regional interactions and increased the attention of scholars to external to the region interactions for innovation. However, the inclusion of a global perspective in the geography of innovation studies has been limited both at an empirical and at a theoretical level, and the predominant regional focus in this field of research has not permitted the same conceptual inclusiveness of the different geographical scales as the theories which have been developed under the GPN framework.

First, the geography of innovation literature has almost empirically covered exclusively geographical areas in Europe and the US, neglecting areas in other parts of the world, particularly in developing countries, even though the GPN literature has from the beginning tried to emphasize the inclusion of these economies in the debate (Ernst, 2002; Coe et al., 2004). The geography of innovation literature has instead focused on studying the geography of innovation in selected well-known or successful clusters and regions in developed economies (e.g. Owen-Smith and Powell, 2004; Bathelt et al., 2004; Coenen et al., 2004; Genter and Levitt, 2005; Moodysson, 2008; Moodysson et al., 2008; Tödtling et al., 2011). As pointed out almost one decade ago by Zhou and Xin (2003), the lack of contributions on the role of regions in emerging economies still needs to be filled. This gap is discussed in section 2.2.4.

Second, in the geography of innovation field of research, the relevance and presence of global interaction for innovation seems to be determined by the existence of specific conditions (related to the existence of certain types of knowledge-based activities in the region or the presence of specific types of regional institutions). In emerging economies, the presence of global interaction may follow different types of conditions. This is discussed in section 2.2.5, where the relevance of global interaction for innovation in emerging economies contexts is clarified using evidence from innovation, development studies and international business.

Third, global interaction considered in geography of innovation studies has regarded almost exclusively the study of the global sourcing of innovation[13] (e.g.

[13] The global sourcing of innovation for researchers in this field is usually considered to be both market and technological knowledge acquired, for example, through personnel who have been internationally recruited, participation at international fairs and exhibitions, the use of international market surveys, the use of international journals or magazines, scientific

Blažek et al., 2011; Moodysson et al., 2008; Martin and Moodysson, 2011ab; Sotarauta et al., 2011; Tödtling et al., 2011), leaving to other literature fields (e.g. innovation studies) the investigation of other modes of globalization of innovation. This is discussed in sections 2.2.6.

### *2.2.4 The ex(in)clusion of emerging economies in the geography of innovation*

As Dicken (2004) underlines, economic geographers can tend to be 'parochial' in the selection of the part of the world upon which they focus their attention. Yeung and Lin (2003) and Yeung (2009), in their epistemological discussions on economic geography studies, explain how the representation of Asia (besides Japan) has been often under-theorized. They also state that the ongoing debate between the local and global levels should be re-addressed and enlarged beyond the study of European and North America regions to be able to bring new insights into theories.

As stated in the previous section, most of the work related to mapping and investigating the geography of innovation has focused empirically on well-known and selected clusters and regions in the most industrialized part of the world, in particular in Europe and North America. To quote some examples: the Boston biotechnology region by Owen-Smith and Powell (2004); the film industry in Los Angeles, the advertising industry in London, the high-technology cluster in Silicon Valley by Bathelt et al. (2004); the Canadian biotechnology clusters and provinces by Genter and Levitt (2005); Medicon Valley, the Life-Science and the Moving Media Industry in the Skåne region in Sweden by Coenen et al. (2004), Moodysson (2008), Moodysson et al. (2008) and Martin and Moodysson (2011ab); the Aachen technology region in Germany by Plum and Hassink (2011); the Vienna area by Tödtling et al. (2011) or the Quebec provinces by Shearmur (2011).

Moreover, the role of the region in innovation and growth has been largely demonstrated for regions in developed countries, while there have been few and only recent contributions in developed countries, particularly emerging economies. From a theoretical point of view, Asheim and Vang (2006) attempt to formulate a

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publications, licenses and patents, but also through collaborations with global partners. Research in this field looks at the conditions for global sourcing, as well as the implications that global sourcing may have for the region, assuming a 'passive' role of the region as a recipient of knowledge. Therefore, no theoretical distinctions in these studies are made between the different modes through which a region may participate in globalization of innovation processes that can point out also to a more 'active' role of the region (as in the case of firms' R&D collaborations).

first re-conceptualization of the role of the region in Asia by looking at the relevance that external capital and foreign MNCs may have for the growth of two specific regions: Shanghai (China) and Bangalore (India)[14]. Li (2009), in an empirical study of 30 regions in China with historical data from 1998 to 2005, demonstrates that innovation activities are distributed unevenly among Chinese regions and that the changes in institutions and policies in different regions are mainly responsible for the different quality of innovation performances. The recent work of Fu et al. (2012) in Shenzhen and Dongguan in China shows, by applying a more institutional approach, how the two different regional innovation systems have been strongly shaped by the different path dependent nature of governance. The work of Chaminade and Vang (2008) in India, through qualitative analysis, demonstrates how the specific regional system in Bangalore has facilitated the transition of the software cluster from competing on cost towards also competing on innovation.

Despite these attempts, there are a lack of studies that look specifically at the role of the regions in emerging economies in sustaining firms' globalization of innovation processes or at the complementary role that regional interactions for innovation play in those countries with respect to interactions for innovation developed at a global level (Chaminade, 2011). Indeed, the elaborated theoretical frameworks in geography of innovation research tested mainly in regions in developed countries may not be suitable for regions in developing countries, where the socio-economic and institutional conditions may be very different (Wang and Tong, 2005; Yeung, 2009, 2010).[15] Many scholars of international business have in general underlined how emerging economies like China has developed a very peculiar institutional change that is unprecedented and that needs to be taken into account when analyzing the expansion of these economies into international markets (Peng, 2003, Peng et al., 2008; Gao et al., 2010). In addition, the growth dynamics of regions in emerging economies seem to be quite different from those in regions in developed countries (Schiller, 2012), showing a much more rapid change that may affect the degree of efficiency of regional interactions for innovation. As Mackinnon (2002) underlines *'[…] Much recent research in economic geography fails to address questions of adaptation and*

[14] Also the works of Fromhold-Eisebith (1999; 2002) show the relevant role of MNCs for the growth of RIS in less developed countries (i.e. Bangalore).

[15] For example, the framework developed by Tödtling and Trippl (2005) to isolate the specific conditions related to different types of RIS that characterize peripheral regions, old industry regions and fragmented metropolitan regions in developed countries and that shape firms' local-global interactions may not apply to developing countries, which are usually characterized by a much more structural and general lack of socio-economic and institutional conditions.

*renewal in terms of how regions can sustain growth in the face of rapid changes in technologies and markets […]'* (p. 306).

The RIS literature and geography of innovation research suggest that, despite possible global linkages, the region should remain a key geographical level at which innovative capacity is shaped. Nevertheless, because of the existence of different conditions in emerging economies, it is still unclear if the regions in these countries have the same relevant role in shaping innovation as in developed countries. Does the inclusion of emerging economies in the geography of innovation research change some of the key concepts theoretically developed in the European and North American regions? As suggested by Yeung (2007) the inclusion of emerging economies may provide an extremely fertile ground for the development of new concepts, methodological innovations and existing theories. As we will see in the next section, firms in emerging economies, may depend more on foreign technologies and therefore on the global interactions (Fu et al., 2011; Pietrobelli and Rabellotti, 2007; Lundvall et al., 2009a). Yeung (2010) and other economic geographers (such as Fromhold-Eisebith, 1999, 2002; Schiller, 2012) underline also that in development dynamics of East Asian regions, exogenous forces and in particular the translocal networks may have played a much more important role than the endogenous regional forces:

'These endogenous approaches […] are perhaps more appropriate to the study of advanced industrialized economies because most regions and territories in these economies have established substantial territorialized assets in the forms of immense social capital, pro-growth institutions, absorptive capacities, and so on. When applied uncritically to the East Asian context, however, these endogenous approaches tend to run out of their contextual specificity and become too narrow and myopic […]' (Yeung, 2010, p. 8).

### *2.2.5 Local vs global interactions in developing countries: evidence from other disciplines*

The concept of 'global' in the geography of innovation studies should include both a higher degree of geographical inclusion and a more extensive consideration of the weight and types of global interactions. In particular, how do these global interactions complement local interactions in developing countries, particularly in emerging economies?

In general, the contributions related to the analysis of global interactions in sustaining growth in developing countries have been derived more from the literature on innovation, economic development and international business than strictly from the economic geography discipline (Humphrey and Schmitz 2002;

Marin and Arza, 2009; Morrison et al., 2006; Pietrobelli and Rabellotti, 2007).[16] Innovation and development studies have often been combined (Lundvall et al., 2009b),[17] offering some investigation into the mechanisms connecting firms with their regional/national and global knowledge providers and collaborators for innovation. Padilla- Pérez et al. (2006), while studying two regions in Mexico, demonstrates not only the importance of regional conditions and interactions for development and sustaining firm innovation, but also the importance of interaction with foreign subsidiaries. Pietrobelli and Rabellotti (2009, 2011) instead show the relevance in developing countries of combining the national system with global interactions. In other words, the potential participation in innovation processes of indigenous firms in developing countries is conditioned both by the quality and governance type of the GVC in which firms participate and the quality of the National Innovation System that sustains the indigenous development of capabilities and absorptive capacities.[18]

In demonstrating the importance of foreign technologies for indigenous innovation (Lundvall, 1992; Hobday, 1995), scholars from these branches of research and from international business have clearly shown that regions/nations from developing countries are open systems with global linkages of a different nature. Evidence shows that firms in developing countries (particularly emerging economies) rely strongly on the international acquisition of technologies and therefore on technological imports, for example, of machineries and equipment that may not be available in the local environment (Gereffi, 1999; Gereffi and Kaplinsky, 2001; Gereffi et al., 2005; Ernst, 2002; Giuliani et al., 2005; Humphrey and Schmitz, 2002; Lee et al., 1988; Morrison et al., 2006). We also know that the technological spillovers from foreign MNCs located in these countries and the spatial proximity between the MNCs affiliate and local suppliers are relevant for sustaining firms in their innovation processes and, to a lesser extent, their internationalization/globalization processes (Ariffin and Bell, 1999; Cantwell and Piscitello, 2007; Dunning, 1993, 1994; Hobday, 1995, Lall, 1978; Radoševic, 1999; Ivarsson and Alvstam, 2004, 2005ab, 2009, 2010, 2011; Saliola and Zanfei, 2009). Taking the perspective of the country of origin of FDI, the recent theory of MNCs in the international business literature has also emphasized how foreign firms from the most catching up developing countries are locating knowledge-intensive activities abroad not only to exploit, but also to augment their

[16] See also UNCTAD reports (published in various years) and the recent Handbook of Innovation Systems and Developing Countries edited by Lundvall et al. (2009a).

