UNIVERSITY OF MESSINA

DEPARTMENT OF ECONOMICS

PH. D. COURSE IN ECONOMICS, STATISTICS AND MANAGEMENT

XXX CYCLE

NEVER VENTURE, NEVER WIN!

THE CHINESE RUSH TO INNOVATION AND REGIONAL DEVELOPMENT

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Acknowledgments

When I started this Ph. D. course I was recently back in Italy after several international cooperation experiences. The last one, and probably the toughest assignment was to work in Iraqi Kurdistan in Syrians refugees' camps.

It was not simple for me to adapt myself to the academic lifestyle again, most of all, it was not easy to re-shape my interests in order to meet the needs of the course and it costed me a huge mental effort. At some point I started to ask myself if I could make it, and if I ever would be able to fit into the required standards. Then I met two persons who changed my approach and the course of the events. Today I can say that I owe the conclusion of this course and the redaction of this thesis to both my guiding professors at University of Messina.

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During these three years many people came and left, and I want to thank all those who stayed making this period an invaluable part of my personal and professional growth.

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When you are a student one of the hardest part is to go over your ideas and to have the possibility to share them with professors, which makes you more comfortable in pursuing your goal. It was very useful for me to present my thoughts to professors in the economics department and all those who came in visiting. I value their suggestions in this thesis.

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I want to dedicate this thesis to my grandparents, you are with me always, and I feel it.

1 Chapter 1: Introduction

1.1 Theoretical framework

Innovation is considered as a way of reshaping an organization, or also as a reaction to modifications in the external environment or as a preventive measure to influence the environment (Damanpour, 1996). Thus, the concept of innovation generally includes a wide range of economic and social aspects, including new products, innovative services, new technologies, new organizations of company structure, new administrative systems, or new strategies or programs relating to organization members. So innovation is intended as the generation of new knowledge and new ideas in order to help new business creations, or as a tool for the improvement and administration of internal business processes, with the aim of improving the quality of the outputs fitting the market needs (du Plessis, 2007).

Of course innovation does not involve only firms, but it is the result of the interaction between numerous institutional actors. There is a large debate going on, during the last decades, about the locus of innovation and the spillover effects of new knowledge creation. According to Porter (1998) the local dimension plays a crucial role in the pursuing of the competitive advantage by firms. Indeed, the localization of the specialized skills and the interactions between institutions, partners and customers inside the regions converge in a unique innovative system. Many are the studies that aim to theorize this system: among the most relevant Lundvall (1992), with the concept of National Innovation Systems, and Cooke (1997), which emphasized the role played by the clusters inside the system re-shaping the idea at regional level (Regional Innovation System).

In this thesis, I analyze the importance of the local dimension from the strategic point of view in order to underline how the behavior of innovation gate keepers (firms and universities) and policy makers (central and regional governments) influences the regional development.

The title of the thesis is emblematic, I choose to quote one of the most ancient and read book in world, that is also happened to be Chinese. The quote in the title comes from: “The art of the war” written by general Sun Tsu. I choose this title on one hand to put the stress on the geographic region taken into account. On the other hand, to emphasize that the innovation is a real challenged taken by China and it is played with strategy and accuracy demonstrating that innovation and regional development both implemented with strategy and coordination increase the chances to succeed.

Almost always, innovation has been considered as a prerogative of the advanced world (commonly the TRIAD: United States, Europe, and Japan). By contrast, emerging economies have usually been considered as constant followers or imitators, being technological innovation one of the most important factors for economic development.

This is, nowadays, only in part true. As a matter of facts, we have seen that since the studies of Romer (1986) and Krugman (1991) it was demonstrated that most innovative activities depend upon the spread of the economic knowledge and that the productivity capacity of firms depends also upon the effort put in R&D (Grossman and Helpman, 1991; Romer, 1986). On the ground on those studies Jaffe et al. (1993) has demonstrated that universities and research centers play a key role stimulating the regional development through the spread of information. That leads to the fact that other actors, considered until some decade ago as latecomers, are occupying the global panorama in terms of innovation production. Just to mention one of the most indicative examples, China is now one of the most prolific and innovative country in world, thanks to great effort made by the government in boosting the indigenous innovation through an enormous increment of the public R&D expenditure (Li, 2012). The Chinese environment is the representation of the dichotomy expressed in the above mentioned studies. Indeed, on the one hand, we have the increment in innovation production given by the rising in R&D expenditure, and, on the other hand, we have that a key role in the production is played by universities that are funded by public resources. The clear strategy implemented by the Chinese government is to drive the country from being an industry-based economy to become an innovation-driven global leader.

According to these considerations the main idea of the thesis is to concentrate the analysis of innovation and regional development on the Chinese framework, in order to identify the functioning of the innovation drivers in a such peculiar context. The study aims to stress how the interactions between the different actors in the innovation system are re-shaping the firms' behavior and how the great participation of the public sector in the production of innovation is acting like a booster for the regional development, through the intervention on the innovative level of the country.

1.2 Research setting

Since the starting of the new millennium we are assisting to a huge increase of Chinese innovative capabilities. Just to take as an example one of the most common tools used in order to measure the innovative production (that is the World Intellectual Property Office's annual World Intellectual Property Indicators report), we have that the China State Intellectual Property Office (SIPO) received in 2015 1.101.864 patents filing. With an increment rate of +18.7, China still maintains the world leadership as the result of focused political strategies actuated by the government. China signed the Paris Convention for the Protection of Industrial Property followed by the Patent Cooperation Treaty in 1994. In 2001, China joined the World Trade Organization (WTO) and became a member of the TRIPs (Trade- Related Intellectual Property Rights) agreement. Then, the Chinese Parliament

emended three times (in 1992, 2000 and 2009) the Patent Law to meet the international standards and to boost the innovative development of the country, by adopting a patent system in line with the most developed countries. The adopted system is now based on the "first-to-file" principle and adopts the three criteria for patentability of novelty, utility, and non-obviousness, in which the publication of the patents requires around 18 months after the application date, and the patent rights protection are extended for 20 years (Liegsalz and Wagner, 2013; Sun, 2003; Tang, 2008; Yang, 2008).

At the policy level the Chinese government adopted in 2006 the "Medium to Long–term National Plan for Science and Technology Development 2006-2020" (MLP), with two declared thresholds: by the end of 2020, to build an "innovation society", and, by the end of 2050, to lead the innovation in science and technology at global level.

1.3 Structure of the thesis

In order to conduct the study on the relationships between innovation and regional development in the Chinese context, I identified different aspect of influence on the local development. As first step I focused my attention on the key role played by the universities in boosting the innovation. Indeed, firstly I checked out how the public and private investments influence and shape the technological output of universities, as measured by patents. Secondly, I studied the impact of the regional policies through incentives at regional level for the production of patents, with the aim of boosting regional innovation outcomes. Finally, I focused my attention on the impact generated by innovation on employment.

Formally the thesis is composed by five chapters. The first one is the present introduction in which I give a general overview of the dissertation explaining the aim of the research, the context in which is conducted and the contributions.

In the second chapter, I set the theoretical framework of the entire dissertation, by going through the literature on "innovation" and "regional development". I investigated the publications issued in accordance with these two keywords, by performing a co-citation network analysis and then I investigate the new trends in terms of related literature.

In the third chapter, I analyze the contribution to innovation given by universities. The paper investigates how the effort made in R&D private expenditure and in S&T public expenditure affect the universities' patent production in terms of quantity and quality.

The forth chapter presents an analysis of the public policies in terms of subsidies offered by the regional governments in order to stimulate patent applications. The paper investigates the impact generated by the innovation production in terms of patents on the regional economic growth,

highlighting the influence generated by the subsidy program for the development of indigenous inventions.

The fifth chapter investigates the relationship between innovation and regional employment. The paper aims to measure the impact generated by the innovative level of the region on the level of regional employment and the level of the salaries gained by employees in the region.

1.4 Abstracts

Here following the abstracts of the papers:

- Paper 1 (chapter 2): In the last decades the concepts of Regional Development and Innovation have evolved together into a commonly used analytical panorama generating a new stream of study focused on the importance of the local level. As matter of facts scholars have studied the relevance of the regional environment on the development of the local innovative capabilities. The approach is focused on different levels: at local level, using the Regional Innovation System approach in order to investigate the impact of local innovation development and its influence on firms' behavior with the consequent development of specific regional policies; and at firm level investigating the relationships between firms and local institutions (regional governments, universities and research centers) and the consequent collaboration paths between firms and the other actors within the system.

  The present paper, with the use of dedicated tools like VOSviewer and CitNetExplorer, aims to review and summarize the most important studies about regional development and innovation and offers a general overview on the most recent studies. Far from considering the study the last word in terms of literature review the goal is to draw the attention to a cross domain literature field that is claiming an increasing attention among scholars and practitioners.

  The closing considerations highlight the tendencies of the further researches which would help managers and policy makers to better promote innovation and researchers to better focus their attention in studying the phenomenon.
- Paper 2 (chapter 3): This paper focuses on the impressive growth of the patenting activity of the Chinese universities over the last two decades. Previous studies on this topic have been mainly concerned with the contingent and institutional factors that have favored the collaborations between Chinese universities and industry, the ways firms have accessed university-level knowledge and the impact of such knowledge on firm innovation outputs. We complement this branch of management literature by investigating the potential, but so far

unexplored, impact of innovative capabilities (which have been boosted from public expenditures in S&T and private investments in R&D) on university research patents. Our results, based on empirical data, demonstrate that the number of patents owned by Chinese universities is affected positively by public expenditures in S&T and negatively by private investments in R&D. Moreover, digging deeper in the patent quality indicators, findings reveal that both patent claims and citations are affected positively by public expenditures in S&T and negatively by private investments in R&D. The research and policy implications of these findings are discussed.

- Paper 3 (chapter 4): This paper considers the dynamics driving the regional growth in China with specific attention to the hypothetically growth-enhancing role of innovation and innovation-policy. Using a longitudinal panel dataset of Chinese regional macroeconomic observations, university research activity in terms of granted patents and regional pro-patent policies, the research shows how regional economic circumstances and public policies for innovation drive the local development.

  Results emphasize that the contribution of regional pro-patent policies is relatively modest in terms direct impact on growth. Moreover, there are substantial differences between the role of public and private research. Meanwhile the private effort in research demonstrates a mild positive impact on growth, the public appears in countertendency. Implications of these findings are discussed in the paper.
- Paper 4 (chapter 5): This study considers the dynamics driving the Chinese regional development with specific attention to the linkage between innovation and employment. Using a longitudinal panel dataset of Chinese regional macroeconomic observations from the National Bureau of Statistics of China, the research shows how regional innovation, measured in terms of patent applications, pushed by public, private and foreigners' investments in R&D leads to a positive impact on regional employment and wage bills.

  Results emphasize that the contribution of innovation on employment is relevant. Moreover, there are substantial differences between the role of public and private investments and FDI that generate a different impact on number of employed people and wage bill. Implications of these findings are discussed in the paper.

1.5 Theoretical contributions

The papers give contributions to the literature and bring implications for both scholars and policy makers.

- In the first paper I found that public expenditures in S&T generate a positive impact on the number of patents filed by universities, while the role of private firms seems controversial. In doing so, the study contributes to at least two lines of research. On the one hand, it makes it clearer the reasons underlying the surge of Chinese patenting. On the other hand, it clearly distinguishes between the effects of public and private investments in R&D. Overall, results offer an interesting and somehow unexpected interpretation. While the effect of public investments in S&T on university research activity confirms the expectations, the effect of private R&D investments seems counterintuitive. Indeed, it emerges that private firms do strongly impact on universities' patenting activity. Firstly, universities file a lower number of patents in presence of greater levels of private investments in R&D. Secondly, in those conditions, patents are re-shaped in their characteristics: they are less generic (more specialized) and less impactful (lower number of citations).
- In the second paper, results disclose interesting findings. Firstly, it has been shown the separate contribution given by the patent activity to the regional economic growth, which is negative for the universities and inconsistent for the firms. Secondly, if analyzed jointly, the universities' patent production still generates a negative effect on regional GRP. However, the firms' production influences positively the economic growth. Thirdly, the policies appear to be inconsistent on the direct growth with the exception of the granted-contingent policy that generates always a positive effect thus demonstrating the economic relevance of the market capacity of the patent.
- The third paper confirms the hypothesis according to which innovation impacts positively on the local development, and specifically on employment. The paper investigates both lines of investment (public and private), by showing their contribution to the analyzed phenomenon. It is important also to notice in the study the behavior of the FDIs that positively influence regional wages but not employment. That is due to the fact that foreign firms or foreign funded projects aim to intercept a higher level of specialization hiring more qualified people (with higher level of salary). This implication confirms the ongoing transformation of the Chinese economy from being industry-driven to technology-driven.

1.6 Other contributions during the Ph. D.

- Cesaroni, F., Baglieri, D., Crupi, A., 2017. 1.19 – Closing Distances Between Academia and Market, in: Comprehensive Medicinal Chemistry III ed., edited by Samuel Chackalamannil David Rotella Simon Ward. pp. 520–528. doi:10.1016/B978-0-12-409547-2.12304-2

- Crupi, A., Cesaroni, F., Baglieri, D., 2017. Firms ab. capacity & universities patenting activity. Findings from Chinese CNT sector. Acad. Manag. Proc. 2017. doi:10.5465/AMBPP.2017.16290abstract
- La Rocca, T., Abbate, T. D'Amico, A., Crupi, A., 2017. The impact of territorial certifications on the firm value creation: an empirical verification in Europe. Forthcoming in Sinergie-SIMA "Value co-creation: management challenges for business and society" conference proceedings. ISBN: 97888907394-8-4 .
- Crupi, A., Cesoroni, F., Cinici, M.C., Schifilliti, V., 2017. Technology based growth: does R&D boost employment in China? Forthcoming in IASOS Congress – Usak University – conference proceedings.

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du Plessis, M., 2007. The role of knowledge management in innovation. J. Knowl. Manag. 11, 20–29. doi:10.1108/13673270710762684

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Liegsalz, J., Wagner, S., 2013. Patent examination at the State Intellectual Property Office in China. Res. Policy 42, 552–563. doi:10.1016/j.respol.2012.06.003

Lundvall, B., 1992. National Systems of Innovation (London: Pinter). Links.

Porter, M., 1998. Clusters and the new economics of competition.

Romer, P.M., 1986. Increasing Returns and Long-Run Growth. J. Polit. Econ. 94, 1002–1037. doi:10.1086/261420

Sun, Y., 2003. Determinants of foreign patents in China. World Pat. Inf. 25, 27–37. doi:10.1016/S0172-2190(02)00086-8

Tang, M., 2008. Technology transfers from university to industry in the Chinese national innovation system.

Yang, D., 2008. Pendency and grant ratios of invention patents: A comparative study of the US and China. Res. Policy 37, 1035–1046. doi:10.1016/j.respol.2008.03.008

2 Chapter 2: Innovation and Regional development: a theoretical framework.

2.1 Introduction

The modern era is totally shaped on the global competition and the concept of innovation is linked with the idea of cutting the geographic distance. It seems a paradox studying the phenomenon of innovation at regional level because is well known as the improvement in technology and competition made the traditional role of location less influent (Porter, 2000).