[17] As discussed by Lundvall et al. (2009b), many researchers dealing with developing countries have taken advantage of a combination of research in the field of innovation systems and development economics to study the technological catching up of those countries.

[18] Absorptive capacity is defined as *'the ability of a firm to recognize the value of new, external information, assimilate it and apply it to commercial ends*' (Cohen and Levinthal, 1990, p. 128).

competitive advantages (Dunning and Narula, 1995; Kuemmerle, 1999). Almost all new emerging MNCs from those countries highlight their global knowledge-seeking strategies, especially with the development of affiliates in the developed world (Athreye and Kapur, 2009; Barnard and Cantwell, 2008; Duysters et al., 2009; Niosi and Tschang, 2009). In this way, MNCs' strategies are devoted to developing geographically dispersed networks between parent companies and affiliates to facilitate the transfer of technology, skills and assets to the country of origin (Cantwell and Piscitello, 2005). Foreign MNCs are seen here as key points for facilitating connections between the local and global contexts (Cantwell and Iammarino, 2002; Archibugi and Iammarino, 2002).

As demonstrated by studies of innovation, development and international business, owing to the strategic role of global interactions in developing countries, the evolution of the global-local debate in the geography of innovation should be followed by expanding the analysis of different typologies of global interactions, particularly with the aim of capturing adequately the different modes of participation in the globalization of innovation process of firms and regions from these countries.

### *2.2.6 Globalization of innovation framework to study other forms of global interactions*

While studies into innovation and international business have extensively analyzed and discussed different modes of global interaction for innovation (i.e. different technology transfer mechanisms involving global knowledge) such as international trade, technology imports and outward FDI (Radoševic, 1999; Dunning, 1994; Lall, 1992), the geography of innovation research field in economic geography has focused on studying the technology and market sources of innovation.

Even though global sources of innovation as treated in the economic geography may be considered to be an important mode of global interaction for innovation, they show only one direction of the global flow of knowledge/innovation from the rest of the world to the region, as the global pipelines concept defined in Bathelt et al. (2004) does. This not only stresses the passive role of the region as a mere recipient of innovation, but also gives a partially global perspective on the types of relations that the region and firms located within the region can build with global actors and develop at a global level. The concept of 'global' in the geography of innovation has thus been explored only partially because the types of global interactions analyzed have been mainly limited to showing one direction.

The inclusion of other modes of global interactions for innovation (e.g. global research collaboration, the global generation of innovation through the out-bound location of R&D to the rest of the world or the global exploitation of innovation through the global export of new products and services) could theoretically enrich the local-global debate, thereby contributing to the globalization of innovation, namely the flow of innovation from the region to the rest of the world.

As discussed in section 2.2.5, the innovation literature has paid great attention to the different modes of global interaction for innovation and their possible positive effects on firms and local contexts. In particular, Archibugi and Michie (1995) carefully consider the different modes of interactions in the globalization of innovation in innovation studies. Their contribution drew academic attention at the end of the 1980s and beginning of the 1990s towards the technological advancement and internationalization of trade and business collaboration in more advanced countries. They argue that the globalization of innovation cannot be considered to be a single phenomenon. They distinguish between the global exploitation of technology, the global generation of technologies and global technological collaboration. These modes resemble different types of global interactions where the flow of innovation can take different directions. In their work, *the global exploitation of technologies* refers to firms' exploitation of their technological outputs in the international markets. *The global generation of technologies* refers instead to the development of FDI by MNCs. Finally, *the global technological collaboration* refers to the ability to develop innovations involving other firms and organizations such as universities and government research agencies in other countries.[19] The seminal work of Archibugi and Michie (1995) is a good framework to introduce other forms of global interactions besides global sourcing into the geography of innovation studies, because it considers recognized modes of interactions for innovation that happen at a global level in some depth, although it takes a more macro perspective and uses very few technological indicators. In particular, the principal use of patents and technological cooperation agreements indicators limits the set of tools

[19] The different modes of globalization of innovation may also be considered to be the consequence of two strategies: asset exploiting and asset seeking (Castellani and Zanfei, 2006; Dunning and Lundan, 2009). Asset exploiting commonly refers to the development of new markets for existing products or services (Castellani and Zanfei, 2006), but it is often used in the innovation literature to refer to the export of innovations (Chen et al. 2009). Asset seeking alludes to the objective of acquiring knowledge assets that may not be available in the local environment. Global collaboration for innovation or global generation of innovation may be considered to be asset-seeking strategies.

necessary to investigate widely the modes of participation of firms and regions in the globalization of innovation processes.[20]

This thesis expands and reframes Archibugi and Michie's (1995) taxonomy of the different modes of globalization of innovation. First, the different modes of globalization are investigated through a direct analysis of firm's experiences and strategies in relation to innovation.[21] Second, the thesis considers the different modes of globalization of innovation also in relation to regions in emerging economies.[22] Third, a broader definition of innovation is applied.[23] Finally, a fourth mode of globalization of innovation is added to the taxonomy, namely the global sourcing of innovation which is traditionally considered also on the geography of innovation studies and that we have previously shown to be relevant in the context of emerging economies.

The taxonomy used in the thesis is as follows:

*The global exploitation of innovation* refers to the specific firms' strategies[24] to access international markets with new products or new services. The *global generation of innovation* refers instead to firms' offshoring of innovation activities both internal and external to the firm for the purposes of serving the home country or global markets in a location outside the firm's home country. *Global research collaboration* alludes to firms' joint development of know-how or innovation with the participation of partners from more than one country. This collaboration may take a variety of forms, from generic research collaboration at an informal level to specific R&D joint-ventures, R&D alliances and contractual R&D that involve a variety of actors, including firms, research centers, universities and the government. *Global sourcing of innovation* (technology) refers to the international

[20] The Global exploitation of technologies is mainly measured by the numbers of patents extended in foreign markets; the global generation of technologies has been proxied by the patents of multinationals developed outside the multinational home countries; the global technological collaboration has been proxied by counting the number of technology cooperation agreements developed at an international level.

[21] This mirrors in particular the Oslo manual indications: instead of investigating innovation phenomena through the exclusive use of traditional indicators (e.g. patents and formal agreements), the new orientation (e.g. the Community Innovation Survey) monitors the specific innovations carried out by firms by asking firms the questions related to their innovation activities and strategies (OECD, 1997).

[22] Archibugi and Pietrobelli (2003) carried out the first attempt to explore the impact of the different modes of globalization of innovation in emerging economies, but the results of the research were limited and the authors claimed that further research was required.

[23] In this thesis the firm's innovation is also classified on the basis of the product and service novelty on the market (e.g. new to the firm; new to the country and new to the world) and not only in relation to its technological output.

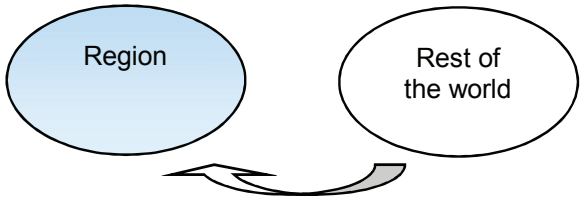
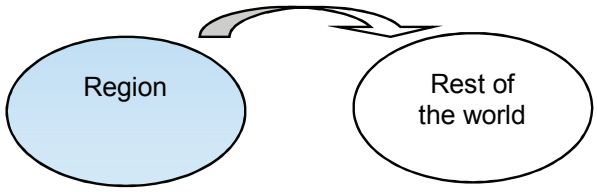
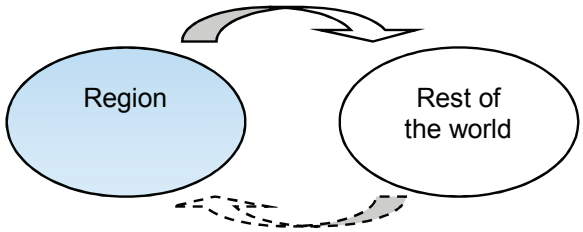
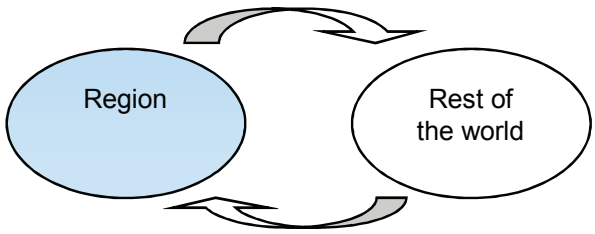
[24] While Archibugi and Michie (1995) examine patents developed abroad, this thesis looks at the specific strategies undertaken directly by firms approaching the international market.

acquisition of extramural R&D, machinery and equipment, other external knowledge and training mainly defined as in the Community Innovation Survey.

The four modes of globalization of innovation analyzed in this thesis indirectly point out to the directions of innovation flow: from the rest of the world to the region in the case of global sourcing, from the region to the rest of the world in the case of global exploitation of innovation and global generation of innovation (although in this last case there is also a reverse effect to the region[25]) and bidirectional cross-border innovation flows involving firms in the region and firms and organizations in the rest of the world. In this way, the thesis aims to overcome the limited perception of global interactions in the geography of innovation. Fig. 2 shows how these modes of globalization of innovation have been principally treated in the thesis.

[25] Even though the direction of innovation flow is from the region to the world, the generation of innovation often corresponds to an MNC's asset-seeking strategies: MNC's offshore activities in other locations also to transfer knowledge into the country of origin (Cantwell and Piscitello, 2005). In this respect, as this model points out innovation flows from the world to the region as well.