By contrast the idea of innovation itself has deep roots in territorial experiences of industrial clusters and localized knowledge spillovers (Doloreux and Parto, 2004). The geographic location assumes new significances given the fact that resources, funds and technology are well accessible in the local market and firms do not need to be located anymore close to the large market that they are serving and also governments are losing their prevalence in influencing the global market.

Following this, the concept of regional dimension is assuming a greater importance and is representing a new way of considering national and local economies, according also to the role played by the different level of governments and institutions involved in the development. As matter of facts innovation is the result of the collaboration between institutional, political and social actors and the regional dimension is the place in which economy and innovation interact (Storper, 1997). The rising interest for the regional dimensional, as proxy to analyze the innovation-driven economies, started from considering the central role played by the local resources in boosting innovative capabilities of the local environment and the competitiveness of firms. The present paper highlights the importance of the geographic proximity as strategic factor that helps the improvement of the general innovative level of the system. As matter of fact, proximity is the way thanks to which the knowledge has spread among the private and public actors and is also the key for firms and universities to adapt and reshape their behavior in order to get the highest profit.

As stated by Porter (1998) in a global economy the competitive advantage is the result of local extremely specialized abilities and knowledge linked to institutions, partners and customers inside the regions. This is also stated in other studies that show how firms innovative outputs are related with regional endemic characteristics such as the level of specialization of the labor force, the accessibility to the labor market, the presence of spillover effects and the institutional and policy makers support (Cooke, 2001; Tödtling and Trippl, 2005). But innovation does not involve only firms and local capabilities. It is also matter of social and institutional relationships. On one hand the social

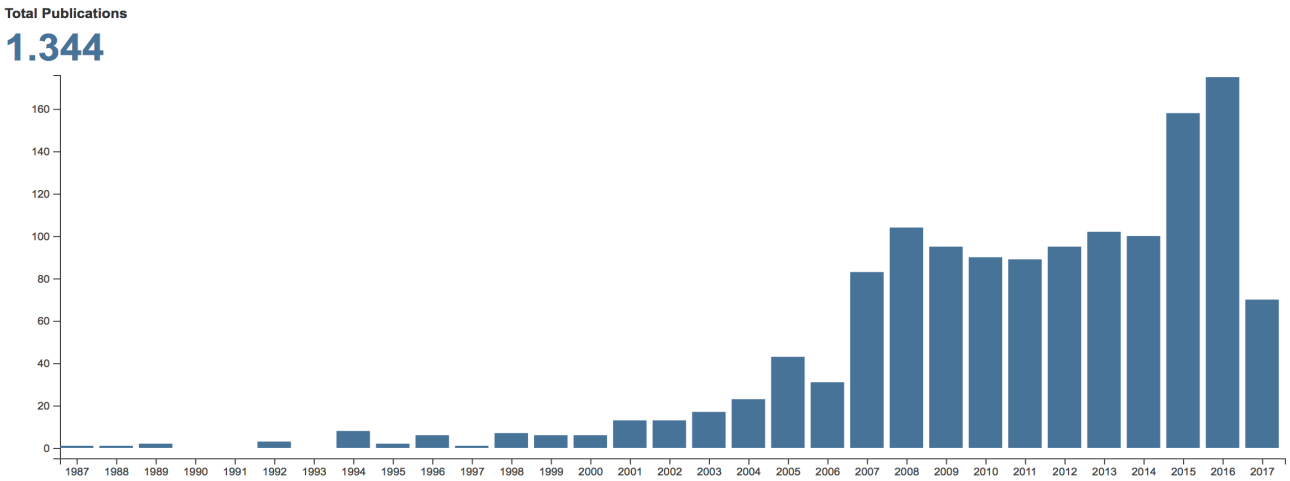
panorama determines the economic, socio-cultural and political dynamics strengthening the innovation and learning capabilities increasing the value of the capital composed also by social interactions and connections within the community (Storper, 1997).

On the other hand, at institutional level, innovation will arise with higher proficiency thanks with the proximity to the knowledge source. In this view the geographic location plays a key role, indeed, in terms of local unit of analysis, the literature identifies the concept of cluster, as element of observation (Porter, 2000). Regional clusters are composed by firms operating in same or similar technological field, public institutions such government, education institutions and logistic services (Porter, 1998). The cluster works like a unique synergic entity in which innovation is boosted by the knowledge spillover given by the geographic proximity that helps the flows of information at every level.

On the ground of the just cited theories the aim of this paper is to give a general overview on the most important studies that link the concept of regional development to the concept of innovation in order to give a general framework of the pillars on which is based this literature context.

As shown by figure 1 and 2[1], indeed, the analyzed field of study is raising the general interest among the scientific community. Starting from 2000 publications and related citations in matter of "Innovation" and "Regional Development" have been increased of 31% and the trends indicate a still increasing interest within scholars and policy makers.

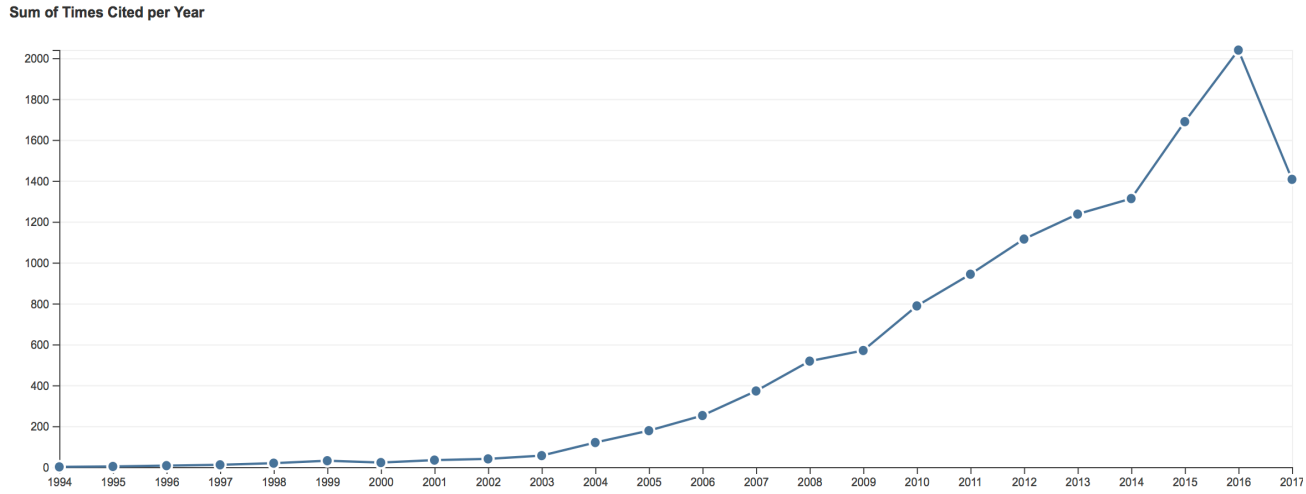
Figure 1: total publications about "innovation" and "regional development"



Source: web of knowledge.

[1] Data from www.webofknowldge.com. Entry queries: "regional development" and "innovation" in "topic". Extracted 1344 publications in categories: "management" and "business".

Figure 2: total sum of citations received yearly by the publication about "innovation" and "regional development"



Source: web of knowledge.

2.2 Methodology

The present study is based on a literature review analysis conducted on all the publications in matter of regional development and innovation. The selection of those studies has been conducted on the online database by Thomson and Reuters "web of science core collection". The research has been conducted in the categories "Management" and "Business" using the keywords "Regional Development" and "Innovation" as topic in all fields. The result is a set of 1344 documents with a sum of the times cited of 12765, an average citation per item of 9,5 and a h-index of 56. Appendix 1 reports the entire list of the selected articles with the total number of citations and the average of the citations per item[2]

In order to summarize the characteristics of this cohort of publications I run different analysis by combining diverse techniques.

In the first place, using the VOSviewer software, I displayed a networks analysis running a text mining analysis with the scope to isolate the most used words in the titles and abstracts of the publications. The results is a network subdivided per cluster according to the chronological criterion that identifies the mutation in the scholars' interest with respect to analyzed arguments.

In the second stage I run bibliometric analysis of the co-citation frequencies of publications in the entire cohort. These frequencies are determined on the base of the articles published and cited with

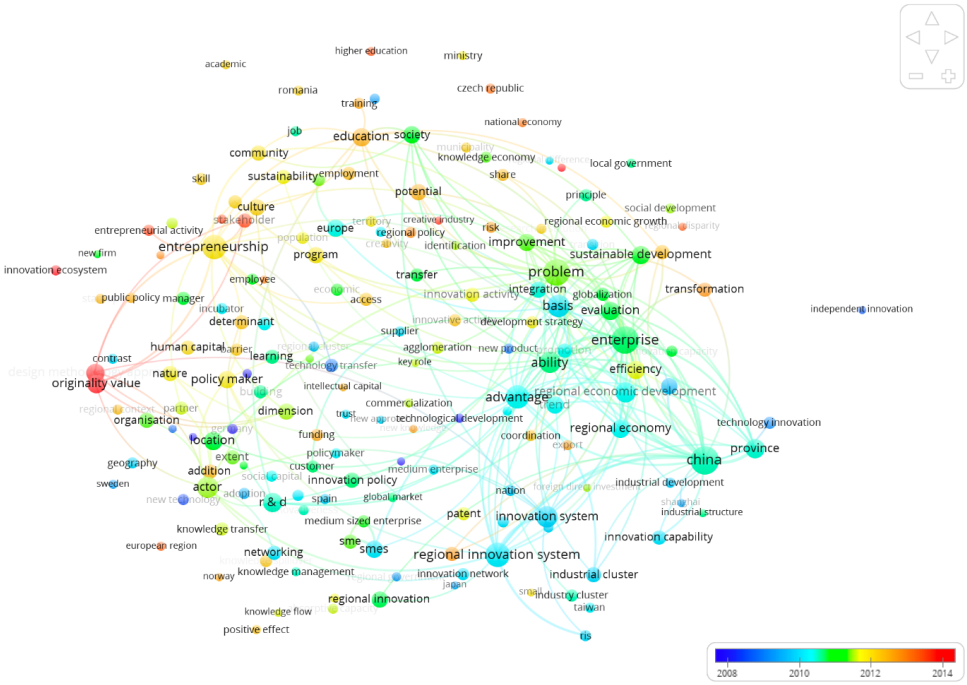
[2] Source: www.webofknowldge.com.

no time limitation. The result is a displayed network in which are highlighted the most co-cited publications divided by cluster in accordance with the studied subjects.
In order to go deeper in the analysis I focused my attention on every single cluster of network. I identified the most cited citations in the subset and using a specialized tool, CitNetExplorer, I tracked down the literature stream generated by those studies following, also in this case, the chronological criterion. Summarizing the paper presents a general overview of the most relevant publication in the selected fields and it shows the chronological development of the literature streams generated by the most co-cited publications in order to offer exhaustive panorama of the literature ground in terms of innovation and regional development.

2.3 Description of the results

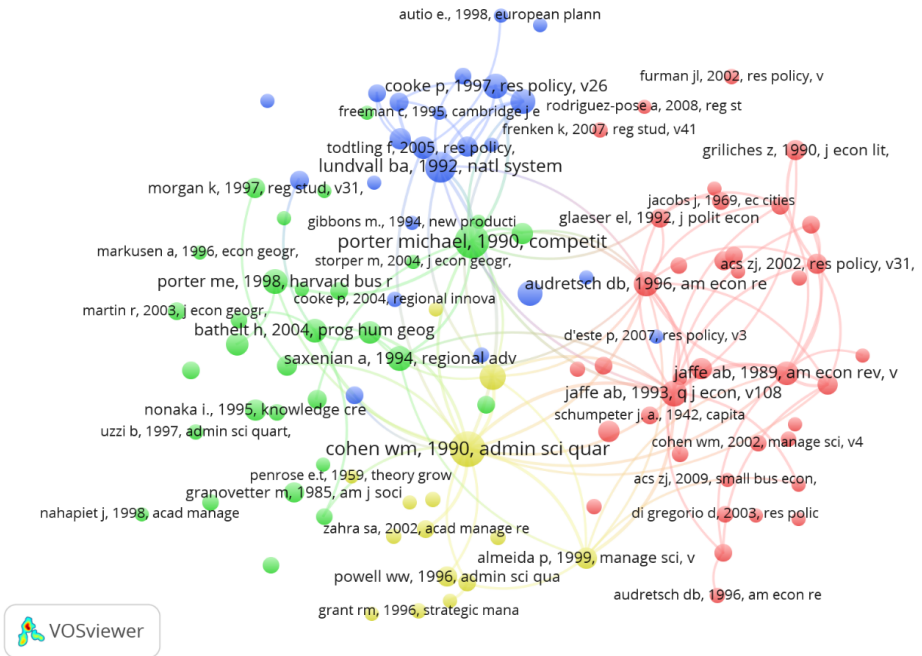
Across the last years the interest of scholars has been shifted covering different aspects related to the analyzed subject. Figure 3 displays the results of a text mining analysis conducted on titles and abstracts of the selected publications. The network is obtained running a text mining analysis on the titles and abstracts of the selected publications. The network spotlights the most used words and is divided (by colors) into different clusters according to the chronological criterion (as shown in the legend) going from the 2008 (blue) to 2014 (red).
As shown in figure 3, we assisted to a massive increment in studies about “regional economic development”, “innovation systems” and specifically “regional innovation system” around the year 2010, following we have a rising attention on the Chinese environment passing through the concepts of “innovation capability” and “industrial cluster”. Most recently the interest of the research is captured by concepts linked to the integration of resources and capabilities at different level of the innovation system. The use of words like “culture”, “education/higher education”, “employment”, “sustainability”, “human capital” and “innovation ecosystem” suggest that the analysis has been shifted considering more relevant the “social” components of the local environment.

Figure 3: network analysis words frequencies (title and abstract)



Once the first analysis has been displayed according to the usage of the words in order to identify the most interesting fields of studies for the scholars, in the second stage I run the bibliometric analysis of the publication focusing the study on the co-citation frequencies. Figures 4 and 5 respectively show the displacement of the network and the intensity of the network.

Figure 4: network analysis co-citantions



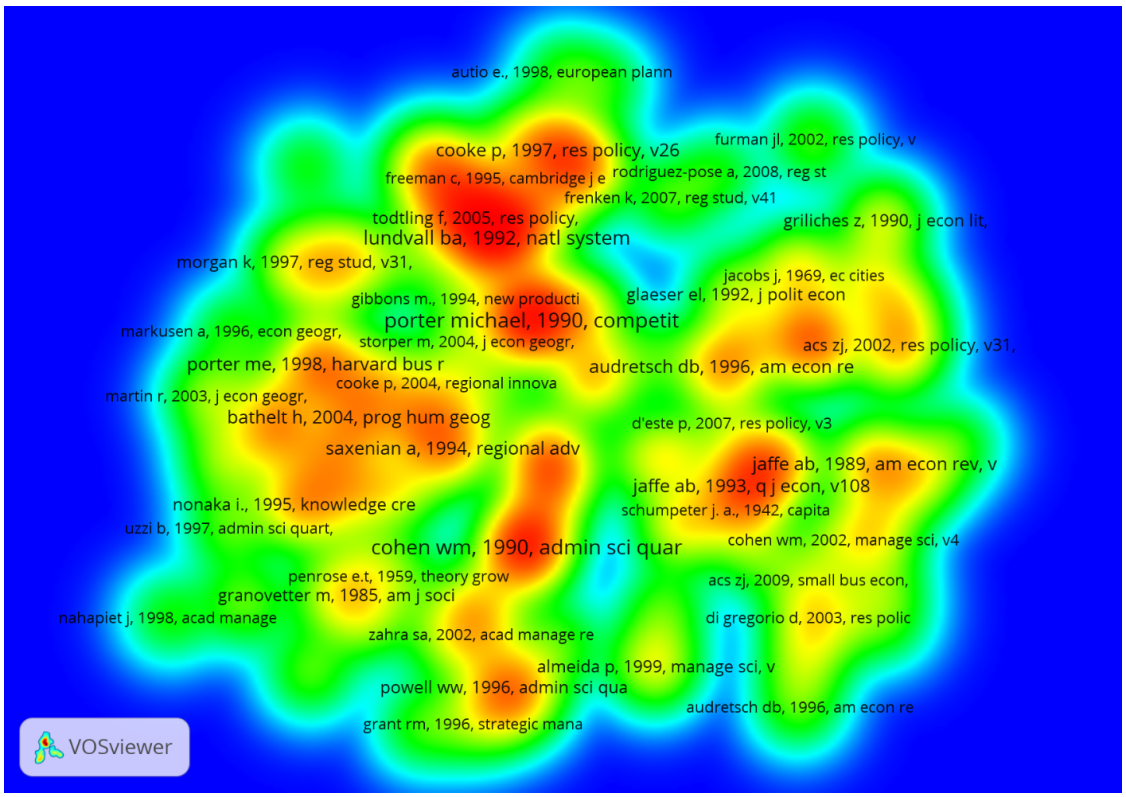
As highlighted in figure 4 the network is composed by four different clusters. On the right side (red cluster) of the network are clustered all the publication that exploit the idea of the knowledge transfer through the lens of the proximity conditions. As shown in figure 4 the maximum density of the co-citing frequencies is concentrated around the studies of authors like: Jaffe (1993), Audretsch (1996) and Acs (2002).

Moving up in the network is possible to identify the second cluster (blue cluster) that deals with the concept of the National Innovation System (NIS) and the translation of the idea at regional level with the implementation of the concept of Regional Innovation System (RIS). The greatest density in the cluster is placed around the studies of Lundvall (1992), Cooke (1997, 2001), Edquist (1997), Etzkowitz (2000) and Todtling (2005).

The third cluster (green cluster), placed in the left side of the network, grouped the studies about the regional conditions and the firms' competitive advantage and the one of the most cited author in this literature stream is Michael Porter, specifically in the cluster is underlined the contribution given by the article published in 1990, 1998 and 2000.

Closing the virtual circle, the last cluster, in the bottom of the network (yellow cluster) is the cluster about the firms' absorptive capacity and the evolutionary economics, the most relevant authors in the cluster are Choen (1990), Powell (1996), Almeida (1999) and Zahra (2002).

Figure 5: density of the co-citation frequency network



2.3.1 Cluster one – the geography of the knowledge transfer

The cluster grouped all the publications in the network that deal with the concept of transfer of knowledge according to geographic proximity. As showed in figure 4 and 5 among the most cited authors is possible to identify the studies of Jaffe et al. (1989) with 59 links, a total link strength of 548 and 59 citations, Jaffe et al. (1993) with 104 links, a total link strength of 745 and 70 citations, Audretsch et al. (1996) with 102 links, a total link strength of 645 and 63 citations and Acs et al. (2002) with 93 links, a total link strength of 406 and 42 citations. According to these studies there is a strictly correlation between the transfer of knowledge and the geographic localization. As matter of facts the knowledge spillovers tend to be geographically grouped (Jaffe, 1993).

Starting from Romer (1986) and Krugman (1991) it was demonstrated that most innovative activities depend upon the spread of the economic knowledge and that the productivity capacity of firms depends also upon the effort put in R&D (Grossman and Helpman, 1991; Romer, 1986). On the ground on those studies Jaffe et al. (1993) has demonstrated that universities and research centers play a key role stimulating the regional development through the spread of information. The knowledge generated by universities is embedded and codified into legal documents, the patents, that contain the geographical information about the inventors and the owner of the patent. In order to measure the trail left by the knowledge flows, the authors focus their research in analyzing the patent citations. As matter of facts citations legally demarcate the scope of the right on the property embedded in the patent. Eventually the paper statistically demonstrates that the trails of knowledge spillovers are geographically located.

Following the spatial dimension approach also Audretsch et al. (1996) focused their attention on the geographical distribution of innovation. The evidences descripted by the authors indicate that innovation tends to be geographically clustered. This tendency is driven by the fact that innovation is caught thank to effort spent in R&D by universities and firms so the most innovative activities are concentrated in the firms in which the production is geographically closed to the places in which innovation is generated.

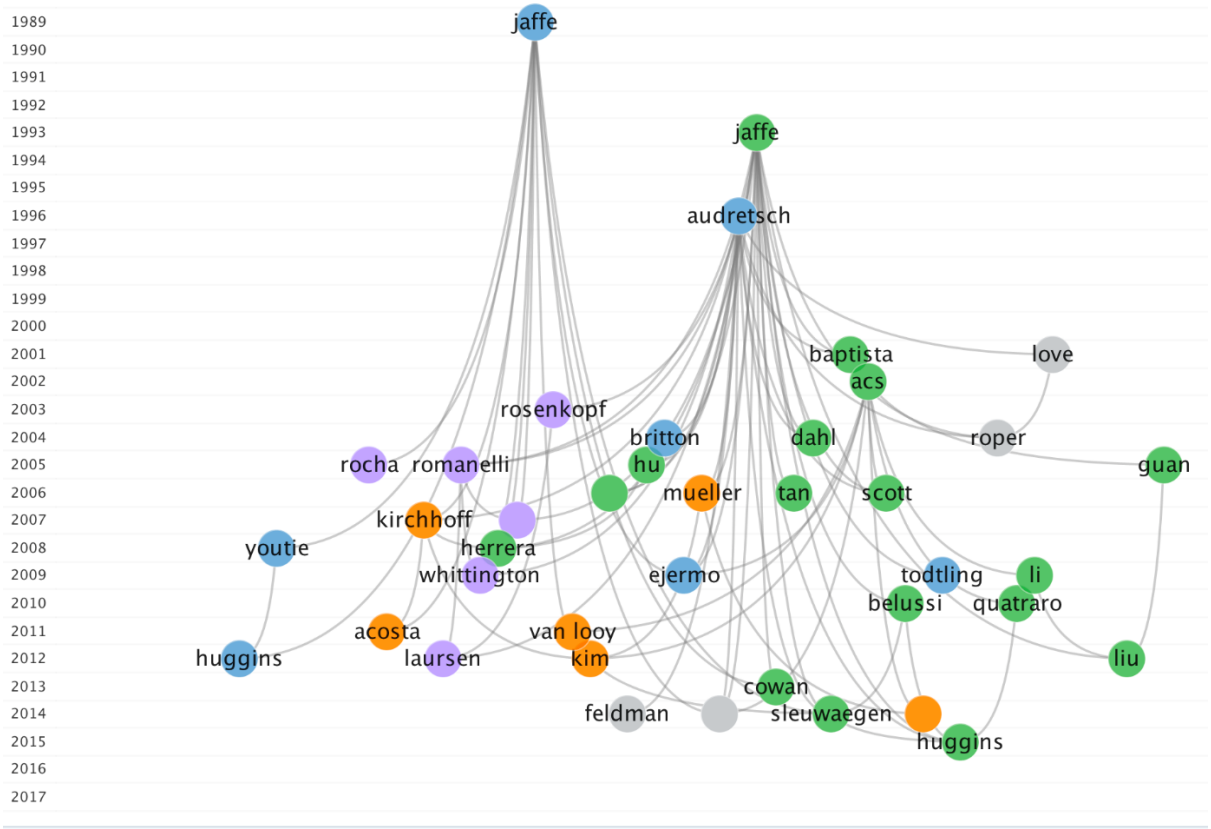
Drilling down the network and following the chronological path is possible to individuate the development of the literature stream generated by the cited studies (figure 6).

The literature about the localized knowledge spillovers focuses its attentions, in the further development, on two different aspects. The first aspect investigates the role played by universities as principal component of the cluster. The second aspect studies the strategies and methodologies of knowledge transfer between the different actors of the system.

Thus on one hand we have studies such as Van Looy et al. (2011) that point out the attention on the experience of entrepreneurial universities. The academic entrepreneurial mission aims to empower

the capacity of regions and nations in the emerging technology fields and according to the authors scientific productivity of universities is positively related to the entrepreneurial effectiveness. Universities with a larger scientific efficiency are more incline for developing entrepreneurial activities because firms consider the scientific production of the university as a condition for selecting academic partners. The study findings suggest the complementary role of academia and industry in innovation systems with the universities' key role in focusing on basic research as expression of the long term view of investment in research.

Figure 6: expanded citations tree for cluster 1



On the same ground the study of Acosta (2011) that analyzes the relationship between universities knowledge spillovers and new firms location in high-technology fields. Considering the spillover generated by the three most important university outputs: knowledge-based graduates, research activities, and technological knowledge the study focuses its attention to the creation on new firms. The result is that university spillovers are significant in clarifying the location of new companies in high-technology sectors.

On the other hand Hugging (2015) suggest that entrepreneurship acts a most important booster of regional innovation and development. The study considers the relationship between entrepreneurship,

innovation and regional development in the light of network dynamics. Especially the characteristic of the networks created by the firms is a principal driver for the regional growth.

The entire cohort is composed by 152 papers, I selected among the most recent and the most cited the three described above in order to give a general idea about the path followed by the literature in the last years. For a complete information table 1 enlists the publications in the network selected according the chronological criterion (the most recent – last five years) and according to their relevance. A rapid visual scan of the titles in the table confirms the inclination of this studies subset to investigate on one hand the relationship between market and academy pointing out the central role played by the universities; and on the hand the importance of the geographical localization as driver from the knowledge spillover and the regional development.

Table 1: articles in the cluster (last five years more than 2.0 citation frequency)

Authors	**Title**	**Source**	**Year**	**Cit.**
huggins, r; thompson, p	entrepreneurship, innovation and regional growth: a network theory	small business economics	2015	4.0
lau, akw; lo, w	regional innovation system, absorptive capacity and innovation performance: an empirical study	technological forecasting and social change	2015	2.0
kolympiris, c; kalaitzandonakes, n; miller, d	location choice of academic entrepreneurs: evidence from the us biotechnology industry	journal of business venturing	2015	2.0
modrego, f; mccann, p; foster, we; olfert, mr	regional entrepreneurship and innovation in chile: a knowledge matching approach	small business economics	2015	2.0
feldman, mp	the character of innovative places: entrepreneurial strategy, economic development, and prosperity	small business economics	2014	9.0
sleuwaegen, l; boiardi, p	creativity and regional innovation: evidence from eu regions	research policy	2014	6.0
tavassoli, s; carbonara, n	the role of knowledge variety and intensity for regional innovation	small business economics	2014	3.0
hajek, p; henriques, r; hajkova, v	visualising components of regional innovation systems using self-organizing maps-evidence from european regions	technological forecasting and social change	2014	3.0

tsvetkova, a; thill, jc; strumsky, d	metropolitan innovation, firm size, and business survival in a high-tech industry	small business economics	2014	2.0
qian, hf; haynes, ke	beyond innovation: the small business innovation research program as entrepreneurship policy	journal of technology transfer	2014	2.0
cowan, r; zinovyeva, n	university effects on regional innovation	research policy	2013	4.0
marrocu, e; paci, r; usai, s	proximity, networking and knowledge production in europe: what lessons for innovation policy?	technological forecasting and social change	2013	2.0
laursen, k; masciarelli, f; prencipe, a	regions matter: how localized social capital affects innovation and external knowledge acquisition	organization science	2012	6.0
liu, mc; chen, sh	mncs' offshore r&d networks in host country's regional innovation system: the case of taiwan-based firms in china	research policy	2012	3.0
kim, y; kim, w; yang, t	the effect of the triple helix system and habitat on regional entrepreneurship: empirical evidence from the u.s.	research policy	2012	3.0
huggins, r; johnston, a; stride, c	knowledge networks and universities: locational and organisational aspects of knowledge transfer interactions	entrepreneurship and regional development	2012	3.0
hervas-oliver, jl; albors-garrigos, j; de-miguel, b; hidalgo, a	the role of a firm's absorptive capacity and the technology transfer process in clusters: how effective are technology centres in low-tech clusters?	entrepreneurship and regional development	2012	2.0
broekel, t	collaboration intensity and regional innovation efficiency in germany-a conditional efficiency approach	industry and innovation	2012	2.0

2.3.2 Cluster two – from National Innovation System to Regional Innovation System

The cluster collects the publications dealing with the concept of National Innovation System and the transformation of the theoretical framework into Regional Innovation System which considers the local dimension and the regional dynamics.

Looking at the cluster and at the density (figure 4 and 5) is possible to identify the most relevant studies such as: Lundvall (1992) with 105 links, a total link strength of 695 and 98 citations; Todtling and Trippl (2005) with 96 links, a total link strength of 379 and 50 citations; Cooke (1997) with 98 links, a total link strength of 485 and 66 citations; Cooke (2001) with 100 links, a total link strength of 380 and 49 citations; Edquist (1997) with 90 links, a total link strength of 274 and 36 citations; Etzkowitz (2000) with 90 links, a total link strength of 261 and 61 citations.

One of the most complete study about the National Innovation System is offered by Lundvall (2007). In his punctual analysis the author gives his personal point of view on the interpretation of the concept of National Innovation System (NIS) according to the a new prospective offered after twenty years from the first conceptualization of the NIS idea. In its closing remarks the author summarizes the importance of understanding how the institutions within the system act together. Indeed, the educational system, the welfare policies, the regulation of financial markets and labor market is crucial in order to support the productive sector creating that innovative push indispensable for the implementation of the innovative capacity of the entire system.

Going deeper into the dynamics that drive universities to play a key role in determining the scientific offer in a national innovation system Etzkowith and Leydesdorff (2000) analyze the relationship between the actors in the Triple Helix: university-industry-government as drivers for the system development thanks to the interactions and negotiations between the actors. Especially looking at the introduction of new technologies the system must reorganize itself and according to the authors the research conduct by the universities laboratory can generate a positive push in order to re-determine the network shape and the interactions between the different actors.

By contrast the study conduct by Cooke (2001) analyzes deeper the shape of the National Innovation System and the local drivers within the system that determine the re-shaping in Regional Innovation System (RIS). The paper identifies the lineaments of the RIS categorizing them in the local dimension of the innovation development and the consequent spillovers among the public and private actors in the network. According to Cooke in order to define a Innovation System as Regional it must contain five key elements: first the region as local levels of government, second the innovation as creation and commercialization of new products and processes, third the network as a developed system of trust based relationships between actors with common interests, forth the learning as the embeddedness of new knowledge and capabilities in routine and conventions and fifth interaction as formal and informal communication about innovation.