**Figure 2. Modes of globalization of innovation analyzed in this thesis**

| Mode of globalization of innovation | Activities included in this mode of globalization |
|---|---|
| Global sourcing of innovation (Flow of innovation to the region)<br>  | Source of technology or knowledge from an international organization (clients, suppliers, consultancy etc.) including:<br>• International extramural R&D<br>• International acquisition of machinery and equipment<br>• International acquisition of other external knowledge |
| Global exploitation of innovation (Flow of innovation from the region)<br>  | Use of new products or services mainly as a strategy to access international markets |
| Global generation of innovation (Flow of innovation from the region, but often exploited back by the region)<br>  | Offshoring of innovation 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 |
| Global research collaboration (Flow of innovation from and to the region)<br>  | • International research collaboration with other firms<br>• International research collaboration with other universities and research centers |

## 2.3 The insertion of a firm level perspective into the geography of innovation

### *2.3.1 Including firm level factors in the geography of innovation*

In the geography of innovation literature, the main attention of studies is the capacity at a meso level (regional and sectorial) to support innovation processes. The region has therefore been interpreted frequently as a coherent object of study, almost as an individual with unique qualities (MacKinnon et al., 2002; MacLeod, 2001; Shearmur, 2011). However, the specific characteristics of firms and individuals on the geography of innovation have been almost ignored particularly the fact that the interaction for innovation depends not only on the region and quality of the RIS but also on the absorptive capacity of single actors (individuals and firms) (Giuliani, 2007; Maskell, 2001; Moodysson, 2008). In the case of individuals, the exchange of knowledge related to innovation can depend on profession, friendship relation and specific specialization (Moodysson, 2008). In the case of firms, this may depend on size, organizational form, and quality of the internal R&D and absorptive capacity (Blanc and Sierra, 1999; Cohen and Levinthal, 1990; Dunning, 2001; Giuliani, 2007; Giuliani and Bell, 2005). Giuliani and Bell (2005) show the fundamental role that certain 'star' firms in a Chilean wine cluster have as gatekeepers for the other cluster firms in sustaining the local-global interaction. In another work, Giuliani (2007) empirically investigates Italian and Chilean wine clusters and shows that knowledge is not uniformly distributed in a cluster because of differences in firms, for example, in terms of capabilities. The conclusion that can be drawn from these two works is that the micro level may affect the structure of knowledge interactions at the meso level.[26]

The analysis of micro factors seems to be particularly important when considering developing countries. Innovation and development studies confirm that in such contexts, if a firm does not develop a minimum level of internal technological capabilities, this can hamper its ability to upgrade and engage in both innovation and internationalization processes (Bell and Pavitt, 1993; Fu et al., 2011). The meso dimension (regional or sectorial) may therefore begin to become relevant only after firms have developed a minimum level of innovation

[26] Tödtling et al. (2009) in their empirical analysis of regional interactions for innovation also take into consideration the internal capabilities of the firm (R&D and patents). However, discussion of these factors in the paper is limited. Another attempt to combine the meso and micro level in the geography of innovation field was that of Srholec (2010) who works more in the field of the economics of innovation. In his work, he demonstrates empirically that in the Czech Republic both the regional framework and the firm level factors influence the probability to innovate of a firm.

capabilities[27] or absorptive capacity to interact with external partners, especially on a global scale (Chaminade and Vang, 2008; Cohen and Levintal, 1989, 1990; Fu et al., 2011). Internal resources and capabilities can be seen in these contexts not only as positive factors shaping globalization and innovation, but also as essential factors for catching up processes in those economies. Firms' internal capabilities become crucial, for example, for developing a minimum level of absorptive capacity that can benefit both the adoption of foreign technologies and collaboration with external partners (Cohen and Levinthal, 1989; Fu et al., 2011).

Despite the rapid growth of China and India in the international arena, it is important to remember that they remain developing countries. Therefore, the development of firms' internal technological capabilities[28] for developing global linkages may compensate for eventual weaknesses related to domestic/regional innovation systems (Ernst, 2002). It thus follows that firm level factors such as firms' resources and capabilities need to be taken into account adequately in these economies when discussing local-global interactions for innovation.[29]

The inclusion of firm level factors in research calls for the use of an interdisciplinary approach to the problem which can combine different points of investigation. Theories developed from the GPN perspective clearly underline the use of a combination of the micro perspective used in international business studies with the meso and macro perspective used in economic geography (Pellenbarg and Wever, 2008). This is because both the organizational and the institutional levels at different scales as well as the position of each single actor in the governance structure of the network need to be taken into account (Dicken, 2008, 2011b). The school of Gothenburg (e.g. Ivarsson and Alvstan, 2005ab; 2009; Ström and Wahlqvist, 2010), or the recent contribution of German geographers (e.g. Fromhold-Eisebith and Fuchs, 2012; Schiller, 2012) are good examples in this respect, bringing about new insights into the geography of international economic interactions and transnational firms or industrial transitions. The specific field of the geography of innovation studies would benefit

[27] The literature on innovation related to developing economies has mainly underlined how the innovation capabilities in those countries are often behind the technological frontier: they are incremental and imitative, confined often to the firm's operations (Kim, 1997; Knell and Shrolec, 2009; Shrolec, 2011).

[28] Technological capabilities in developing countries have been investigated by many authors since the 1980s (Bell and Pavitt, 1993; Dahlman et al., 1987; Ernst et al., 1998; Hobday, 1995; Katz, 1987; Kim, 1980; Lall, 1990; Lee et al., 1988).

[29] Moreover, as demonstrated already in studies related to GVC/GPN firms from emerging economies are usually engaged in captive forms of relationship with buyers from developed countries due to the lack of internal capabilities (Gereffi et al., 2005). The development of internal capabilities is therefore even more fundamental in global network related to innovation for increasing the catching up processes by these economies.

from the influence of the international business discipline. Nevertheless, while the contributions by a micro approach into the geography discipline have been regarded mainly 'the relational aspects' of the GPN perspective (i.e. the analysis of firms institutional and organizational changing in respect to routines and power relations), taking into consideration the context of emerging economies it would also be particularly important to investigate the specific firms' resources and the competences necessary for the participations of firms and regions in these area in the global geography of innovation. This thesis aims to make a contribution in this direction by investigating regions in China and India with a particular consideration to both firm level factors that in the international business literature have been considered to be important in shaping both innovation and internationalization and the regional factors traditionally considered in economic geography.

### *2.3.2 Firm level factors shaping innovation and internationalization*

Since the 1980s, the resource-based view (RBV) literature (Barney, 1986, 1991; Kogut and Zander, 1992; Lippman and Rumelt; 1982; Penrose, 1959; Rumelt, 1984, 1987; Teece et al., 1997; Wernefelt, 1984) has emphasized that firms build their competitive advantages through their unique tangible and intangible internal factors. While the RBV has mainly concentrated on which firm level factors sustain firms' competitive positions and innovation, the international business literature has principally studied the firm level factors that sustain internationalization processes. With the introduction of the eclectic OLI framework[30] (Dunning, 1980), the international business literature, applying a conceptual similar framework of firm's resources based view (Wang et al., 2012), has started to demonstrate how factors such as firm size, ownership structure, the characteristics of managers, previous experiences in the market may be important determinants of firms' international strategies and performance (Bonaccorsi, 1992; Calof, 1994; Dean et al., 2000; Dunning, 1980, 1988; Fritch and Lukas, 2001; Harvey and Novicevic, 2000; Johanson and Vahlne, 1977; 2009; Kleiknetch and Van Reijnen 1992; Moen, 1999; Sousa et al., 2008; Vonortas, 1997)[31]. The international business literature then focused an important part of the studies on the investigation of the firm's technological resources and capabilities (Basile,

[30] The OLI framework is the combination of three advantages: O (ownership of firm resources that can be capitalized internationally); L (location) and I (internalization of firm specific advantage) that determines the firm's propensity to internationalize.

[31] The previous contribution by Hymer (1960) and Vernon (1966) attempted to demonstrate that some factors such as the firm's stage in the product life cycle or its technological capacity may explain the firms' internationalization.

2001; Özçelik and Taymaz, 2004; Rodríguez and Rodríguez, 2005; Roper and Love, 2002, Tseng et al., 2007; Chen and Hennart, 2002).

While a technological resource can be defined as a general system or factor that embodies knowledge (Leonard-Barton, 1992)[32], the technological capability is instead defined as *'the ability to make effective use of technological knowledge in efforts to assimilate, use, adapt and change existing technologies*' (Kim, 1997, p. 4).[33] Much of the literature has in recent years been devoted to understanding which of these capabilities and resources may determine the outward FDI related to strategies of resource-exploitation, asset-seeking and knowledge sourcing (Wang et al., 2012). With the increased internationalization of innovation, the focus has also moved to technological resources and capabilities more directly related to increasing innovation (Castellani and Zanfei, 2006; Ito and Wakasugi 2007; Kyläheiko et al., 2011).

Human capital[34] is considered to be crucial as a *technological resource*, (Hatch and Dyer, 2004; Hitt et al., 2001). A high quality of human capital is one of the main determinants of a firm's competitive advantage (Itami, 1997) and it is considered to be a key resource for sustaining innovation (Cohen and Levinthal, 1990; Dantas et al., 2007; Giuliani and Bell, 2005; Liu et al., 2009; Romijin and Albaladejio, 2002; Srholec, 2010; Vega-Jurado et al., 2008). The machinery and equipment in use is also shown to be another important resource to determine the level of technological output and innovation performance (Huang et al., 2011; OECD, 1996; The OECD observer, 1997).

*Technological capabilities* in the literature instead can be classified in terms of theoretical framework, unit of analysis and degree of performance (e.g. Bell and Pavitt 1995; Ernst et al., 1998; Kim, 1999; Lall 1992). In this thesis I distinguish between product-related technological capabilities and process-related technological capabilities (Lall, 1992). In product-related technological capabilities, the determinants for increasing innovation include R&D capabilities (Dantas et al., 2007; Romijin and Albaladejio, 2002; Srholec, 2010; Vega-Jurado et al., 2008). Together with human resources, internal R&D capabilities are considered in international business to be crucial firm level factors for sustaining not only a generic expansion of the firm into international markets (Gustavsson et al., 1999; Rodríguez and Rodríguez, 2005), but also for the international

[32] A technological resource is, for example, human capital or the system of machinery and equipment presents in the firm.

[33] The capability with respect to a resource generally implies the *'learning and accumulation of new knowledge on the part of the firm'* (Iammarino et al., 2010, p. 3).

[34] Human capital is composed by individuals with different skills, education, training and experiences.

exploitation of innovation (Yang et al., 2010; Lin et al., 2006). Some research has emphasized that internal R&D may also be a determinant of R&D collaboration with global partners (global collaboration for innovation), or a capability that may help to absorb global knowledge for increasing innovation performances (global sourcing of innovation) or to establish R&D centers abroad (global generation of innovation) (Fu et al., 2011; Shmiele, 2012). With regard to process-related technological capabilities instead, I include the introduction and use of new processes. The practices of quality management, for example, have been shown to be relevant for innovation (Prajogo and Sohal, 2006; Perdomo-Ortiz et al., 2009, Hung et al., 2011). [35]

In sum, the geography of innovation has suffered from 1) a lack of inclusion of developing economies contexts, 2) a limited analysis of global flows of innovation and 3) a limited attention to the firm level characteristics. This thesis contributes to these research gaps by bringing together the micro and meso dimensions to study regions in emerging economies. Meso and micro levels are combined to test if both the region and the firm level factors have a role in explaining the participation of Indian and Chinese firms in the different modes of globalization of innovation (article 1). They are also used to assess if resources and capabilities affect different types of strategies undertaken in global markets by firms located in Chinese and Indian regions (article 2), and to show that there are significant differences across regions with regard to the geographical spread of the networks and the modes of globalization of innovation (article 3). Lastly, to show how some modes of globalization of innovation and some specific firms' capabilities are fundamental for firms located in Chinese and Indian regions for sustaining higher innovation performances (article 4).

## 2.4 Theoretical reflections

This chapter illustrates the current state of the art in the geography of innovation literature. It shows how this field of research has become delinked from the geography of production and from the use of a GPN perspective, with a preference for studies of successful regions in developed countries and with a framework mainly based on the RIS perspective. The second chapter discusses the fact that the currently changing geography of innovation, involving regions in emerging economies, may affect some of the theories developed in this research field. In particular, it shows how to overcome the current gaps in the field related to the under-investigated global and micro dimensions through the use of a more

[35] In the thesis I also consider the specific structural characteristics of firms such as size and organizational form.

interdisciplinary theoretical approach. Some other theories in innovation and international business studies are illustrated within an attempt to integrate and adapt them to the current framework in the geography of innovation.

When studying firm level factors, the theory used in this chapter has been mainly based on the RBV theory. This theory has been preferred over other theories used in international business studies that instead apply institutional, network or evolutionary perspectives (Dunning and Lundan, 2008). The decision to focus on RBV derives mainly from the idea that a first study of which internal resources and capabilities may be significant for firms located in emerging economies is necessary for understanding the catching up processes. The simple ability to acquire, absorb and deal with information and knowledge may be a very important factor in these economies to compete with strong regions in developed countries. Moreover, as Dunning and Lundan (2008, 121) point out, global asset-seeking investments relative to knowledge intensive activities (innovation) depend more than asset-seeking investments related to production on the specific resources and capabilities owned by the firm. The nature of the activity (innovation and not production) has been another point in favor of an RBV perspective.

The use of RBV theory for studying the micro dimension has nonetheless some limitations and the reader needs to be aware that on a micro level these theories may help to explain only partially the globalization strategies related to innovation. If on the one hand the thesis has emphasized the relevance of regional institutions through a RIS perspective, at the micro level the resources based view gives indeed little attention to the institutional part of managerial decisions and to the cultural patterns of work organization (Dunning and Lundan. 2008, 126-127). When considering the micro dimension, studying institutions implies taking a much more relational approach to the internationalization theories. One topic that has not been investigated in this thesis, and which is central to the GPN perspective, has been the organizational nature of the relations, the distribution of power among the networks, and the evolution of these relations (Dicken, 2011b; Johanson and Vahlne, 2009). The study of the power asymmetry among different actors around the world in the different modes of globalization of innovation may help to disclose in depth the real competitive position that firms and regions in emerging economies have in the changing geography of innovation. A definition of the structure and property of the network may help also to define more clearly how global networks should be linked to a specific RIS (Eraydin, 2005). A question about these considerations comes naturally: Which part of the value created in the changing geography of innovation can be really retained by firms and regions belonging to emerging economies? This question certainly deserves further attention and requires the use of a more institutional perspective, possibly

rethought in the light of the nature of innovation activities and of the recent trends involving firms and regions from emerging economies.

Different scholars from international business studies - in particular those concerned with FDI theories - have also pointed out the importance of looking at national institutions and specificities (Rondinelli, 2005; Dunning and Lundan, 2008). Despite the role of the region, we have to recognize the different role that the State, for example, may have in emerging economies (Dicken, 2011c; Dunning and Lundan, 2008). In countries like China, globalization seems to be more the result of a top-down approach fostered by national and local governments than the result of a bottom-up process realized by entrepreneurs.[36] This may also have consequences for the specific dynamics of regional development (Wang and Tong, 2005; Schiller, 2012). Last but not least, in discussing the changing geography of innovation, we also need to be aware of the existence of sectorial specificities behind the ones related to different type of knowledge bases. Sectors have also different characteristics for example in terms of industrial technologies, structures and dynamics (Malerba, 2005; Pavitt 1984). In the thesis I will consider 3 specific sectors, but it is behind the present scope to investigate in detail these other aspects.

[36] This is at clearly evident in the case of China, also because of the participation in the economy of many State-owned enterprises.

# Chapter 3 - Method

## 3.1 Method of investigation: comparative analysis

The method of investigation concerns the modality that a researcher selects to investigate the problem formulation. As an important research question, the thesis aims to test if some of the general assumptions in the literature on the relevance of the region in shaping the geography of innovation also apply to regions in emerging economies. The thesis aims in particular to investigate in these contexts the role of the region as well as of firm level factors in explaining and sustaining firms' innovation performances and their participation in the globalization of innovation. These problem formulations have been approached through the method of *comparative analysis*. Comparative analysis is commonly used in social sciences (Bristlin, 1976; Hantrais, 1995). In particular, this method is normally useful when it is necessary to identify, analyze and explain both similarities and differences across different objects of analysis and to understand better these differences in terms of social and institutional conditions (Hantrais, 1995). One of the problems of comparative analysis is the difficulty for a researcher accessing databases that can be comparable (Hantrais, 1995). This might explain why in the specific field of geography of innovation comparisons in terms of regions in emerging economies have until now been rare (Asheim and Vang, 2006). In this thesis, comparative analysis both in terms of regions and in terms of sectors was possible thanks to the types of databases used. The two primary databases used for this study (see section 3.3) are based on two surveys that have been designed from the beginning to ensure the maximum comparability of the results in terms of countries/regions and sectors.

Following the main trend in comparative research (Deutsch, 1996), the empirical approach of this thesis is mainly quantitative, since this easily allows us to contrast the same data and evaluate whether the findings can in some way be generalized. Quantitative analysis is also very useful when the theoretical background arises from a deductive mode of argumentation that needs to be confirmed, when the main goal is to create an overview of a problem and when it is necessary to test some hypotheses (Olsen and Pedersen, 2005). Yin (2003, p. 6) underlines that surveys and quantitative analysis may be used for exploratory types of investigations and when the aim is to describe the incidence of a phenomenon, as in the case in this thesis.

## 3.2 Research setting

As discussed in the previous section, this thesis used comparative analysis of regions and sectors as its main method of investigation. In terms of regions, the thesis analyzes and compares two regions in emerging economies: one in India (Pune) and one in China (Beijing)[37]. In article 3, comparisons are done also at a larger scale by comparing different regions not only in China and India (Pune and Beijing included), but also in Europe. In terms of sectors, the thesis analyzes three sectors: green biotech; automotive components and software.[38] This section aims to discuss this research setting.

### *3.2.1 Geographical focus: Pune (India) and Beijing (China)*

The geography of innovation research has almost exclusively limited its empirical analysis to regions in Europe and North America, although evidence about the entrance of some regions in China and India in the global geography of innovation are increasing. This thesis uses as its geographical research setting regions in these two emerging economies to expand the debate on the geography of innovation.

Regions in China and India are interesting examples to investigate since in these two countries the participation of firms in innovation activities is increasing (Altenburg et al., 2006, 2008; Chaminade and Vang, 2008). Almost all the large MNCs from the developed countries have now established some activities in these emerging economies and many of them are also increasingly relocating their R&D activities and knowledge-intensive functions in some successful regions (Altenburg et al., 2006; Asakawa and Som, 2008; Chen, 2007; Gereffi, 2009; Karlsson, 2006; OECD, 2008; Reddy, 2011; Tung, 2005). Even though India has not developed the same intensive growth as China in terms of science and technology (S&T) activities (Valli and Saccone, 2009), both countries are increasing their research output while developed economies like US and Europe are carrying out less research (Global market institute, 2010).

Despite the majority of innovations in these two countries being of an incremental or marginal nature (Kim and Nelson, 2000; Li, 2009; Srholec, 2011; Zhou and Xin, 2003), in recent years the number of cases of important product

[37] Article 2 analyzes the same two regions in China and India as that in articles 1 and 4, with the only difference that the region in China in this second paper is defined as Jing-Jin-Ji, since it includes also a minor numbers of firms that are located close to Beijing in the neighboring provinces of Tianjin and Hebei.

[38] In article 3 the sector analyzed is ICT (that is, software and telecommunication equipment).

innovation has also increased (Asakawa and Som, 2008; Christensen et al., 2010). There is even some evidence of the increasing development of more radical innovations from China and India that are been exploited in other parts of the world. One example is the nano car developed by Tata Motors in India. Since the mid-1990s, China has also gradually increased its development of high-tech products (Chen, 2007; Valli and Saccone, 2009). Several reasons seem to be behind the general economic growth and shifting of these countries towards innovation:

- In recent years, China and India have shown an important upgrading of their indigenous innovation capabilities (Asakawa and Som, 2008; Chen, 2007; Medcof, 2007; Parthasarathy and Aoyama, 2006). For example, from the beginning of the new century in less than eight years China and India has increased the numbers of patents by seven and three times respectively (Fu et al., 2011). The upgrading of capabilities has also been sustained by the presence of foreign MNCs in terms of the positive effect on technology transfer to local firms and the general upgrading of the capabilities of indigenous suppliers (Buckley et al., 2002; Eden et al., 1997; Ivarsson and Alvstam, 2005ab, 2009; 2010, 2011; Kokko et al., 1996; Motohashi and Yuan, 2010).[39]

- A second important reason is the fact that China and India have recently increased the availability of low cost but well-trained human capital, particularly engineers, which is also an important point of attraction for many MNCs from developed countries (Hu and Jefferson, 2004; Li and Scullion, 2006; Mitra, 2007; OECD, 2008; Schwaag, 2006; Sun et al., 2007). Even though the number of engineers per million of inhabitants in these two countries is not that impressive in relative terms (214 in India and 340 in China), the percentage increase in the number of graduate engineers per year has reached 10.4% in India and 9.9% in China (Banerjee and Muley, 2008 cf Herald, 2009). India, for example, is now the second largest country in terms of the number of researchers (Asakawa and Som, 2008; EIU, 2004).