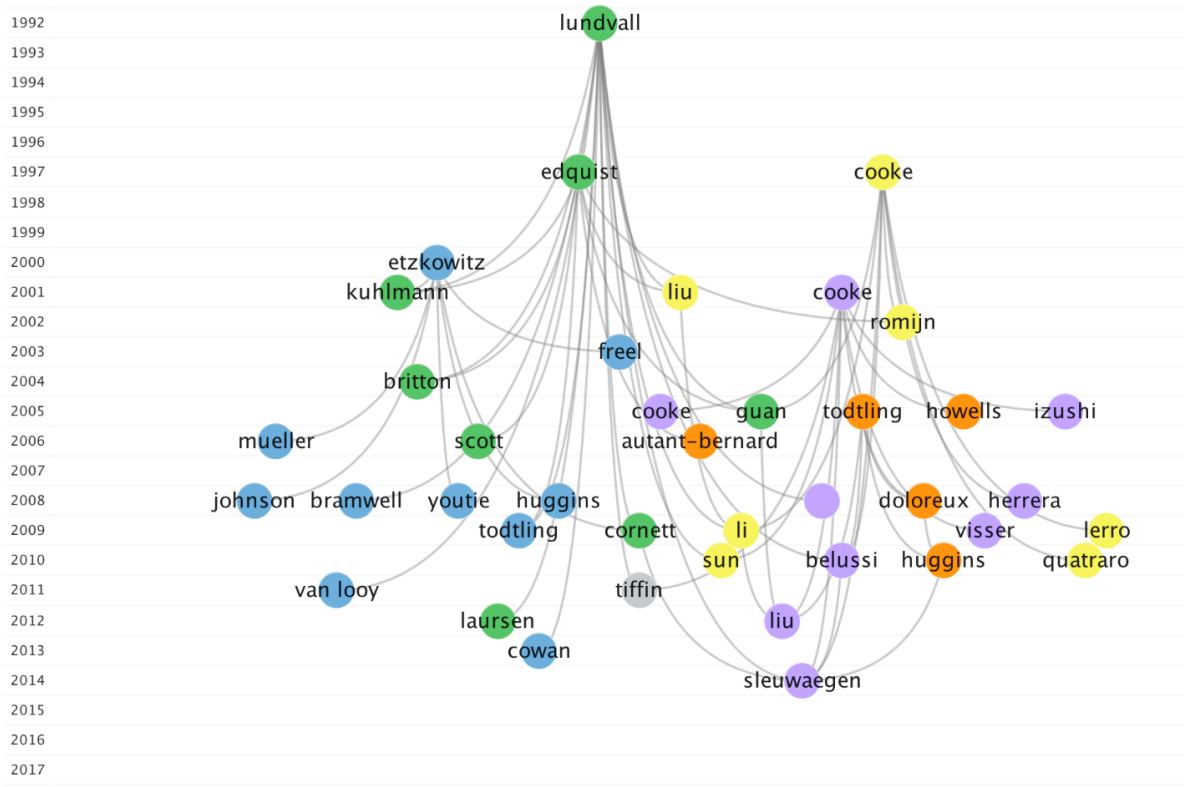
On the ground of this theories Todtling and Trippl (2005) constructed their analysis in identifying the different categories of region according to their prerequisites in terms of innovation development, barriers and relationships between actors. The study, starting from the definition of RIS, given by

Autio (1998) and Cooke (1998), analyzes the interdependences at regional level between firms and institutions in the innovation system discussing how the interactions differ within the region. The authors identify in conclusion three different type of region: first the peripheral region characterized by a scarce effort in R&D, a low level of innovation, scarce interactions between firms and weak interest of institutions; second the old industrial regions with many firms and strong interactions but with a "traditional" industrial vocation; last the metropolitan regions characterized by high levels of specialization but with possible lack of innovation development.

The suggestions given by the authors in order to improve the innovative effort in those regions is to improve and empower the regional economy in the first case, to renew the industrial sectors and infrastructure with innovation-oriented policies in the second case and to encourage the internationalization in the last case.

Figure 7 shows the chronological development of the literature stream generated by these most important publications of the network. Pointing the attention on the most recent we have the study of Cowan (2013) in which authors the paper analyzes empirically whether the expansion of a university system affects the local industry innovation and investigate the impact of the creation of new schools finding a positive influence on the regional innovation activities. Indeed, they find that the opening of a new educational institutions leads to an increase in the number of patents filed by regional firms thanks to the creation of high quality scientific outputs by the new schools.

Figure 7: expanded citations tree for cluster 2



On the other hand Sleuwaegen (2014) focuses its attention on the role of creative workers in the region as a booster of regional innovation in the European Union. The study underlines how the presence of skilled human capital taken as regional expertise, adequate technological infrastructure, involvement of national and regional institutions, impact positively on the regional patenting activity. This one entire cohort is composed by 264 papers, I selected among the most recent and the most cited the three described above in order to give a general idea about the path followed by the literature in the last years. For a complete information table 2 enlists the publications in the network selected according the chronological criterion (the most recent – last five years) and according to their relevance.

Table 2: articles in the cluster (last five years more than 2.0 citation frequency)

Authors	**Title**	**Source**	**Year**	**Cit.**
berbegal-mirabent, j; lafuente, e; sole, f	the pursuit of knowledge transfer activities: an efficiency analysis of spanish universities	journal of business research	2013	2.0
brekke, t	entrepreneurship and path dependency in regional development	entrepreneurship and regional development	2015	2.0
brown, r	mission impossible? entrepreneurial universities and peripheral regional innovation systems	industry and innovation	2016	2.0
brown, r; mason, c	inside the high-tech black box: a critique of technology entrepreneurship policy	technovation	2014	3.0
cowan, r; zinovyeva, n	university effects on regional innovation	research policy	2013	4.0
fu, wy; diez, jr; schiller, d	interactive learning, informal networks and innovation: evidence from electronics firm survey in the pearl river delta, china	research policy	2013	3.0
hajek, p; henriques, r; hajkova, v	visualising components of regional innovation systems using self-organizing maps-evidence from european regions	technological forecasting and social change	2014	3.0
hervas-oliver, jl; albors-garrigos, j;	the role of a firm's absorptive capacity and the technology transfer process in clusters:	entrepreneurship and regional development	2012	2.0

de-miguel, b; hidalgo, a	how effective are technology centres in low-tech clusters?			
huggins, r; johnston, a; stride, c	knowledge networks and universities: locational and organisational aspects of knowledge transfer interactions	entrepreneurship and regional development	2012	3.0
kim, y; kim, w; yang, t	the effect of the triple helix system and habitat on regional entrepreneurship: empirical evidence from the u.s.	research policy	2012	3.0
lau, akw; lo, w	regional innovation system, absorptive capacity and innovation performance: an empirical study	technological forecasting and social change	2015	2.0
laursen, k; masciarelli, f; prencipe, a	regions matter: how localized social capital affects innovation and external knowledge acquisition	organization science	2012	6.0
li, xb	behind the recent surge of chinese patenting: an institutional view	research policy	2012	3.0
liu, mc; chen, sh	mncs' offshore r&d networks in host country's regional innovation system: the case of taiwan-based firms in china	research policy	2012	3.0
marrocu, e; paci, r; usai, s	proximity, networking and knowledge production in europe: what lessons for innovation policy?	technological forecasting and social change	2013	2.0
miller, k; mcadam, m; mcadam, r	the changing university business model: a stakeholder perspective	r & d management	2014	2.0
probert, j; connell, d; mina, a	r&d service firms: the hidden engine of the high-tech economy?	research policy	2013	2.0
sleuwaegen, l; boiardi, p	creativity and regional innovation: evidence from eu regions	research policy	2014	6.0
spigel, b	the relational organization of entrepreneurial ecosystems	entrepreneurship theory and practice	2017	2.0

The analysis of the second cluster and the developing of the further researches converge inn many points with the findings of the precedent cluster. As matter of facts there is a clear field of interaction

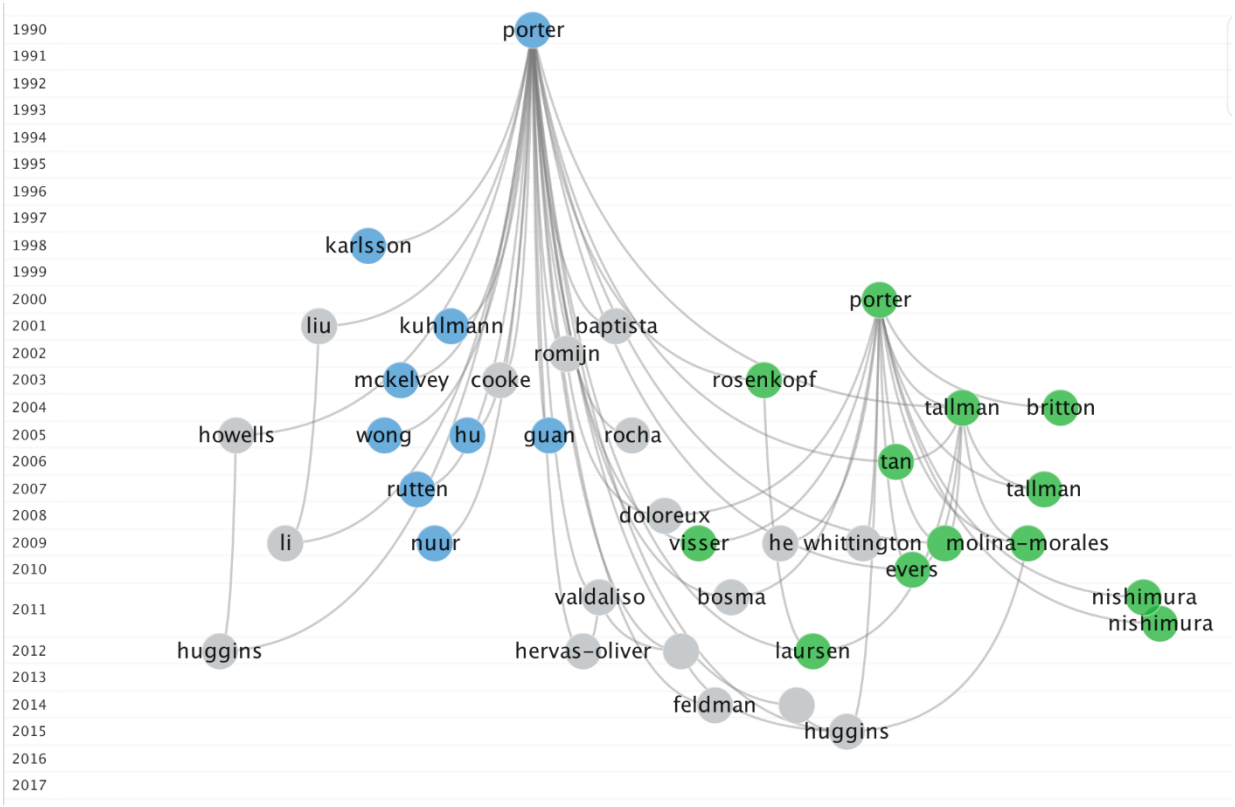
in which the clusters tend to overlap the one dealing with the universities role. The clusters overlapping phenomenon is also visible in the co-existence in both subset of studies such as Van Looy et al. (2011), Huggins (2012), Cowan (2013), Todtling (2009) and Youtie (2008).
In both the cluster there is a large number of studies that focus their attention on the contribution given by the universities research activity and knowledge production in contributing to the localization knowledge spillover in the first cluster and in boosting the innovative capacity of the entire system in the second cluster.
According to this view and according to role played by universities is evident how the first cluster deals with the single relationship between universities and firms meanwhile the second cluster explode this relationship at a higher level considering the entire local network of interactions modifying the national innovation system approach with the regional one.

2.3.3 Custer three – firms' competitive advantage

The third cluster grouped the publication dealing with regional conditions and the firms' competitive advantage. The most relevant studies in the network are those from Michael Porter (1990) with 106 links, a total link strength of 718 and 116 citations; and Porter (2000) with 92 links, a total link strength of 322 and 51 citations.
In the article "The Competitive Advantage of Nations" Porter (1990) analyzes the capacity of the countries to express in terms of competitive advantage the inner innovative and productive capabilities. As stated by the author "national prosperity is created, not inherited" (Porter, 1990. Pg. 73) so the power of nation to create value is embedded in the industrial capacity to create innovation and to reshape the productive panorama. As matter of fact the key role is played by the capacity of firms to influence governments and institutions to support the economic structure.
Later in 2000 with the article "Location, Competition, and Economic Development: Local Cluster in a Global Economy" Porter leaves behind the national macro level analyzing in deep the microstructure focusing the attention on the importance of the organized local dimension (cluster) within the global panorama innovation-driven. Clusters are intended like geographical localized network of linked firms, specific suppliers, service providers, associations and institutions (e.g., universities, research centers, trade associations) that compete but also cooperate.
Clusters are considered as concentrations of highly specialized abilities and knowledge, institutions, competitors, related businesses, and customers in a particular geographical framework. The geographic, cultural, and institutional geographic closeness leads to particular relationships, most resourceful information, powerful incentives, and other benefits in productivity growth otherwise difficult to gain from a distance.

The figure 8 shows the drilling down path generated by the two paper over the year. Among the most recent studies there is the cited above article of Huggins (2015) and the article of Feldman (2014) in which the author investigate the reason why investments in some places generate jobs and economic growth while comparable investments made in apparently same places fail to gain the desired results. The answer lies in the concept of location. Indeed, the reason why some regions are most prosperous than the others is due the fact the human substrate created by the interactions between institutions and public and private and the local environment create unique characteristics that lead the locality to a common purpose.

Figure 8: expanded citations tree for cluster 3



This one entire cohort is composed by 178 papers, I selected among the most recent and the most cited the three described above in order to give a general idea about the path followed by the literature in the last years. For a complete information table 3 enlists the publications in the network selected according the chronological criterion (the most recent – last five years) and according to their relevance.