- Finally, the policymaking role of local and national governments in these two countries has been crucial (Brandt and Thun, 2010; Narayanan, 2010). For example, the inclusion of China in the 1990s in the World Trade Organization placed competitive pressure on indigenous firms, which forced them to look at new channels for building and upgrading their capabilities (Brandt and Thun, 2010, p. 1555). Both Indian and Chinese central and local governments have also

[39] The positive spillover effect of MNCs remains conditional on the degree of the embeddedness of the MNCs in the local context and on the existence of strategic coupling between local institutional assets and MNC assets (Asheim and Vang, 2006; Chen 2007; Dicken, 2003).

developed policies to attract foreign MNCs to invest and establish R&D activities (Lv and Liu, 2011; Narayanan, 2010) through fiscal incentives or conditioning the establishment of the activity to the participation of indigenous firms in joint ventures.

The shift being observed in China and India is not only related to the capacity of these two countries to innovate or to the fact that they are becoming favored destinations for locating knowledge-intensive activities abroad. These countries are also increasing their internationalization processes through outbound FDIs devoted to acquiring new strategic assets in other countries (Athreye and Kapur 2009; UNCTAD, 2006). Some companies from these economies have, for example, started offshoring specific innovation activities in developed countries (Amighini et al., 2009; EIU, 2007). The main reasons seem to be related to access to sources of knowledge, favorable institutions and important research and innovation environments in more dynamic and mature regions. The cases of China's Haier group and India's Tata group or Infosys for example are meaningful in this respect (Duysters et al., 2009; Niosi and Tschang, 2009).

The inclusion of China and India into the global geography of innovation and their active participation in the globalization of innovation does not involve all national areas. Different regions indeed show different regional trends of development, and specific locations perform better than do others (Chaminade and Vang, 2008; Huggins et al., 2007; Li, 2009). More careful analysis of the innovation linkages of dynamic regions with the rest of the world may be fundamental to understand the strategic and potential position of specific regions in China and India in the global arena as well as to test how complementary local-global interactions for innovation in those regions are. The thesis therefore takes into consideration mainly two specific regions that have undergone very important developments in recent years: Pune (India) and Beijing (China).[40]

Beijing is considered to be the scientific and technological heart of China and thus the leading S&T region in terms of both its research infrastructure and its innovation performance (Guan et al., 2009). In total, 71 universities and 371 research institutes existed in Beijing at the end of 2003 (Beijing statistical Information Net, 2005, cf. Chen and Kenney, 2007). These include some of Asia's best known universities and research institutions, such as the Chinese Academy of Science (CAS), Peking University and Tsinghua University. One of the most important IT science parks, the Zhong'guancun Science Park (ZGC), is also located in Beijing, in the Haidan district, in close proximity to CAS, Peking

[40] Article 3 also considers other Chinese and Indian regions with a different degree of development such as Shenzhen and Shanghai in China and Bangalore, Trivandrum, Mumbai, Hyderabad, New Delhi and Chennai in India.

University and Tsinghua University. Moreover, it is estimated that around 400 R&D centers from MNCs are located in Beijing and Shanghai, representing approximately 50% of all R&D centers located in China in 2005-2006 (China Knowledge, 2009).

This large concentration of research institutes and universities in Beijing and the presence of the ZGC park[41] explains the region's high performance in terms of innovation. Almost 40% of S&T initiatives in mainland China are performed in Beijing (Research Group of Chinese S&T development strategy, 2002, cf. Guan et al., 2009). In 2000, a quarter of the government's S&T funds ended up in institutions located in Beijing, and about 18% of all patents were also granted to Beijing (Chen and Kenney, 2007). Furthermore, the region is considered to be the most active municipality in terms of technology transfer from university to industry (Hong, 2008). Industrially, Beijing has a specialization in high-tech industries. In recent years, approximately one quarter to two thirds of the city's total industrial added value has been attributable to high-tech businesses (Chen and Kenney, 2007; Guan et al., 2009).

Pune is increasingly attracting the attention of academics as a growing research and innovation center in India, gradually catching up with Bangalore. Owing to its proximity to Mumbai, as well as the combined presence of foreign companies, research labs and good education and research institutions, MNCs considers Pune to be an attractive city in which to establish their production and, more recently, R&D activities. In 2008, it was estimated that around 600 R&D centers of MNCs were established in India. Of those, approximately 100 were in Pune (Zinnov, 2009). Pune is characterized by a strong presence of firms in the IT, auto-component, chemical and pharmaceutical industries. Biotechnology is also an emerging sector in the local cluster (Basant and Chandra, 2007). The IT and biotech industries represent the two new drivers of the Pune economy (MCCIA, 2008ab).

The Pune area offers a large number of educational facilities. The city of Pune has 6 universities and 600 functional colleges and PG departments (MCCIA, 2008a). The presence of a certain number of educational institutions in Pune allows good access to skilled labor, training and R&D facilities devoted to the needs of the local market. Technical and engineering education is particularly aimed at training employees in the ICT and auto-component industries in the area

[41] The ZGC park is considered by many researchers a knowledge intensive region itself (Wang, 1999) since many of the high tech firms and research organizations located in Beijing are embedded into this park. Firms investigated in the present thesis are also firms outside the specific park.

and is ensured by the presence of engineering and professional colleges such as the Pimpri Chinchwad College of Engineering and the Modern Education Society's College of Engineering. These colleges sustain the current growth of local expertise in the field of engineering services and design. Other institutions are relevant for training and research in biotechnology and pharmaceuticals, e.g. the Indian Drugs Research, the Agharkar Research Institute and the National Chemical Laboratory.

### *3.2.2 Sectoral coverage*

As research shows, the geography of innovation is also industry specific, i.e. sectors with different knowledge bases may be associated with different degrees of globalization and innovation (Asheim and Gertler, 2005; Martin and Moodysson, 2011ab; Moodysson, 2008; Moodysson et al., 2008). The varying nature of knowledge bases (analytical, synthetic or symbolic) can lead to different dynamics of global-local interactions for innovation, as discussed in section 2.2.2.

The sectors taken into account in this thesis are green biotech (considered to be an analytical sector, automotive components (a synthetic sector) and the software sector,[42] which is mainly a mix of the analytical and synthetic knowledge base types[43]. These sectors are perfectly suited for the purposes of the present study, as in all cases production and innovation activities, although following specific pattern of globalization characterizing each industry, are already globally distributed (Altenburg et al., 2008, Gertler and Levitte, 2005; Plum and Hassink, 2011).

## 3.3 Data Collection

To investigate the role of regions in shaping the globalization of innovation in these three sectors, two distinct databases collected for two research projects have been used:

The *VR Project* "Emerging Trends in Asia: from Cost Based Producers to Global Suppliers of Innovations" (2007-2010) with the aim of understanding how some regions are moving from low cost to innovations and the links between firms

[42] In article 3, the sector analyzes is the ICT sector, which also includes firms involved in the production and development of software.

[43] Indeed, all knowledge bases can be found in this sector. Analytical knowledge can be found, for example, in the development of new software that requires the use of complex algorisms; synthetic knowledge in some dedicated software applies to simple engineering parts and symbolic knowledge in the game software industry.

and regional competences and the global location of innovation. The project coordinated by CIRCLE brought together researchers from Sweden (CIRCLE) and from China (UCAS) and India (IIBM).

*INGINEUS project* (Impact of Networks, Globalisation, and their INteraction with EU Strategies) funded by the EU FP7 with the aim of investigating the impact of globalization and the rapid growth of selected emerging economies on the competitiveness and strategies of EU firms, industries and regions. Special focus has been placed on the formation of global innovation networks. The project brought together researchers from EU countries (Italy, Denmark, Germany, Estonia, Sweden, Norway and the UK) and from some of the most important emerging economies in the world (notably Brazil, China, India and South Africa).

For these two projects, together with other researchers, I had the opportunity to participate in the design of surveys,[44] which were used to collect firm-level data in this thesis. Articles 1, 2 and 4 are based on data collected through the VR project. Article 3 is instead based on data collected through the Ingineus project, which allowed for a comparison with European countries.

The *VR project survey* was carried out in 2008 in Pune (India) and Beijing (China), and in three specific sectors (automotive components, green biotech and software). Data refers to the year before. In total, 1087 firms responded to the survey. The data collected at the firm level using the same questionnaire in the two regions and in the three sectors were related to firms' structural characteristics (i.e. size, age), innovation activities, internationalization strategies, competences and local global linkages. Concerning the extrapolation of sample firms, in neither of the two regions is there a unique database from which to extrapolate the sample.[45] We thus needed to combine different databases from entrepreneurial associations, local chambers of commerce, professional survey firms, and so on. In both regions, we aimed to use the best of the same methodology to select the sample and collect data (e.g. the use of a random sample; same typology of contact person to address the interview such as the R&D manager). Nevertheless, some differences are present in the collection of the data mainly because of the different

[44] Since I was involved in the VR project when it had already started, my participation in the design was only partial related to finalizing the survey tool.

[45] Owing to the high degree of informality in developing countries, particularly in certain industries such as auto components, the entire population can oscillate substantially depending on the source and whether the informal sector is included or not. For example, in Pune MCCIA (2008a) estimates a population of 6000 firms in Pune in the auto components sector (formal and informal), while the Ministry of Science and Technology (IDC, 2008) and Singh (2006) estimates that there is approximately 500 auto component firms in India in total. This is also the number of members registered in the Auto Component Manufacturer's Association of India (www.acmainfo.com).

cultural approaches that exist in the two countries. In Pune, data were collected through face-to-face interviews, while in Beijing we mainly used phone interviews. The response rate for the total population for Beijing was approximately 32% for automotive components, 2.5% for software[46] and 33% for green-biotech. In Pune, if we consider the estimation of the Chamber of Commerce for the software and green biotech industries (MCCIA, 2008b) and the estimates of the Ministry of S&T (2008) for the automotive component industry, the response rates were 37% for software, >21.4% for green biotech and >54% for automotive components[47].

In the INGINEUS project, the survey was conducted in 2009-2010 in nine countries, namely: Brazil, India, China, South Africa, Norway, Sweden, Germany, Estonia and Denmark, and in three sectors (ICT, Automotive, Agroprocessing). Altogether 1215 firms responded to the survey. The firm-level data contain information on their locations, the main production activities and sizes, markets, sales information and R&D activities. The core of the questionnaire focused on the types of innovations, geographic networks and collaborations with customers, suppliers, universities, research institutions and the government, the offshoring of production and innovation and the role institutional frameworks (mainly at a national and at an international level) supporting or hampering access to global innovation networks. Each country participating in the project had a specific sector to focus on. In the ICT sector, which is the only sector analyzed in article 3, 936 responses were collected in total. Since the survey was conducted in very different contexts (some in developed countries and some in emerging economies), differences in the types of databases used, methods of contact and response rates are reasonably present. For example, although a web-based questionnaire was originally considered for all countries, cultural differences required us to rethink it, in particular emerging economies. In India, face-to-face interviews were preferred, while in China the use of phone calls was predominant. Further, the response rate differed from country to country. In China, the response rate was 2.7% (corresponding to 243 responses), whereas in India it was 25.2% (324 responses). In developed countries the response rate was more similar: in Estonia it was 14% (17 responses), in Norway 11.9% (181 responses) and in Sweden 10.3% (171 responses).[48]

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[46] Even though this sector may be under-represented, it is also the sector in Beijing where we obtained the higher percentage of total responses compared to the other sectors (40.7% of the all collected responses in Beijing belong to the software sector).

[47] Due to financial constrains, the targeted number of responses was 200 responses for the automotive components and software sectors in each sector and region. For the green biotech sector, since it is a relatively 'new sector', we aimed to collect around 100 responses for each region.

[48] For further detailed information about the method used in the Ingineus project, it is possible to consult the public methodological report available at

Despite these methodological limits, great effort was placed in both surveys to construct reliable databases. First, the surveys aimed from the beginning to be comparable across countries/regions and sectors by using the same questions in each country/region and sector. Only a few questions, for example, relating to product specification and value chain types were sector-specific. In order to minimize the differences in the interpretation of the questions in different cultural and geographical contexts, the use of complex questions was avoided. Sectorial and country experts were consulted for the design of both questionnaires. The comparability of the two surveys was also tested using pilot questionnaires and for the Ingineus survey, a test on the survey instrument was also carried out. To test the reliability of the data and for the presence of non-responses-bias, when possible we checked the consistency between samples and sets of non-respondents. We also checked that the distribution of the sample was similar to the total population in terms of size, using the statistics available.[49] The surveys used to conduct the empirical analysis are presented as Appendix A and B at the end of this thesis. Methodological limitations are also discussed in the individual articles.

Cases studies were also conducted in both projects. I personally participated to the conduction of six interviews in Beijing with firms in the three sampled sectors (green biotech, software and automotive components) and one with the Zhongguancun Science Park (ZGC). In the Pune region, I participated in conducting 10 interviews with firms in the three different sectors and one interview with the Mahratta Chamber of Commerce. I also participated in conducting 6 interviews in Sweden with national and foreign MNCs in the ICT and automotive components sectors that had started offshore innovation activities in some regions in China and India. These further confirmed how firms from emerging economies have started to participate in the globalization of innovation processes. Even though the interviews have not been directly used in any of the articles contained in this thesis, they have contributed to develop a basis for the investigation, representing an important countercheck for validating the quantitative findings.

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http://ingineus.eu/UserFiles/INGINEUS_D2.2_MethodologyReport%281%29.pdf.

[49] As for data collection, the analytical method also had some limitations related to the types of data used. Since both surveys are based on self-reporting, the answers to the questionnaires may contain a certain degree of subjectivity in the interpretation of information. This problem was minimized by using when possible indicators and questions based on the Oslo manual and by including clear definitions in the questionnaires.

## 3.4 Empirical approach

In this thesis, the empirical research has been carried out mainly through the use of quantitative analysis, more specifically using the inferential method (econometric analysis). A quantitative method can be descriptive or inferential. The descriptive method is used to capture the main characteristics of the phenomena under scrutiny and to highlight how these elements are interwoven, but it is not sufficient to make the real relationship between different variables emerge. It is always possible that the relationship between two variables detected by this method is in reality due to external effects (e.g. another variable) interacting with both. In other words, the descriptive method is just a picture, with few possibilities to expose the real links between variables.

The inferential method, by contrast, is a better tool to test hypotheses, since usually requires checking if two or more variables are related in a non-random way. This method uses econometrics instruments and inferential statistics to determine the relationship between a series of variables, with the aim of identifying possible correlations between the phenomena described by those variables, possibly indicating what elements cause which others and providing an estimate of the magnitude of these effects and the associated estimation error. In this way, it is possible to infer that when a certain variable X is increased by a certain amount, we should observe a change of a certain magnitude in a target variable Y. The most important advantage of using this technique is that we can avoid spurious relationships between X and Y.[50] Thus, the inferential method via econometric analysis is the methodology that I found most appropriate for this thesis since it enabled me to analyze the relationship between a series of variables at different levels (from the single firm to the region). In particular, it allowed me to understand if a certain variable has the effect of increasing or diminishing the impact of another variable, as in article 2 and 4. In article 1, it helped to provide an estimate of the effect of the region and of the firm level factors on the globalization of innovation performances of the firms, making sure to avoid spurious relationships. In article 2, it allowed us to see firms' propensities to implement different types of international strategies, given the presence of specific resources and capabilities within the firm. In article 3, it allowed us to distinguish the effect of different variables on different categories of regions. Finally, in article 4 it helped to explore the relation between firms' internal resources and capabilities, the geographical spread of external networks supporting innovation and firms' innovation performances.

[50] This means that we are able to avoid finding out that the correlation we observe between X and Y is actually the result of an indirect relationship between X and another variable Z, or between Y and Z.

## 3.5 Methodological reflections

This chapter presents some important methodological aspects and choices relative to the method of investigation, research setting, data collection and empirical approach used in the thesis. Even though the decision to use inferential method in the exploration of the data has been my personal choice, other methodological aspects of the thesis (mainly related to the collection and choice of data and content of the questionnaires) have been necessarily conditioned by the specific two projects in which I have been involved in and in the presence of other partners partially responsible for these tasks. The choice of the specific regions and the sectorial coverage as well as the use of a quantitative approach rather than a qualitative approach (i.e. the development of deep case studies), even though justifiable in the context of my thesis, also reflects the type of data that it was possible to collect in the context of an emerging economy through the two projects. If on the one hand the use of the data from these two projects constrained my choices and decreased my control over the methodology, it certainly has many other positive aspects. One was the possibility of confronting my personal ideas and approaches, along with the other academics involved in the projects and with different cultural background, experience and research approaches. Another is that the joint work within an international team composed by academics from developed as well as emerging economies helps to better define the criteria to assess the quality of the data and the quality of a chosen methodology, since the chosen criteria are meant to overcome cultural and geographical barriers and possible problems in data collection. This last point is particularly relevant in the contexts of emerging economies. The difficulty of create datasets at micro and regional levels with international quality standards in such economies is well known. Also, the reader needs to be aware that some intra- and inter-variations that may create some hurdles in the generalization of the results remain present. Also the questionnaires had some limitations due to the necessity to create simple questions to be used in differnt contexts. An ‘optimal’ questionnaire could have contained more objective information related to the innovation activities and performances of these firms (e.g. formal number of contract agreements; number of joint patents; new products selled in new and distint markets, etc.) and more information about the Regional Innovation System and types of institutions where firms were locally embedded.

# Chapter 4 - Summary and conclusions

## 4.1 Summary of findings

The aim of **article 1** was to explore the interplay between the region and the firm level factors in two regions in emerging economies.

The contribution of this paper is twofold:

On an empirical level, the article expands the investigation into emerging economies. With the investigation of regions in emerging economies (Pune in India and Beijing in China), this article takes explicit account of the existence of other empirical contexts beyond those well exploited in geography of innovation studies. The existence of global interactions for innovation is explored herein by comparing two regions in three different sectors. From these findings, it emerges that firms in Pune use more global linkages than firms in Beijing (particularly in the software sector), showing that differences may exist between regions and sectors, as already demonstrated by the most recent contributions to the literature concerned with the geography of innovation field.[51]

On a theoretical level, article 1 contributes to the geography of innovation studies by exploring analytically the complex relationship between firm-level factors, the region and global interactions. It also aims to go beyond the study of the global sources of innovation investigated in the recent geography of innovation articles (e.g. Martin and Moodysson, 2011ab; Moodysson et al., 2008; Plum and Hassink, 2011; Sotarauta et al., 2011; Tödtling et al., 2011) to explore other forms of global interactions for innovation. Since the study of global sources of innovation has the limitation of being able to point out only an unidirectional flow of innovation from the rest of the world to the region, the article complements this by investigating other directions of innovation (from the region to the rest of the world and the bidirectional cross-border collaboration for innovation involving firms in the region and firms and organizations in the rest of the world). In doing so, article 1 makes use of a conceptual framework developed in innovation studies,

[51] In relation to sector specificities, the findings partially confirm the results from knowledge-based theories (Asheim and Coenen, 2005; Coenen et al., 2006; Moodysson et al., 2008) that indicate that the sectors that are more analytical knowledge-based compared with those that are more synthetic knowledge-based use more global interactions for innovation. While the automotive component industry (a synthetic knowledge-based sector) performs less well than the software sector (considered a mixture of analytical and synthetic knowledge-based activities), as is evident also in articles 2 and article 4, the biotech sector (which is normally more analytical knowledge-based) has less global linkages with respect to the software sector.

in particular the taxonomy of Archibugi and Michie (1995) related to the existence of different modes of globalization of innovation. The taxonomy is here adapted to analyze firms and regions in China and India. In the paper, three distinct modes of globalization of innovation are analyzed: the global exploitation of innovation, global sourcing of technology and global research collaboration. These three modes represent a specific way of developing innovation activities: through exploitation (when commercializing innovations in international markets), through sourcing (when acquiring international sources of knowledge to be used for innovation purposes) and through research collaboration when collaboration in R&D are cross-border.

Another aim of article 1 was to explore the question of whether firm level factors influence the geography of innovation. Article 1 uses the theories developed in the RBV stream and international business studies to analyze the combined effect of firm level factors and the region on the capacity to develop globalization of innovation. The findings show that regional differences may also reflect micro-level factors and therefore that aggregate observations at the level of the region or of the sector can also be decomposed into firm-level mechanisms. In particular, the paper shows that the interplay between the firm level factors and the region in which firms are located explains the different propensities of firms in those regions to engage in different modes of globalization of innovation. The analysis of micro factors also enlightens the existence of different types of firm strategies. This induces us to reflect on whether the recent involvement of firms in the investigated regions in the globalization of innovation processes is also related to the fact that these emerging economies may have started to change their types of strategies to access global markets. This is analyzed in the second article.