Table 3: articles in the cluster (last five years more than 2.0 citation frequency)

Authors	Title	Source	Year	Cit.
barth, s; barraket, j; luke, b; mclaughlin, j	acquaintance or partner? social economy organizations, institutional logics and regional development in australia	entrepreneurship and regional development	2015	1.0
broekel, t	collaboration intensity and regional innovation efficiency in germany-a conditional efficiency approach	industry and innovation	2012	2.0
doran, j; jordan, d; o'leary, e	the effects of the frequency of spatially proximate and distant interaction on innovation by irish smes	entrepreneurship and regional development	2012	2.0
feldman, mp	the character of innovative places: entrepreneurial strategy, economic development, and prosperity	small business economics	2014	9.0
ferreira, j; estevao, c	do the cluster locations really matter to regional performance? evidence from the tourism industry	transformations in business & economics	2012	1.0
fundeanu, dd; badele, cs	the impact of regional innovative clusters on competitiveness	challenges and innovations in management and leadership 12th international symposium in management	2014	1.0
herrmann, am; taks, jl; moors, e	beyond regional clusters: on the importance of geographical proximity for r&d collaborations in a global economy-the case of the flemish biotech sector	industry and innovation	2012	1.0
hervas-oliver, jl; albors-garrigos, j; de-miguel, b; hidalgo, a	the role of a firm's absorptive capacity and the technology transfer process in clusters: how effective are technology centres in low-tech clusters?	entrepreneurship and regional development	2012	2.0
hsu, sm; hsieh, ph; yuan, st	roles of "small- and medium-sized enterprises' in service industry innovation: a	service industries journal	2013	1.0

	case study on leisure agriculture service in tourism regional innovation			
huggins, r; johnston, a; stride, c	knowledge networks and universities: locational and organisational aspects of knowledge transfer interactions	entrepreneurship and regional development	2012	3.0
huggins, r; thompson, p	entrepreneurship, innovation and regional growth: a network theory	small business economics	2015	4.0
ingstrup, mb; christensen, pr	transformation of cluster specialization in the wake of globalization	entrepreneurship and regional development	2017	1.0
kalapouti, k; varsakelis, nc	intra and inter: regional knowledge spillovers in european union	journal of technology transfer	2015	1.0
lau, akw; lo, w	regional innovation system, absorptive capacity and innovation performance: an empirical study	technological forecasting and social change	2015	2.0
laursen, k; masciarelli, f; prencipe, a	regions matter: how localized social capital affects innovation and external knowledge acquisition	organization science	2012	6.0
lechner, c; leyronas, c	the competitive advantage of cluster firms: the priority of regional network position over extra-regional networks - a study of a french high-tech cluster	entrepreneurship and regional development	2012	1.0
modrego, f; mccann, p; foster, we; olfert, mr	regional entrepreneurship and innovation in chile: a knowledge matching approach	small business economics	2015	2.0
rubach, s	collaborative regional innovation initiatives: a booster for local company innovation processes?	systemic practice and action research	2013	1.0
sleuwaegen, l; boiardi, p	creativity and regional innovation: evidence from eu regions	research policy	2014	6.0
spigel, b	the relational organization of entrepreneurial ecosystems	entrepreneurship theory and practice	2017	2.0

tsvetkova, a; thill, jc; strumsky, d	metropolitan innovation, firm size, and business survival in a high-tech industry	small business economics	2014	2.0
vaz, e; vaz, td; galindo, pv; nijkamp, p	modelling innovation support systems for regional development - analysis of cluster structures in innovation in portugal	entrepreneurship and regional development	2014	1.0

The above short summary of the most important paper in the network and a rapid screen to the titles in table 3 highlight the propensity of the studies to deal with the analysis of the regional conditions in which especially firms operate. The studies stress the importance of the strategies implemented by firms in order to get the higher competitive advantage. The network, in dealing with the geographic location tends to interact with the second one. The area of common interest is delineated by the presence in both network of the studies of Huggins (2014; 2012), Laursen (2012) and Kuhlmann (2001); indeed, those studies focus their attention in the analysis of the strategies made by the different actors inside the innovative system to interact and cooperate among them in order to reshape the system getting and maintain the competitive advantage.

2.3.4 Cluster four – Absorptive Capacity and internal firms' capabilities

The fourth cluster grouped the publications regarding the internal firm capability that makes possible an effective knowledge transfer among organizations, being them both firms and universities The most relevant studies in the network are those from Cohen and Levinthal (1990) with 106 links, a total link strength of 977 and 124 citations, Almeida and Kogut (1999) with 98 links, a total link strength of 458 and 48 citations, Powell et al. (1996) with 95 links, a total link strength of 360 and 41 citations and Zahra and George (2002) with 87 links, a total link strength of 236 and 32 citations.

The study of Powell and Koput (1996) opens the discussion about the contribution given to innovation by the networks of inter-organizational relationships at firm and industry level. The paper starts from the assumption that the learning process need different kinds of organizations and organizational interacting between them in order to develop and transfer knowledge. Indeed, if is true that knowledge is acquired from collaboration on specific topic it has been demonstrated in the paper that, in the spillover stage, knowledge does not tend to follow any predetermined path but tends to be spread into multiple, unmapped directions. The stream is governed by the receptive capacity of firms that capture the knowledge thanks to the absorptive capacity and the ability to manage inter-organizational skill at managing collaborations.

At the same level is showed that is most important for firms to have a portfolio of collaborations first because they increase the opportunity to using connections to improve the inflow of information, resources, and products; and second, so they become much more proficient tending to increasing the number of collaborations with different partners.

In this environment the competition changes its character becoming not anymore a zero- sum game but a win-win relationship in which new tools for intercepting resources are develop in collaboration with competitors advanced in knowledge.

On the ground of investing the firm's internal capabilities in matter of knowledge transfer propention and readiness lies the paper written by Zahra and George (2002). The aim of the paper is to investigate the capacity of firms to intercept the knowledge flow generated by the innovation system starting from the studies in Absorptive Capacity within the different fields of the discipline such as: the strategic management (Lane and Lubatkin, 1998; Nahapiet and Ghoshal, 1998), technology management (Schilling, 1998), international business (Kedia and Bhagat, 1988), and organizational economics (Glass and Saggi, 1998). The authors suggest a new way of thinking Absorptive Capacity (ACAP) considering it a dynamic capability related to the knowledge creation and utilization that allows firms to increase and maintain a competitive advantage.

Findings of the authors are that ACAP occurs as two subsets of "*potential and realized absorptive capacities*" (Zahra and George, 2002, pg. 185). Potential capacity includes the capabilities in terms of acquisition and assimilation of the knowledge, and realized capacity aims to the knowledge transformation and exploitation.

Those studies converge on the idea that firms adapt their "behavior" according to the external innovative stimuluses. Thus, geographic location and knowledge spillovers force them to develop internal capabilities in order to cope with the environmental competition. The examined cluster closes a virtual circle around the concept of knowledge production and transfer. Indeed, the idea is that is not sufficient that firms are geographically located near the sources of innovation, or that the external environment is flourish in term of innovation production, or that they have the ability to establish linkage with the other actors within the system. To better exploit the capacity to interact within the system and to generate positive results in terms of regional development firms must be provided of internal capabilities and tools able to catch the external innovative incentives transforming them in innovation outputs.

As shown in figure 9 the chronological literature stream generated by those publications is very flourish just to mention some of the most important and recent studies we have Chaminade (2008) that focuses her attention on the shifting role of regional innovation systems and regional policies in

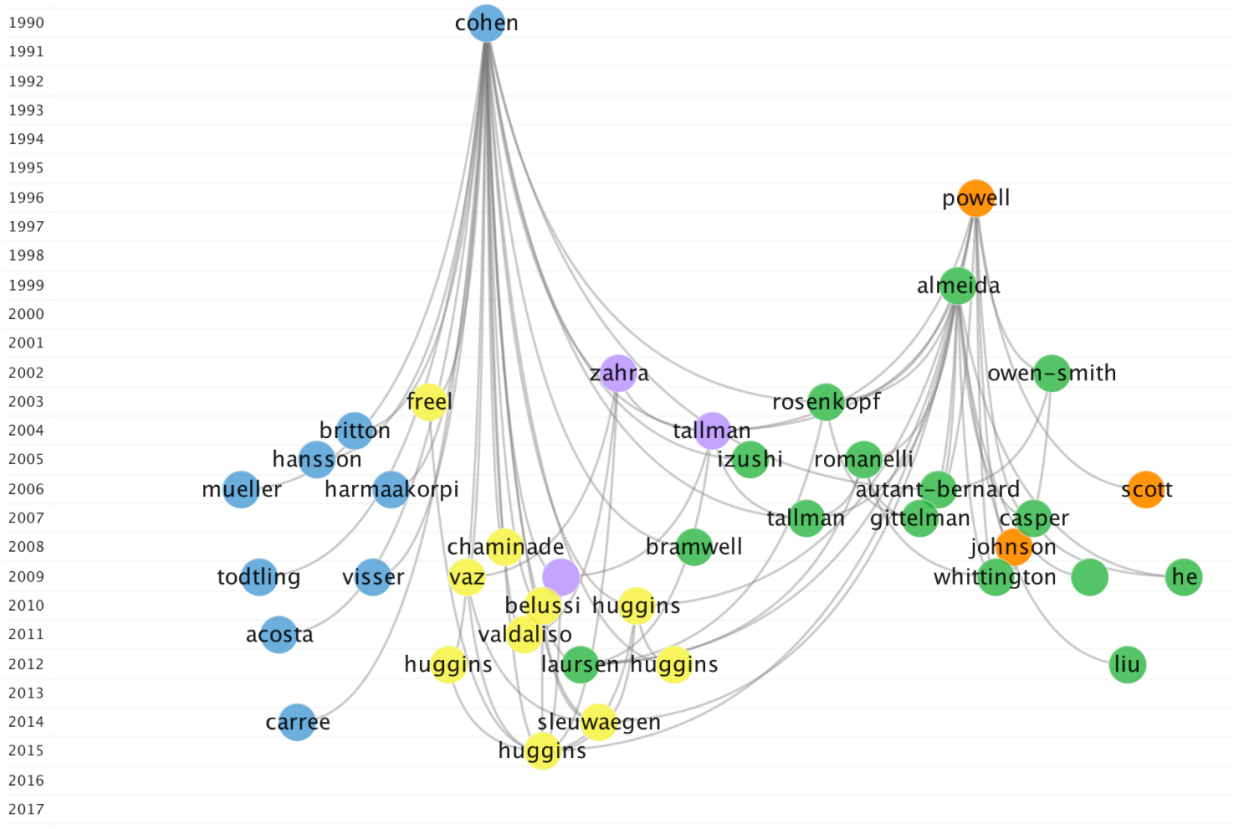
helping the transition of local firms in developing economies from competing on low costs towards becoming knowledge leader in global panorama.

Another important study is the one conducted by Laursen (2012) that deals with the regional localization of the social capital and its influence on external knowledge acquisition. Findings suggest that the firms' location in a region characterized by an elevated level of social capital gives a higher propensity to innovate.

This one entire cohort is composed by 181 papers, I selected among the most recent and the most cited the three described above in order to give a general idea about the path followed by the literature in the last years. For a complete information table 4 enlists the publications in the network selected according the chronological criterion (the most recent – last five years) and according to their relevance.

Screening the titles in subset in table 4 is possible to notice how the centrality, also in the literature stream, remains focused on the firms' ability to interact with the external environment. Firms, in order to cope within the system, adapt their strategies and their internal resources to absorb the knowledge spillover created within the system exploiting the productive opportunities given by the new sources of knowledge. It is not a case that in this stream compares terms such as "ecosystem", "internalization", "collaboration intensity" and "competitiveness".

Figure 9: expanded citations tree for cluster 4



Here the approach is purely focused on the strategies and indeed, the cluster overlaps with the precedent in studies such as: Huggins (2014, 2012; 2015), Valdaliso (2011), Whittington (2009) and Tallman (2004; 2007). Those studies consider on one hand the pursuing of the competitive advantage and on the other hand the implementation of internal strategies to reach it through the absorptive capacity closing the circle around the strategic approach used by the firms in order to get the highest competitive advantage possible according to the external innovative conditions.

Table 4: articles in the cluster (last five years more than 2.0 citation frequency)

Authors	**Title**	**Source**	**Year**	**Cit.**
alnuaimi, t; opsahl, t; george, g	innovating in the periphery: the impact of local and foreign inventor mobility on the value of indian patents	research policy	2012	1.0
bonaccorsi, a; colombo, mg; guerini, m; rossi-lamastra, c	the impact of local and external university knowledge on the creation of knowledge-intensive firms: evidence from the italian case	small business economics	2014	1.0
brekke, t	entrepreneurship and path dependency in regional development	entrepreneurship and regional development	2015	2.0
broekel, t	collaboration intensity and regional innovation efficiency in germany-a conditional efficiency approach	industry and innovation	2012	2.0
caiazza, r; richardson, a; audretsch, d	knowledge effects on competitiveness: from firms to regional advantage	journal of technology transfer	2015	1.0
carree, m; della malva, a; santarelli, e	the contribution of universities to growth: empirical evidence for italy	journal of technology transfer	2014	3.0
castrogiovanni, gj; domenech, j; mas-verdu, f	variations in sme characteristics and the use of service intermediaries for r&d	canadian journal of administrative sciences-revue canadienne des	2012	1.0

		sciences de l administration		
d'angelo, a; majocchi, a; zucchella, a; buck, t	geographical pathways for sme internationalization: insights from an italian sample	international marketing review	2013	1.0
fernandes, ci; ferreira, jjm; raposo, ml	drivers to firm innovation and their effects on performance: an international comparison	international entrepreneurship and management journal	2013	1.0
fitjar, rd; rodriguez-pose, a	firm collaboration and modes of innovation in norway	research policy	2013	1.0
giuliani, e	network dynamics in regional clusters: evidence from chile	research policy	2013	1.0
hayter, cs	constraining entrepreneurial development: a knowledge-based view of social networks among academic entrepreneurs	research policy	2016	1.0
hayter, cs	a trajectory of early-stage spinoff success: the role of knowledge intermediaries within an entrepreneurial university ecosystem	small business economics	2016	1.0
herrmann, am; taks, jl; moors, e	beyond regional clusters: on the importance of geographical proximity for r&d collaborations in a global economy-the case of the flemish biotech sector	industry and innovation	2012	1.0
hervas-oliver, jl; albors-garrigos, j; de-miguel, b; hidalgo, a	the role of a firm's absorptive capacity and the technology transfer process in clusters: how effective are technology centres in low-tech clusters?	entrepreneurship and regional development	2012	2.0
huggins, r; johnston, a; stride, c	knowledge networks and universities: locational and organisational aspects of knowledge transfer interactions	entrepreneurship and regional development	2012	3.0
huggins, r; johnston, a; thompson, p	network capital, social capital and knowledge flow: how the nature of inter-	industry and innovation	2012	3.0

	organizational networks impacts on innovation			
huggins, r; thompson, p	entrepreneurship, innovation and regional growth: a network theory	small business economics	2015	4.0
kalapouti, k; varsakelis, nc	intra and inter: regional knowledge spillovers in european union	journal of technology transfer	2015	1.0
kolympiris, c; kalaitzandonakes, n	geographic scope of proximity effects among small life sciences firms	small business economics	2013	1.0
lau, akw; lo, w	regional innovation system, absorptive capacity and innovation performance: an empirical study	technological forecasting and social change	2015	2.0
laursen, k; masciarelli, f; prencipe, a	regions matter: how localized social capital affects innovation and external knowledge acquisition	organization science	2012	6.0
liu, mc; chen, sh	mncs' offshore r&d networks in host country's regional innovation system: the case of taiwan-based firms in china	research policy	2012	3.0
lundberg, h; andresen, e	cooperation among companies, universities and local government in a swedish context	industrial marketing management	2012	2.0
marrocu, e; paci, r; usai, s	proximity, networking and knowledge production in europe: what lessons for innovation policy?	technological forecasting and social change	2013	2.0
mitchell, r; boyle, b; burgess, j; mcneil, k	"you can't make a good wine without a few beers": gatekeepers and knowledge flow in industrial districts	journal of business research	2014	2.0
mowery, dc; ziedonis, aa	markets versus spillovers in outflows of university research	research policy	2015	1.0
qian, hf; haynes, ke	beyond innovation: the small business innovation research program as entrepreneurship policy	journal of technology transfer	2014	2.0
sleuwaegen, l; boiardi, p	creativity and regional innovation: evidence from eu regions	research policy	2014	6.0

2.4 Conclusion

The present paper offers a descriptive approach on innovation and regional development in order to simplify the understanding on how the relationships between the actors within the innovation system help the technological development of the territories. This point of view has been adopted in order to highlight the key role played by the regions in the economic and technological development, to point the attention on how the regional development contributes in shaping the industrial sectors and to investigate how national and regional policies intervene in boosting the innovative capacities of all the actors involved.

Following the analyzed literature, we know that the innovative characteristics of the region are improved when firms act as innovator implementing high levels of technological development and most of all when they tend to collaborate with the other private and public actors within the system. According to this a relevant role is also played by the institutional peculiarities of the region, the scientific infrastructures, the technology transfer system mixed with the strategies adopted by the firms and their innovative performance.

However, the large use of the concepts "regional development" and "innovation" and their wide application generates a lot of interest among scholars and the broadness of the two concept is cross domain so sometimes it is difficult for scholars giving a unique point of view about the relationship between the two dimensions. As matter of facts due to the enormous and various amount of proxies used in order to capture the innovative capabilities of firms or local actors and due to the numerous quantity of proxies used to capture the innovative outputs is impossible to determinate a unique path in drawing the interdependency between innovation and regional development. But on the other hand such variety of studies gives back the idea of the dynamism of the research field and the possibility to intercept numerous economic phenomena investigating the local response to the innovation improvement. This aspect is making the study field even more interesting thanks to the implications at policies level.

International institutions, national and local governments, policies makers and scholars are focusing their attention on the local level in order to implement national and regional policies to boost the innovative capabilities at global level. As matter of facts the new challenges arising from innovation are reshaping the literature production. As seen above in the last decade the research interests are shifted from the industry and firm level to a wider level. New phenomena are interesting scholars such as the rising of the green energy, the more relevant role played by the university research, a crescent attention to the employment policies in the developing economies and the affirmation of new descriptive approaches such as the ecosystem.

The discipline is focusing its attention on answering to emerging aspects linked to the rapid innovation development and to offers new tools of analysis. Terms like “education”, “employment”, “human capital”, “sustainability”, “culture” are recently among the most used terms in the related articles. The idea is that the stream of studies is moving from the analysis of the strategies between firms to a deeper level in which the peculiarities of the system and the inside characteristics of the firms are becoming always more relevant. The target now is becoming the inner value of processes, relationships and capabilities, in this panorama an always more relevant role is played by the institutions: on one hand we have universities and research centers that have the declared goal to improve the innovative capabilities of the local environment; on the other hand we find the national and local institutions that are playing both the role of innovation booster issuing dedicated policies and as mediator in the relationships between the different actors.

According to the findings the literature is trying to offer new scenarios in which inscribe those new strategies and linkages. Indeed, the literature is moving toward the study of a new concept: the ecosystem. Scholars are trying to offer new lens to the policy makers to incentivize the harmonization of the national and regional innovation system according to the new behavior path of universities and research center. They discussion among scholars is still at an early stage since one of the most controversial point is the definition of ecosystem itself (Ritala and Almpanopoulou, 2017) or in the definition of the boundaries and the measurement of the outputs generated by the ecosystems (Autio and Thomas, 2014).

Is worthy also to mention, that the approach in the global panorama of important latecomers such as China, with the declared aim to gain the global leadership in innovation, is also forcing the discipline in studying new approaches and new theoretical framework to study the evolution of peculiar contexts such as the Chinese one and other fast growing economies.

The present paper focuses its attention in presenting an exhaustive literature framework analyzing the future research trends. The idea is to offer food for thoughts for the development of further researches and to rise interrogatives about the new tendencies in terms of relationships between the actors within the innovation system. The study shows some limitations most of them due to the exclusive use of Web of Science to select the papers sample. Others are due by the choose of the keywords that might appear wide. In the next future it might be possible to improve the level of the present research study integrating the sample of papers using also Scopus and Google Scholar; going deeper in the literature choosing more detailed keywords; reducing the research fields for the keywords (performing the research only for the titles or for the abstracts); or finally integrating the analysis considering also the affiliation of the authors or the journals ranking.

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Appendix 1

Title	Authors	Source Title	Year	Cit.	Aver.
Overcoming local search through alliances and mobility	Rosenkopf, L; Almeida, P	MANAGEMENT SCIENCE	2003	483	32,2
Knowledge, clusters, and competitive advantage	Tallman, S; Jenkins, M; Henry, N; Pinch, S	ACADEMY OF MANAGEMENT REVIEW	2004	342	24,43
Entrepreneurship, innovation and economic growth: Evidence from GEM data	Wong, PX; Ho, YP; Autio, E	SMALL BUSINESS ECONOMICS	2005	262	20,15
Determinants of innovation capability in small electronics and software firms in southeast England	Romijn, H; Albaladejo, M	RESEARCH POLICY	2002	261	16,31
Comparing innovation systems: a framework and application to China's transitional context	Liu, XL; White, S	RESEARCH POLICY	2001	255	15
Sectoral patterns of small firm innovation, networking and proximity	Freel, MS	RESEARCH POLICY	2003	219	14,6
A comparison of US and European university-industry relations in the life sciences	Owen-Smith, J; Riccaboni, M; Pammolli, F; Powell, WW	MANAGEMENT SCIENCE	2002	206	12,88
'Technology transfer' and the research university: A search for the boundaries of university-industry collaboration	Lee, YS	RESEARCH POLICY	1996	200	9,09

What is the value of entrepreneurship? A review of recent research	van Praag, C. Mirjam; Versloot, Peter H.	SMALL BUSINESS ECONOMICS	2007	179	16,27
Old is gold? The value of temporal exploration in the creation of new knowledge	Nerkar, A	MANAGEMENT SCIENCE	2003	175	11,67
Networks, Propinquity, and Innovation in Knowledge-intensive Industries	Whittington, Kjersten Bunker; Owen-Smith, Jason; Powell, Walter W.	ADMINISTRATIVE SCIENCE QUARTERLY	2009	167	18,56
Do different types of innovation rely on specific kinds of knowledge interactions?	Toedtling, Franz; Lehner, Patrick; Kaufmann, Alexander	TECHNOVATION	2009	164	18,22
Knowledge flows through informal contacts in industrial clusters: myth or reality?	Dahl, MS; Pedersen, COR	RESEARCH POLICY	2004	163	11,64
When do incumbents learn from entrepreneurial ventures? Corporate venture capital and investing firm innovation rates	Dushnitsky, G; Lenox, MJ	RESEARCH POLICY	2005	156	12
Regionally asymmetric knowledge capabilities and open innovation exploring 'Globalisation 2' - A new model of industry organisation	Cooke, P	RESEARCH POLICY	2005	145	11,15
Innovation and export performance: evidence from the UK and German manufacturing plants	Roper, S; Love, JH	RESEARCH POLICY	2002	141	8,81
Entrepreneurship, innovation and industrial development: Geography and the creative field revisited	Scott, A	SMALL BUSINESS ECONOMICS	2006	133	11,08

Incubator best practice: A framework	Bergek, Anna; Norrman, Charlotte	TECHNOVATION	2008	128	12,8
The innovating region: toward a theory of knowledge-based regional development	Etzkowitz, H; Klofsten, M	R & D MANAGEMENT	2005	126	9,69
Exploring the knowledge filter: How entrepreneurship and university-industry relationships drive economic growth	Mueller, Pamela	RESEARCH POLICY	2006	111	9,25
Universities and regional economic development: The entrepreneurial University of Waterloo	Bramwell, Allison; Wolfe, David A.	RESEARCH POLICY	2008	109	10,9
Building an innovation hub: A case study of the transformation of university roles in regional technological and economic development	Youtie, Jan; Shapira, Philip	RESEARCH POLICY	2008	108	10,8
Regional industrial identity: Cluster configurations and economic development	Romanelli, E; Khessina, OM	ORGANIZATION SCIENCE	2005	108	8,31
Location and network effects on innovation success: evidence for UK, German and Irish manufacturing plants	Love, JH; Roper, S	RESEARCH POLICY	2001	102	6
TOO MUCH LOVE IN THE NEIGHBORHOOD CAN HURT: HOW AN EXCESS OF INTENSITY AND TRUST IN RELATIONSHIPS MAY PRODUCE NEGATIVE EFFECTS ON FIRMS	Xavier Molina-Morales, F.; Teresa Martinez-Fernandez, M.	STRATEGIC MANAGEMENT JOURNAL	2009	97	10,78
How do technology clusters emerge and become sustainable?	Casper, Steven	RESEARCH POLICY	2007	97	8,82

Social network formation and inter-firm mobility within the San Diego biotechnology cluster					
Future governance of innovation policy in Europe - three scenarios	Kuhlmann, S	RESEARCH POLICY	2001	97	5,71
Does co-location matter for formal knowledge collaboration in the Swedish biotechnology-pharmaceutical sector?	McKelvey, M; Alm, H; Riccaboni, M	RESEARCH POLICY	2003	93	6,2
Spin-offs from research centers at a research university	Steffensen, M; Rogers, EM; Speakman, K	JOURNAL OF BUSINESS VENTURING	2000	93	5,17
'Energy regions': The transformative power of regional discourses on socio-technical futures	Spaeth, Philipp; Rohracher, Harald	RESEARCH POLICY	2010	87	10,88
Growth of industry clusters and innovation: Lessons from Beijing Zhongguancun Science Park	Tan, Justin	JOURNAL OF BUSINESS VENTURING	2006	86	7,17
How does new business formation affect regional development? Introduction to the special issue	Fritsch, Michael	SMALL BUSINESS ECONOMICS	2008	85	8,5
The new wave of regional innovation networks: Analysis, characteristics and strategy	Cooke, P	SMALL BUSINESS ECONOMICS	1996	85	3,86
Innovation and regional economic development: A matter of perspective?	Howells, J	RESEARCH POLICY	2005	84	6,46
R&D, firm size and innovation: an empirical analysis	Shefer, D; Frenkel, A	TECHNOVATION	2005	84	6,46
Analysing distributed processes of provision and innovation	Coombs, R; Harvey, M; Tether, BS	INDUSTRIAL AND CORPORATE CHANGE	2003	82	5,47

Does geography matter for science-based firms? Epistemic communities and the geography of research and patenting in biotechnology	Gittelman, Michelle	ORGANIZATION SCIENCE	2007	81	7,36
The development of university spin-offs: early dynamics of technology transfer and networking	Perez, MP; Sanchez, AM	TECHNOVATION	2003	81	5,4
Innovation patterns and location of European low- and medium-technology industries	Heidenreich, Martin	RESEARCH POLICY	2009	78	8,67
China's regional innovation capacity in transition: An empirical approach	Li, Xibao	RESEARCH POLICY	2009	77	8,56
Architecting gloCal (global-local), real-virtual incubator networks (G-RVINs) as catalysts and accelerators of entrepreneurship in transitioning and developing economies: lessons learned and best practices from current development and business incubation practices	Carayannis, EG; von Zedtwitz, M	TECHNOVATION	2005	77	5,92
National technology foresight activities around the globe - Resurrection and new paradigms	Grupp, H; Linstone, HA	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	1999	70	3,68
Regions Matter: How Localized Social Capital Affects Innovation and External Knowledge Acquisition	Laursen, Keld; Masciarelli, Francesca; Prencipe, Andrea	ORGANIZATION SCIENCE	2012	69	11,5
Leveraging knowledge across geographic boundaries	Tallman, Stephen; Phene, Anupama	ORGANIZATION SCIENCE	2007	69	6,27

Entrepreneurial effectiveness of European universities: An empirical assessment of antecedents and trade-offs	Van Looy, Bart; Landoni, Paolo; Callaert, Julie; van Pottelsberghe, Bruno; Sapsalis, Eleftherios; Debackere, Koenraad	RESEARCH POLICY	2011	68	9,71
Creating good public policy to support high-growth firms	Mason, Colin; Brown, Ross	SMALL BUSINESS ECONOMICS	2013	67	13,4
What drives the formation of 'valuable' university-industry linkages? Insights from the wine industry	Giuliani, Elisa; Arza, Valeria	RESEARCH POLICY	2009	66	7,33
Entrepreneurship: The role of clusters theoretical perspectives and empirical evidence from Germany	Rocha, HO; Sternberg, R	SMALL BUSINESS ECONOMICS	2005	66	5,08
Is regional innovation system development possible in peripheral regions? Some evidence from the case of La Pocatiere, Canada	Doloreux, David; Dionne, Steve	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2008	64	6,4
Measuring the knowledge base of an economy in terms of triple-helix relations among 'technology, organization, and territory'	Leydesdorff, L; Dolfsma, W; Van der Panne, G	RESEARCH POLICY	2006	64	5,33
Analyzing literature-based innovation output indicators: The Italian experience	Santarelli, E; Piergiovanni, R	RESEARCH POLICY	1996	64	2,91
Learning at the boundaries in an Open Regional Innovation System: A focus on firms' innovation strategies in the Emilia Romagna life science industry	Belussi, Fiorenza; Sammarra, Alessia; Sedita, Silvia Rita	RESEARCH POLICY	2010	61	7,62

Knowledge coherence, variety and economic growth Manufacturing evidence from Italian regions	Quatraro, Francesco	RESEARCH POLICY	2010	60	7,5
The reconfiguration of National Innovation Systems - the example of German biotechnology	Kaiser, R; Prange, H	RESEARCH POLICY	2004	60	4,29
Second generation science parks: from structural holes jockeys to social capital catalysts of the knowledge society	Hansson, F; Husted, K; Vestergaard, J	TECHNOVATION	2005	59	4,54
Clustering biotech: A recipe for success? Spatial patterns of growth of biotechnology in Munich, Rhineland and Hamburg	Zeller, C	SMALL BUSINESS ECONOMICS	2001	58	3,41
Examining the role of international entrepreneurship, innovation and international market performance in SME internationalisation	O'Cass, Aron; Weerawardena, Jay	EUROPEAN JOURNAL OF MARKETING	2009	56	6,22
Globalisation of knowledge production and regional innovation policy: Supporting specialized hubs in the Bangalore software industry	Chaminade, Cristina; Vang, Jan	RESEARCH POLICY	2008	56	5,6
THE REGIONAL INNOVATION SYSTEM IN BADEN-WURTTEMBERG	COOKE, P; MORGAN, K	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	1994	56	2,33
Networking, trust and embeddedness amongst SMEs in the Aberdeen oil complex	MacKinnon, D; Chapman, K; Cumbers, A	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2004	55	3,93
Local development and embedded large firms	Bellandi, M	ENTREPRENEURSHIP AND	2001	55	3,24