**Article 2** follows up article 1 by looking at the international strategy choices that firms in Pune and Beijing[52] pursue when exploring international markets. The findings suggest that these two regions are moving away from pure low-cost strategies. The greater presence of differentiation strategies confirms that these economies not only focus on the production of low cost products and services for accessing other markets. The capacity to perform differentiation strategies is usually linked to the capacity to develop products and services of sufficient quality or to introduce into the market new products and new services able to capture specific niches. In both cases, the use of more knowledge-intensive activities becomes a necessity.

[52] Indeed the analysis is extended not only to Beijing but also to the neighboring provinces of Tianjin and Hebei.

While article 1 showed the relevance of firm level factors in shaping the participation of regions in developing countries in globalization of innovation, article 2 continues with this type of analysis to investigate in depth the role of specific resources and capabilities in relation to the specific internationalization strategies adopted by the two investigated regions. Article 2 is strongly anchored in the international business perspective for the formulation of hypotheses and investigation of the phenomena. This article explores three major resources and capabilities that may be particularly related to the adoption of different international strategies: R&D investment, human resources and process-related technological resources and capabilities. It analyzes also them in relation to the destination market by distinguishing between the markets in developed and developing countries. As in article 1, the technological investment of the firm (intramural R&D) seems to be relevant when firms in those countries exploit products and services in the global market. In article 1, intramural R&D is relevant when the firm exploits innovation globally, while in article 2, it is relevant for developing differentiation strategies in developing country markets and cost strategies in developed country markets, showing that global exploitation may follow different patterns based on the degree of market sophistication. For markets that are more sophisticated (i.e. those in developed countries), cost strategies may still be important because the level of competition in terms of quality and innovation is higher than that of developing countries. In terms of concerns with human resources, despite the fact that this resource in article 1 does not seem to be positively related to any mode of globalization of innovation, in article 2 the quality of human resources seems to matter when firms explore strategies of cost or differentiation, but only in developed country markets. It thus seems as though the effect of this resource is strictly related to the specific market the firm is targeting.[53] Article 2 also provides support to the idea that process-related technological capabilities and resources may lead to internationalization strategies (e.g. differentiation) considered more knowledge-intensive activities. Both the use of advanced machinery and equipment as well as the use of specific quality management systems allow us to induce that an improvement in process innovation may help firms in emerging economies develop strategies beyond that related only to cost leadership.[54]

[53] The human resources effect remains however unclear and in most of the cases limited, as confirmed in article 4, when the specific factors that favor the increase in the degree of innovation are analyzed.

[54] This is also confirmed by the firms' interviews in China and India: the most internationalized firms that were trying to gain a competitive position in the global market not only based on cost strategies were also those that had improved their organization and management systems in recent years.

Article 2 explores differences in the patterns of internationalization between Pune and Beijing and confirms the results of article 1, namely that both the specific regional location and sector have an impact on determining the strategies undertaken in the two regions. In article 2, not only is the Pune region more involved in global markets with respect to the other investigated region, but also the differentiation strategies at a global level are more commonly pursued in the former case, showing the dynamism of this region compared with the Beijing region. We can also confirm the better performance of the software sector in the global market with respect to the other two sectors (automotive components and green biotech).

While article 2 follows article 1 in exploring the micro-aspects and, more specifically, the strategies for internationalization, **article 3** follows up on article 1 by providing a deeper investigation into the role of the region in shaping the globalization of innovation processes. More specifically, article 3 assesses the findings of article 1 in relation to the existence of differences among regions in terms of participation in different modes of globalization of innovation and illustrates the specific regional differences.

In particular, the article makes a specific distinction between the types of RIS and the extent of engagement in globalization of innovation. In this article, RISs are classified based on their institutional conditions (Amin and Thrift, 1994; Tödtling et al., 2011) and levels of innovation dynamism (RIS scoreboard, 2009). We find that global innovation networks, and in particular the global generation of innovation and global collaboration for innovation, may be more present in regions that are neither too innovative nor too institutionally thick, or thin. These types of regions usually have needs in terms of innovation, but also the possibility in terms of capabilities and resources to be involved in globalization of innovation processes. In article 3, Pune region represents this type of RIS.

Article 3 also contributes to the knowledge-base debate in the geography of innovation literature. By investigating in depth a specific sector (i.e. ICT) this article shows that the same industry independent of its knowledge-based nature may also show very different geographical patterns of knowledge collaboration in different types of RIS. Further, article 3 complements the taxonomy of globalization of innovation developed in article 1 by investigating the global generation of innovation, which was not investigated empirically in the previous articles due to data limitations.

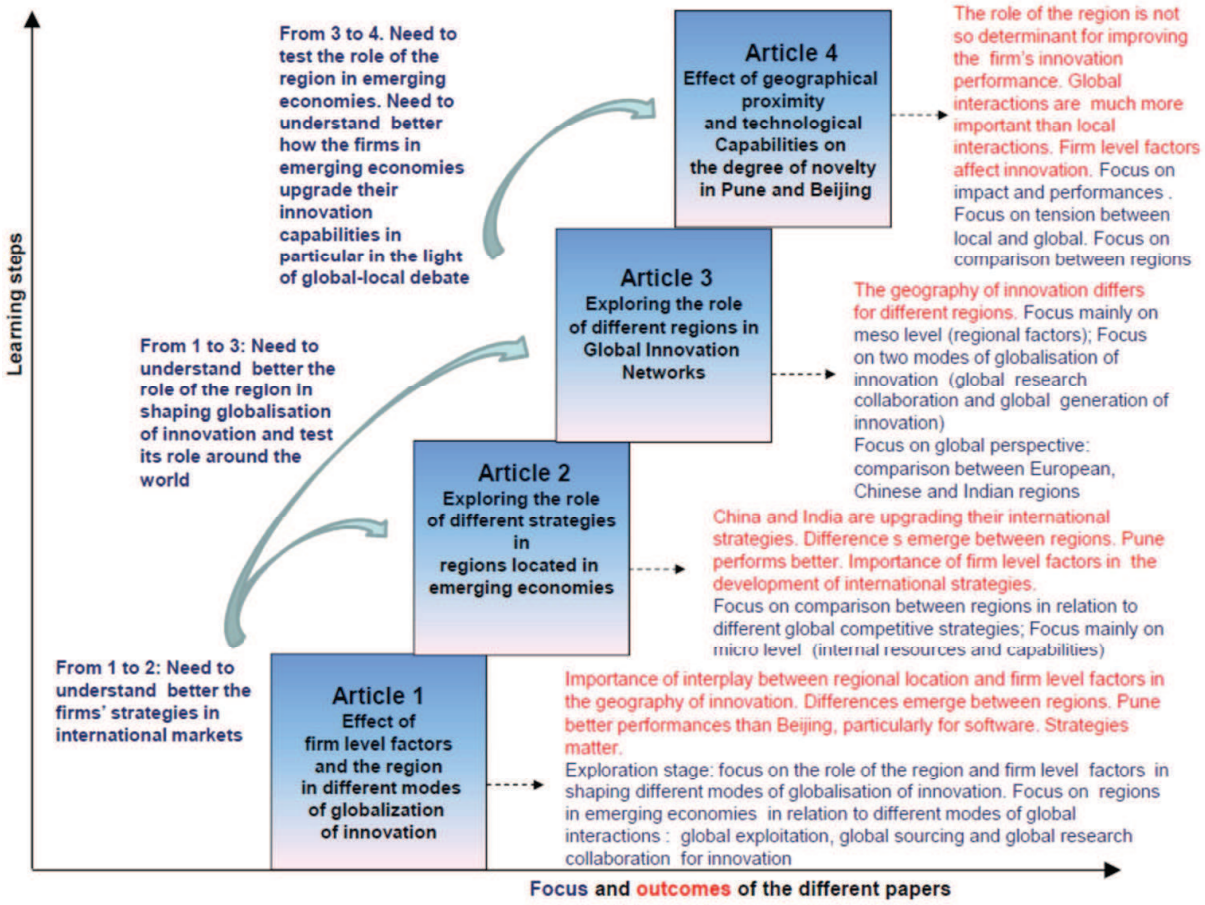
Empirically, article 3 goes beyond the comparisons of the two regions in China and India to analyse 17 regions belonging to different countries around the world. To do so, it was necessary to use a different data source than that used in the first two articles.

While articles 1, 2 and 3 recognize the existence of global interactions for innovation, they do not provide empirical evidence about their relevance for the development of innovation activities, or about their specific relevance on regions in emerging economies. **Article 4** opens up this part of the 'black box' by looking specifically at the impact of local-global interactions on innovation performance. Article 4 investigates how regional and global networks of collaborators for innovation and sources of technologies affect the degree of product innovation in firms in Pune and Beijing. The results are interesting since they show that the role of the region is limited to increasing the degree of innovation for firms located in Pune and Beijing, while the role of global interactions is crucial. The paper confirms the idea coming from innovation studies, and in particular development studies, that global interactions are fundamental for catching up in emerging economies (Lundvall et al., 2009a; Pietrobelli and Rabellotti, 2007; Fu et al., 2011). Furthermore, global research collaboration seems to be one of the most important factors that sustain the capability of firms to upgrade their innovation performance, showing that an active mode of participation in the globalization of innovation is more useful than is a passive mode such as the global sourcing of technologies. The article also has important theoretical implications for the specific economic geography literature that has usually attributed to the region and not to other geographical dimensions the most important role for sustaining innovation (Maskell and Malberg, 1999; Storper and Venables, 2004). This article shows that the region plays a lesser role in emerging economies. While it is true that the capability to innovate may depend on the specific types of RIS and industries, the empirical evidence shows that to become a new to the world innovator, global linkages are crucial, rather than regional ones. The role of the region in these newly industrialized economies still seems to be limited, probably because these are RIS in formation (Chaminade and Vang, 2008; Chaminade et al., 2009), where, the institutions and organizations that foster innovation are still developing despite the great investment in S&T in recent years.

Article 4 also confirms the findings of the previous articles that contribute theoretically to integrating the micro dimension into the geography of innovation debate. In this article, the analysis of specific firm level factors shows how the capacity to increase innovation performance is also related to firms' resources and capabilities, such as the capacity to develop patents, the presence of advanced machinery and equipment and, to a lesser extent, investment in R&D.

Figure 3 shows the focus and the contributions of each of these articles as well the learning path followed throughout the thesis.