		REGIONAL DEVELOPMENT			
Knowledge flow and inter-firm networks: The influence of network resources, spatial proximity and firm size	Huggins, Robert; Johnston, Andrew	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2010	54	6,75
Co-developing products: Involving customers earlier and more deeply	Neale, MR; Corkindale, DR	LONG RANGE PLANNING	1998	54	2,7
Decline of the center: The decentralizing process of knowledge transfer of Chinese universities from 1985 to 2004	Hong, Wei	RESEARCH POLICY	2008	49	4,9
The influence of university R & D expenditures on new business formations and employment growth	Kirchhoff, Bruce A.; Newbert, Scott L.; Hasan, Iftekhar; Armington, Catherine	ENTREPRENEURSHIP THEORY AND PRACTICE	2007	49	4,45
Creating a bridge between university and industry in small European countries: the role of the Industrial Liaison Office	Jones-Evans, D; Klofsten, M; Andersson, E; Pandya, D	R & D MANAGEMENT	1999	49	2,58
Product innovation in small and large enterprises	Karlsson, C; Olsson, O	SMALL BUSINESS ECONOMICS	1998	47	2,35
The segmentation of canary island tourism markets by expenditure: implications for tourism policy	Diaz-Perez, FM; Bethencourt-Cejas, M; Alvarez-Gonzalez, JA	TOURISM MANAGEMENT	2005	45	3,46
Knowledge networks for new technology-based firms: an international comparison of local entrepreneurship promotion	Collinson, S; Gregson, G	R & D MANAGEMENT	2003	45	3
Regional competence and economic recovery: divergent	Bathelt, H	ENTREPRENEURSHIP AND	2001	45	2,65

growth paths in Boston's high technology economy		REGIONAL DEVELOPMENT			
Global gatekeeping, representation, and network structure: a longitudinal analysis of regional and global knowledge-diffusion networks	Spencer, JW	JOURNAL OF INTERNATIONAL BUSINESS STUDIES	2003	44	2,93
Geographical clusters and innovation diffusion	Baptista, R	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2001	44	2,59
Strategy and structure in innovative manufacturing SMEs: The case of an English region	Freel, MS	SMALL BUSINESS ECONOMICS	2000	44	2,44
Technological discontinuities and interfirm cooperation: What determines a startup's attractiveness as alliance partner?	Rothaermel, FT	IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT	2002	43	2,69
Technology-based regional development strategies and the emergence of technological communities: a case study of HSIP, Taiwan	Hu, TS; Lin, CY; Chang, SL	TECHNOVATION	2005	42	3,23
An ex ante evaluation framework for the regional benefits of publicly supported R&D projects	Roper, S; Hewitt-Dundas, N; Love, JH	RESEARCH POLICY	2004	42	3
In what sense 'regional development?': entrepreneurship, underdevelopment and strong tradition in the periphery	Benneworth, P	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2004	41	2,93
GLOBAL RESEARCH-AND-DEVELOPMENT NETWORKS AND LARGE-SCALE INNOVATIONS - THE CASE OF	MILLER, R	RESEARCH POLICY	1994	41	1,71

THE AUTOMOBILE-INDUSTRY					
Behind the recent surge of Chinese patenting: An institutional view	Li, Xibao	RESEARCH POLICY	2012	40	6,67
A knowledge-based typology of university spin-offs in the context of regional economic development	Bathelt, Harald; Kogler, Dieter F.; Munro, Andrew K.	TECHNOVATION	2010	40	5
The contribution of university research to the growth of academic start-ups: an empirical analysis	Colombo, Massimo G.; D'Adda, Diego; Piva, Evila	JOURNAL OF TECHNOLOGY TRANSFER	2010	39	4,88
Roles, resources and benefits of intermediate organizations supporting triple helix collaborative R&D: The case of Precarn	Johnson, William H. A.	TECHNOVATION	2008	39	3,9
What type of faculty member interacts with what type of firm? Some reasons for the delocalisation of university-industry interaction	Azagra-Caro, Joaquin M.	TECHNOVATION	2007	39	3,55
Impact of the length of relationships upon the use of research institutes by SMEs	Izushi, H	RESEARCH POLICY	2003	39	2,6
Firm collaboration and modes of innovation in Norway	Fitjar, Rune Dahl; Rodriguez-Pose, Andres	RESEARCH POLICY	2013	38	7,6
Policies to stimulate regional innovation capabilities via university-industry collaboration: an analysis and an assessment	Van Looy, B; Debackere, K; Andries, P	R & D MANAGEMENT	2003	38	2,53
Innovation and the competitiveness of industries: Comparing the mainstream and the evolutionary approaches	Castellacci, Fulvio	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2008	37	3,7

Regional social capital: Embeddedness, innovation networks and regional economic development	Rutten, Roel; Boekema, Frans	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2007	35	3,18
Strategic human resources, innovation and entrepreneurship fit - A cross-regional comparative model	Wang, ZM; Zang, Z	INTERNATIONAL JOURNAL OF MANPOWER	2005	35	2,69
Science-technology flows in Spanish regions - An analysis of scientific citations in patents	Acosta, M; Coronado, D	RESEARCH POLICY	2003	35	2,33
Drivers of national innovation in transition: Evidence from a panel of Eastern European countries	Krammer, Sorin M. S.	RESEARCH POLICY	2009	34	3,78
The contribution of external service inputs to the product development efforts of small manufacturing firms	MacPherson, A	R & D MANAGEMENT	1997	34	1,62
Network Capital, Social Capital and Knowledge Flow: How the Nature of Inter-organizational Networks Impacts on Innovation	Huggins, Robert; Johnston, Andrew; Thompson, Piers	INDUSTRY AND INNOVATION	2012	33	5,5
Why does the effect of new business formation differ across regions?	Fritsch, Michael; Schroeter, Alexandra	SMALL BUSINESS ECONOMICS	2011	33	4,71
Innovator networks and regional knowledge base	Cantner, Uwe; Meder, Andreas; ter Wal, Anne L. J.	TECHNOVATION	2010	33	4,12
The impact of 'incubator' organizations on opportunity recognition and technology innovation in new, entrepreneurial high-technology ventures	Cooper, Sarah Y.; Park, John S.	INTERNATIONAL SMALL BUSINESS JOURNAL	2008	32	3,2

Global distribution of micro-nano technology and fabrication centers: A portfolio analysis approach	Kautt, Matthias; Walsh, Steven T.; Bittner, Klaus	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2007	32	2,91
Asian development pathways and sustainable socio-technical regimes	Berkhout, Frans; Angel, David; Wieczorek, Anna J.	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2009	31	3,44
An analytical framework for science parks and technology districts with an application to Singapore	Koh, FCC; Koh, WTH; Tschang, FT	JOURNAL OF BUSINESS VENTURING	2005	31	2,38
Managing local knowledge assets globally: the role of regional innovation relays	Asakawa, K; Lehrer, M	JOURNAL OF WORLD BUSINESS	2003	31	2,07
THE INTERNATIONALIZATION OF RESEARCH-AND-DEVELOPMENT BY JAPANESE ENTERPRISES	PAPANASTASSIOU, M; PEARCE, R	R & D MANAGEMENT	1994	31	1,29
Network dynamics in regional clusters: Evidence from Chile	Giuliani, Elisa	RESEARCH POLICY	2013	30	6
Challenges for spatially oriented entrepreneurship research	Trettin, Lutz; Welter, Friederike	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2011	30	4,29
Entrepreneurship and regional competitiveness: The role and progression of policy	Huggins, Robert; Williams, Nick	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2011	30	4,29
Is inventor network structure a predictor of cluster evolution?	He, Jiang; Fallah, M. Hosein	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2009	30	3,33

New technology-based firms in Germany: a survey of the recent evidence	Licht, G; Nerlinger, E	RESEARCH POLICY	1998	30	1,5
Subsidy and networking: The effects of direct and indirect support programs of the cluster policy	Nishimura, Junichi; Okamuro, Hiroyuki	RESEARCH POLICY	2011	29	4,14
Creative destruction and regional productivity growth: evidence from the Dutch manufacturing and services industries	Bosma, Niels; Stam, Erik; Schutjens, Veronique	SMALL BUSINESS ECONOMICS	2011	29	4,14
Proximity, networking and knowledge production in Europe: What lessons for innovation policy?	Marrocu, Emanuela; Paci, Raffaele; Usai, Stefano	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2013	28	5,6
The co-evolution of business incubation and national innovation systems in Taiwan	Tsai, Fu-Sheng; Hsieh, Linda H. Y.; Fang, Shih-Chieh; Lin, Julia L.	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2009	28	3,11
Toward a 'New' Strategic Leadership of Place for the Knowledge-based Economy	Gibney, John; Copeland, Stuart; Murie, Alan	LEADERSHIP	2009	28	3,11
Competency rallying for technical innovation - The case of the Virtuelle Fabrik	Katzy, Bernhard R.; Crowston, Kevin	TECHNOVATION	2008	28	2,8
High technology localization and extra-regional networks	Britton, JNH	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2004	28	2
Technological innovation and interfirm cooperation: an exploratory analysis using survey data from manufacturing firms in the metropolitan region of Vienna	Fischer, MM; Varga, A	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	2002	28	1,75

EUROPEAN TECHNOLOGY POLICY EVOLUTION - CONVERGENCE TOWARDS SMES AND REGIONAL TECHNOLOGY-TRANSFER	ROTHWELL, R; DODGSON, M	TECHNOVATION	1992	28	1,08
Knowledge diffusion and innovation policies within the European regions: Challenges based on recent empirical evidence	Autant-Bernard, Corinne; Fadairo, Muriel; Massard, Nadine	RESEARCH POLICY	2013	27	5,4
Regional innovation systems: development opportunities from the 'green turn'	Cooke, Philip	TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT	2010	27	3,38
The product innovation process of quick-service restaurant chains	Ottenbacher, Michael C.; Harrington, Robert J.	INTERNATIONAL JOURNAL OF CONTEMPORARY HOSPITALITY MANAGEMENT	2009	27	3
Multiple Perspectives on the Challenges for Knowledge Transfer between Higher Education Institutions and Industry	Lockett, Nigel; Kerr, Ron; Robinson, Sarah	INTERNATIONAL SMALL BUSINESS JOURNAL	2008	27	2,7
Regional economic integration and R&D investment	Cuervo-Cazurra, Alvaro; Un, C. Annique	RESEARCH POLICY	2007	27	2,45
Does only size matter in the use of knowledge intensive services?	Garcia-Quevedo, Jose; Mas-Verdu, Francisco	SMALL BUSINESS ECONOMICS	2008	26	2,6
Comparing regional innovative capacities of PR China-based on data analysis of the national patents	Guan, JC; Liu, SZ	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	2005	26	2

Knowledge networks and universities: Locational and organisational aspects of knowledge transfer interactions	Huggins, Robert; Johnston, Andrew; Stride, Chris	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2012	25	4,17
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Innovative networks in manufacturing: some empirical evidence from the metropolitan area of Barcelona	Diez, JR	TECHNOVATION	2000	25	1,39
R&D networks and innovation: Decentralised product development in multinational enterprises	Pearce, R; Papanastassiou, M	R & D MANAGEMENT	1996	25	1,14
The character of innovative places: entrepreneurial strategy, economic development, and prosperity	Feldman, Maryann P.	SMALL BUSINESS ECONOMICS	2014	24	6
Geographical pathways for SME internationalization: insights from an Italian sample	D'Angelo, Alfredo; Majocchi, Antonio; Zucchella, Antonella; Buck, Trevor	INTERNATIONAL MARKETING REVIEW	2013	24	4,8
INNOVATIVE CAPACITY & PERFORMANCE OF TRANSITION ECONOMIES: COMPARATIVE STUDY AT THE LEVEL OF ENTERPRISES	Szabo, Zsuzsanna K.; Soltes, Michal; Herman, Emilia	E & M EKONOMIE A MANAGEMENT	2013	24	4,8
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Regional innovation systems and sustainability - selected examples of international discussion	Gerstlberger, W	TECHNOVATION	2004	24	1,71
Creativity and regional innovation: Evidence from EU regions	Sleuwaegen, Leo; Boiardi, Priscilla	RESEARCH POLICY	2014	23	5,75
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Ethnic diversity, entrepreneurship and competitiveness in a global city	Smallbone, David; Kitching, John; Athayde, Rosemary	INTERNATIONAL SMALL BUSINESS JOURNAL	2010	23	2,88
Explaining incubators using firm analogy	Aaboen, Lise	TECHNOVATION	2009	23	2,56
Pattern of patent-based environmental technology innovation in China	Sun, Yamei; Lu, Yonglong; Wang, Tieyu; Ma, Hua; He, Guizhen	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2008	23	2,3
A regional approach to study technology transfer through foreign direct investment: The electronics industry in two Mexican regions	Padilla-Perez, Ramon	RESEARCH POLICY	2008	23	2,3
Innovation and R&D spillover effects in Spanish regions: A spatial approach	Cabrer-Borras, Bernardi; Serrano-	RESEARCH POLICY	2007	23	2,09

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Incubator, technology, and innovation centres in Switzerland: features and policy implications	Thierstein, A; Wilhelm, B	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2001	23	1,35
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The effect of the triple helix system and habitat on regional entrepreneurship: Empirical evidence from the U.S.	Kim, Younghwan; Kim, Wonjoon; Yang, Taeyong	RESEARCH POLICY	2012	22	3,67
The research university, entrepreneurship and regional development: Research propositions and current evidence	Smith, Helen Lawton; Bagchi-Sen, Sharmistha	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2012	22	3,67
The development of University Technology Transfer stakeholder relationships at a regional level: Lessons for the future	McAdam, Rodney; Miller, Kristel; McAdam, Maura; Teague, Sinead	TECHNOVATION	2012	22	3,67
University spillovers and new business location in high-technology sectors: Spanish evidence	Acosta, Manuel; Coronado, Daniel; Flores, Esther	SMALL BUSINESS ECONOMICS	2011	22	3,14
Social capital, ICT use and company performance: Findings	Steinfield, Charles; Scupola, Ada;	TECHNOLOGICAL FORECASTING	2010	22	2,75

from the Medicon Valley Biotech Cluster	Lopez-Nicolas, Carolina	AND SOCIAL CHANGE			
Taking the ivory from the tower to coat the economic world: Regional strategies to make science useful	Hussler, Caroline; Picard, Fabienne; Tang, Ming Feng	TECHNOVATION	2010	22	2,75
The Complementary Dynamic Effects of Clusters and Networks	Visser, Evert-Jan	INDUSTRY AND INNOVATION	2009	22	2,44
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SME competitive strategy and location behavior: An exploratory study of high-technology manufacturing	Galbraith, Craig S.; Rodriguez, Carlos L.; DeNoble, Alex F.	JOURNAL OF SMALL BUSINESS MANAGEMENT	2008	22	2,2
Universities and knowledge-based venturing: finance, management and networks in London	Huggins, Robert	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2008	22	2,2
Government support for SME innovations in the regional industries: The case of government financial support program in South Korea	Doh, Soogwan; Kim, Byungkyu	RESEARCH POLICY	2014	21	5,25
R&D productivity and the organization of cluster policy: an empirical evaluation of the Industrial Cluster Project in Japan	Nishimura, Junichi; Okamuro, Hiroyuki	JOURNAL OF TECHNOLOGY TRANSFER	2011	21	3
Social capital, internationalization and absorptive capacity: The electronics and ICT cluster of the Basque Country	Valdaliso, Jesus; Elola, Aitziber; Aranguren, Marijose; Lopez, Santiago	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2011	21	3