**Figure 3. Learning path**




## 4.2 The thesis contribution to the geography of innovation field

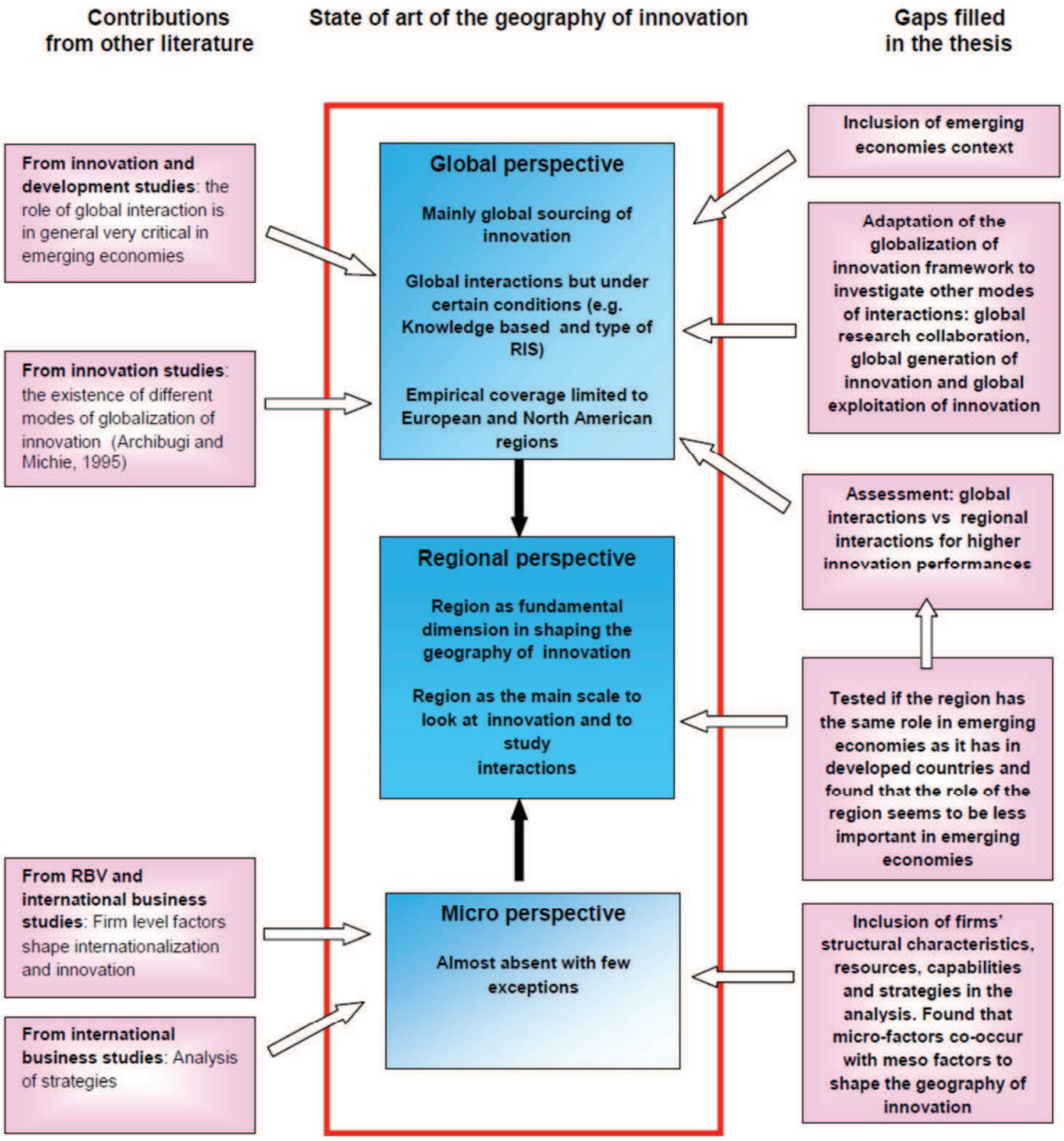
The aim of this thesis has been to study how Chinese and Indian regions are changing the geography of innovation investigating in these contexts the role of the region as well as of firm level factors in explaining and sustaining firms' innovation performances and their possible modes of participation in the globalization of innovation. In doing so the thesis aimed to offer new insights into the geography of innovation studies both from a global and from a micro perspective.

Recent geography of innovation studies have aimed to analyse certain conditions (different knowledge-based activities, RIS with different institutional settings) that may favor global interactions. Despite these advances, the global perspective has been only partially investigated. Until now the geography of innovation studies has empirically explored regions in Europe and North America. Moreover, the global sourcing of innovation has been almost the only mode of globalization of innovation taken into consideration.

The thesis contributes to fill these research gaps. First, it enlarges the empirical geographical coverage of geography of innovation studies including regions in emerging economies. In particular, it tests if the region has the same important role in shaping innovation in emerging economies as it seems to have in developed countries. The conclusion, derived from the empirical analysis of the Pune region in India and the Beijing region in China seems to indicate that, even though the region has a role in sustaining the globalization of innovation, this role seems to be less important with respect to the role attributed traditionally to the region in sustaining innovation in developed countries. Indeed, using contributions from innovation and development studies, this thesis argues that global interactions are preferable to regional interactions for emerging economies to catch up in terms of innovation. Using empirical evidence, this thesis thus shows that in studying the geography of innovation, global interactions need to be adequately considered in relation to different types of contexts (i.e. developed economies or emerging economies). The thesis also adapts the globalization of innovation framework developed by Archibugi and Michie (1995) to investigate other modes of global interactions beyond global sourcing: global research collaboration, global exploitation of innovation and global generation of innovation. In this way it contributes to analyzing other directions of innovation flows, not only from the rest of the world to the region, but also from the region to the rest of the world. Indeed, the results show that despite the main mode of globalization of innovation being the global sourcing of technology, the other modes - global exploitation, global collaboration and the global generation of innovation are also starting to be undertaken by selected firms in some regions in China and India. This thesis thus adds a new perspective to the geography of innovation studies, since the region is intended here as an open system capable not only of absorbing global knowledge but also of providing knowledge to other parts of the world.

This thesis also attempts to strengthen the use of a micro perspective in the geography of innovation studies. In particular, it aims to include a much more detailed analysis of firms' characteristics and behavior (strategies) and its interactions with the region. This thesis takes inspiration from RBV theories and international business studies to demonstrate that micro factors, and in particular firm specific resources, capabilities and structural characteristics (size, organizational form), co-occur with meso factors (region and sector) in shaping the geography of innovation. It thus shows not only that firm level factors matter but also the specific behavior of firm plays a role (e.g. firms can choose specific strategies to exploit international markets and thus innovation activities at global level). Figure 4 summarizes the contribution of the thesis to the geography of innovation field.

**Figure 4. Theoretical and empirical contributions of the thesis to the geography of innovation field**



## 4.3 Concluding remarks

The most important contribution of this thesis has been to strengthen the global and micro perspectives in the geography of innovation field and to show that making use of interdisciplinary studies may help a field of research to advance in many directions. The thesis is the first attempt to explore the interplay between firm-level and regional factors in explaining the globalization of innovation in Chinese and Indian regions. Therefore the reader needs to be aware of what this thesis may be able to explain and what it may not. The thesis certainly contributes to showing that both firm-level and regional factors matter in determining the participation of regions like Beijing and Pune in the global geography of innovation. This is also clearly confirmed by the case studies that have been conducted in Beijing and Pune. However, it is still difficult to quantify how large the explanatory power of the interplay between these two dimensions is and which specific regional factors are considered among the most important. This may depend also on the incidence of the industrial and national dynamics that the present thesis has not adequately captured.

When entering in the specific hypotheses investigated in each of the articles comprising this thesis, some issues are still open and deserve further theoretical and empirical attention. Surprisingly, we found that the internal educational level of human resources and the presence of R&D departments seem not to be relevant for sustaining the globalization of innovation of firms in Pune and Beijing regions. Instead, organizational and process-related type of innovation seems to be very significant. We might therefore need to consider some of the peculiarities of firms in emerging economies with respect to firms in developed economies. The latter have demonstrated clearly how human resources and R&D investments have been determinants for strengthening their competitive position in innovation-related activities at the global level. In almost all the interviewed successful firms from Pune and Beijing participating in some modes of globalization of innovation, the actual investments have instead progressed in the direction of process and organizational renovation as strategies for catching up. Are we in front of different types of business models in which firms from regions in emerging economies approach today the global market, or is this an effect due to the type of position/specialization that firms have gained in their global innovation networks? This remains an open question that deserves further investigation. In particular, the use of a network approach in future research may help to investigate more deeply what relationships firms have with the other actors in the RIS as well as with their global partners.

Considering the hypotheses related to the role that the regional interactions and institutions play in the investigated regions on one hand it is not surprising

that in emerging economies context global interactions for innovation play a more important role than regional interactions due to the larger dependence of these economies on global sourcing and foreign technologies. On the other hand, further investigation of the quality of regional institutions and innovation is needed to understand better why some regions like Beijing that are considered relatively thick in terms of institutions and innovation dynamics are not the most motivated to open up for global collaboration in innovation. Since many recent contributions in international business underline that the types of institutional transitions that are happening in these economies are unprecedented (Gao et al., 2010; Peng, 2003), it would be wise to give more attention to the peculiarities of particular countries. China and India have very different national innovation systems that may substantially affect the way firms and regions in those countries approach other markets (Altenburg et al., 2008)[55].

This thesis has the aim of analyzing a phenomenon at a certain point in time. As underlined by Cantwell et al. (2010, p. 579) due to the unprecedented changes involving countries like China and India at the moment, it is very difficult to give predictions about the future directions of a phenomenon within the specific regions investigated in this thesis. It will therefore be necessary to develop longitudinal research before mapping the existence of specific patterns in the evolution of the trends analyzed. Further research is also needed to develop stronger and more detailed indicators for all the modes of globalization of innovation investigated in this thesis. This is one of the activities I would like to pursue more in depth in my future research. In this last period, widening my reading in the field of international business I also increased my interest in understating the real power position in the global geography of innovation of firms and regions belonging to emerging economies vs. firms and regions in developed countries. A network approach would be probably again be the best methodological choice for further empirical research to map how the different modes of globalization of innovation can open up a more active role for firms and regions in emerging economies in global innovation networks.

[55] Indeed, the rapid growth of investment in innovation that firms from these economies are now making overseas (Chang and Rhee, 2011; Dicken, 2011c, p. 197; Dunning, and Lundan, 2008, p. 754) do not seem to follow a gradual learning process as pointed out by the evolutionary model of the school of Uppsala (Johanson and Vahlne, 1977, 2009). If this model has been good initially to explain why firms internationalize, this framework may result for these contexts obsolete (Chang and Rhee, 2011).

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