On the contribution of public procurement to entrepreneurship and small business policy	Preuss, Lutz	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2011	21	3
From blind spots to hotspots: How knowledge services clusters develop and attract foreign investment	Manning, Stephan; Ricart, Joan E.; Rosatti Rique, Maria Soledad; Lewin, Arie Y.	JOURNAL OF INTERNATIONAL MANAGEMENT	2010	21	2,62
What do we really know about services?	Akehurst, Gary	SERVICE BUSINESS	2008	21	2,1
Entrepreneurship, innovation and regional growth: a network theory	Huggins, Robert; Thompson, Piers	SMALL BUSINESS ECONOMICS	2015	20	6,67
Inside the high-tech black box: A critique of technology entrepreneurship policy	Brown, Ross; Mason, Colin	TECHNOVATION	2014	20	5
The pursuit of knowledge transfer activities: An efficiency analysis of Spanish universities	Berbegal-Mirabent, Jasmina; Lafuente, Esteban; Sole, Francesc	JOURNAL OF BUSINESS RESEARCH	2013	20	4
Theorizing path dependence: a review of positive feedback mechanisms in technology markets, regional clusters, and organizations	Dobusch, Leonhard; Schuessler, Elke	INDUSTRIAL AND CORPORATE CHANGE	2013	20	4
Local responses to global technological change - Contrasting restructuring practices in two rural communities in Austria	Fink, Matthias; Lang, Richard; Harms, Rainer	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2013	20	4
Revisiting incubation performance How incubator typology affects results	Barbero, Jose L.; Casillas, Jose C.; Ramos, Alicia; Guitar, Susana	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2012	20	3,33

Cooperation among companies, universities and local government in a Swedish context	Lundberg, Helene; Andresen, Edith	INDUSTRIAL MARKETING MANAGEMENT	2012	20	3,33
The Impact of Related Variety on Regional Employment Growth in Finland 1993-2006: High-Tech versus Medium/Low-Tech	Hartog, M.; Boschma, R.; Sotarauta, M.	INDUSTRY AND INNOVATION	2012	20	3,33
FLEXIBLE SPECIALIZATION, THE NEW COMPETITION AND INDUSTRIAL DISTRICTS	VANDIJK, MP	SMALL BUSINESS ECONOMICS	1995	20	0,87
University effects on regional innovation	Cowan, Robin; Zinovyeva, Natalia	RESEARCH POLICY	2013	19	3,8
Intangible capital and firms' productivity	Marrocu, Emanuela; Paci, Raffaele; Pontis, Marco	INDUSTRIAL AND CORPORATE CHANGE	2012	19	3,17
How to promote cooperation in the hospitality industry Generating practitioner-relevant knowledge using the GABEK qualitative research strategy	Pechlaner, Harald; Volgger, Michael	INTERNATIONAL JOURNAL OF CONTEMPORARY HOSPITALITY MANAGEMENT	2012	19	3,17
PLACING THE CHOICE BETWEEN EXPLORATION AND EXPLOITATION IN CONTEXT: A STUDY OF GEOGRAPHY AND NEW PRODUCT DEVELOPMENT	Coombs, Joseph E.; Deeds, David L.; Ireland, R. Duane	STRATEGIC ENTREPRENEURSHIP JOURNAL	2009	19	2,11
Knowledge and innovation: The strings between global and local dimensions of sustainable growth	Vaz, Teresa de Noronha; Nijkamp, Peter	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2009	19	2,11
On the dynamics of innovation in Quebec's coastal maritime industry	Doloreux, David; Melancon, Yannik	TECHNOVATION	2008	19	1,9

Articulating the 'three-missions' in Spanish universities	Sanchez-Barrioluengo, Mabel	RESEARCH POLICY	2014	18	4,5
The role of knowledge variety and intensity for regional innovation	Tavassoli, Sam; Carbonara, Nunzia	SMALL BUSINESS ECONOMICS	2014	18	4,5
Enriching strategic variety in new ventures through external knowledge	Larraneta, Barbara; Zahra, Shaker A.; Galan Gonzalez, Jose Luis	JOURNAL OF BUSINESS VENTURING	2012	18	3
The challenge of constructing regional advantages in peripheral areas: The case of marine biotechnology in Tromso, Norway	Karlsen, James; Isaksen, Arne; Spilling, Olav R.	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2011	18	2,57
The Next Generation: Technology Adoption and Integration Through Internal Competition in New Product Development	Taylor, Alva	ORGANIZATION SCIENCE	2010	18	2,25
Local organisations and institutions. How can geographical proximity be activated by collective projects?	Filippi, M; Torre, A	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	2003	18	1,2
The changing university business model: a stakeholder perspective	Miller, Kristel; McAdam, Maura; McAdam, Rodney	R & D MANAGEMENT	2014	17	4,25
Performance of technology transfer offices in Germany	Huelsbeck, Marcel; Lehmann, Erik E.; Starnecker, Alexander	JOURNAL OF TECHNOLOGY TRANSFER	2013	17	3,4
Innovation, entrepreneurial activity and competitiveness at a sub-national level	Gonzalez-Pernia, Jose L.; Pena-Legazkue, Inaki; Vendrell-Herrero, Ferran	SMALL BUSINESS ECONOMICS	2012	17	2,83

Collaboration Intensity and Regional Innovation Efficiency in Germany-A Conditional Efficiency Approach	Broekel, Tom	INDUSTRY AND INNOVATION	2012	17	2,83
Creating advantage in peripheral regions: The role of publicly funded R&D centres	Hewitt-Dundas, Nola; Roper, Stephen	RESEARCH POLICY	2011	17	2,43
Methodological Issues in Measuring Innovation Performance of Spatial Units	Brenner, Thomas; Broekel, Tom	INDUSTRY AND INNOVATION	2011	17	2,43
Location decisions of knowledge-based entrepreneurs Why some Catalan KISAs choose to be rural?	Lafuente, Esteban; Vaillant, Yancy; Serarols, Christian	TECHNOVATION	2010	17	2,12
SUPPORT OF INNOVATION AT REGIONAL LEVEL	Sipikal, Miroslav; Pisar, Peter; Uramova, Maria	E & M EKONOMIE A MANAGEMENT	2010	17	2,12
Regional development and innovation: the role of services	Mas-Verdu, Francisco; Ribeiro Soriano, Domingo; Roig Dobon, Salvador	SERVICE INDUSTRIES JOURNAL	2010	17	2,12
Developing a framework for network and cluster identification for use in economic development policy-making	Pickernell, David; Rowe, Patricia A.; Christie, Michael J.; Brooksbank, David	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2007	17	1,55
Building regional visionary capability. Futures research in resource-based regional development	Harmaakorpi, Vesa; Uotila, Tuomo	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2006	17	1,42
The building of knowledge spaces in Mexico: a regional approach to networking	Casas, R; de Gortari, R; Santos, MJ	RESEARCH POLICY	2000	17	0,94

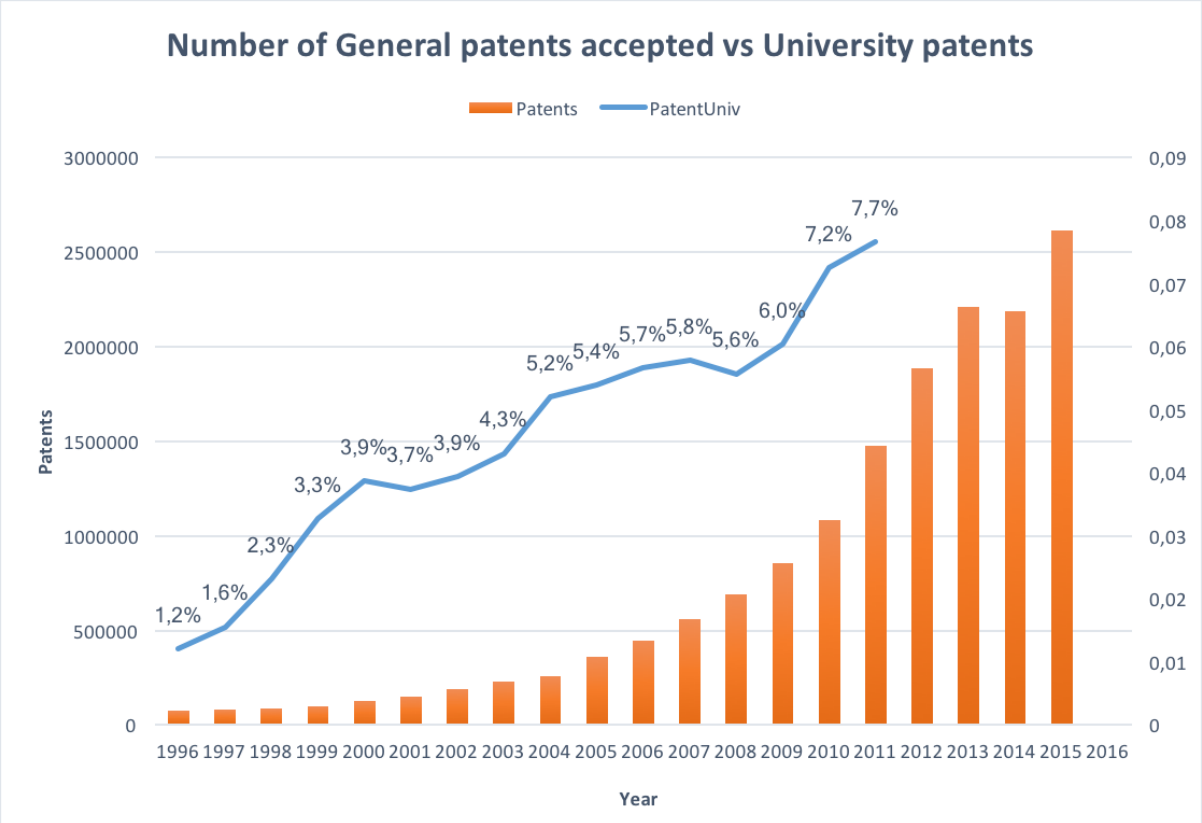
Regional innovation system, absorptive capacity and innovation performance: An empirical study	Lau, Antonio K. W.; Lo, William	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2015	16	5,33
Visualising components of regional innovation systems using self-organizing maps-Evidence from European regions	Hajek, Petr; Henriques, Roberto; Hajkova, Veronika	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	2014	16	4
Interactive learning, informal networks and innovation: Evidence from electronics firm survey in the Pearl River Delta, China	Fu, Wenying; Diez, Javier Revilla; Schiller, Daniel	RESEARCH POLICY	2013	16	3,2
MNCs' offshore R&D networks in host country's regional innovation system: The case of Taiwan-based firms in China	Liu, Meng-chun; Chen, Shin-Horng	RESEARCH POLICY	2012	16	2,67
A study of a university-led entrepreneurship education programme for small business owner/managers	Gordon, Ian; Hamilton, Eleanor; Jack, Sarah	ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	2012	16	2,67
How to improve organizational performance through learning and knowledge?	Kuo, Tsung-Hsien	INTERNATIONAL JOURNAL OF MANPOWER	2011	16	2,29
The structural, social, and strategic factors associated with successful business networks	Besser, Terry L.; Miller, Nancy	ENTREPRENEURS AND REGIONAL DEVELOPMENT	2011	16	2,29

3 Chapter 3: Behind the recent surge of Chinese university patents: A firm's absorptive capacity explanation[3]

3.1 Introduction

The past fifteen years have witnessed a sharp rising of Chinese university patents (Figure 1). Statistics from China's State Intellectual Property Office (SIPO) indicate a steady growth rate of universities and PRO patent families accounting for 13, 4% in 2015 (SIPO Annual Reports, 2016). It is likely to expect that this growth is going to continue in the near future since the ''National Patent Development Strategy'' aims to quadruple University patent applications from 2010 to 2020 (SIPO Annual Report, 2011).

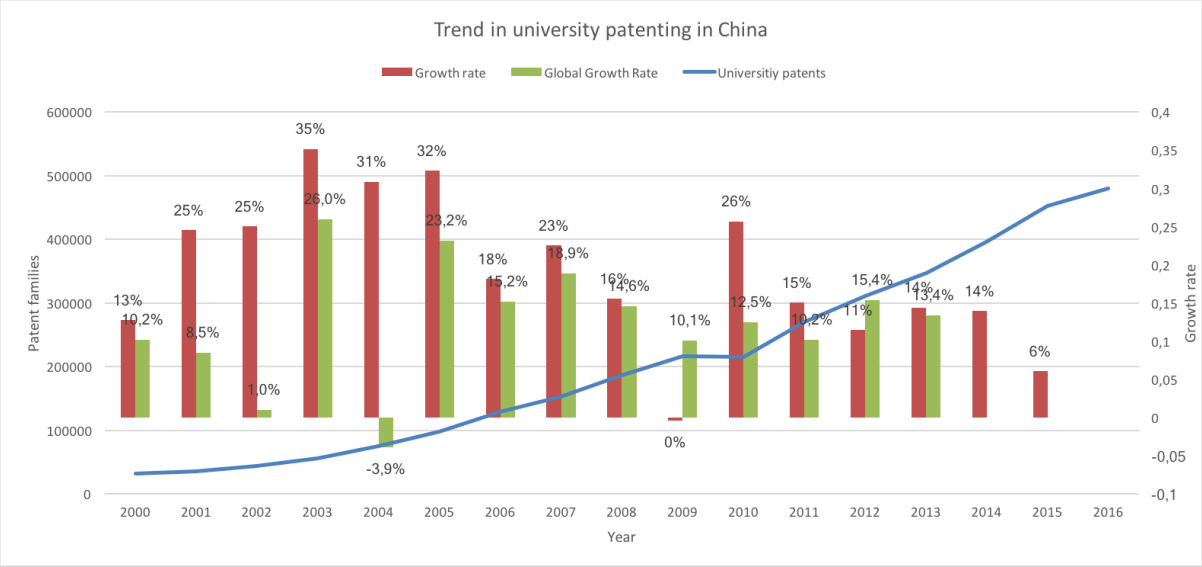
Figure 1: Chinese University Patenting versus General patents



[3] This paper is co-authored with Daniela Baglieri, Fabrizio Cesaroni e Cristina Cinici. An adapted version of the chapter has been presented at the 77th Annual Meeting of the Academy of Management, August 4th – 8th, Atlanta, USA.

The explosion of university patents outclass the worldwide trend (Figure 2) while is perfectly in line with the more general Chinese growth[4].

Figure 2: Chinese University Patents Growth Rate versus Global Growth Rate



Actually, despite numerous scholars from both economics and strategy have drawn their attention toward the surge of patenting in China (Hu, 2010; Hu and Jefferson, 2009; Keupp et al., 2012; Li, 2012; Liegsalz and Wagner, 2013), the growth of university patents has been framed mainly in terms of enhanced collaborations between university and industry. The received studies have examined in fact: (a) contingent and institutional factors – such as social and geographic proximity (Hong and Su, 2010) and subsidy programs (Fisch et al., 2016) – that favor the collaborations between Chinese universities and industrial firms (Zhang et al., 2016; Hu and Mathews, 2008;); (b) the ways firms have accessed university-level knowledge (Gao et al., 2014; Wang et al., 2015, 2013) as well as (c) the impact of such knowledge on firm innovation outputs (Luan et al., 2010). Whether public expenditures in S&T and private investments in R&D boosting innovative capability and competitiveness of firms affect Chinese university research outputs is still a matter of debate.

Clearly, Chinese patent growth, including university patents, has not been fostered by any single event. A range of legal, political and economic factors triggered the growth spiral.

Firstly, China promulgated its patent law on March 12, 1984 (in force on April 1, 1985). In 1985, China became a member of the Paris Convention for the Protection of Industrial Property followed

[4] According to the 2015 Annual Report of the State Intellectual Property Office of the P.R.C. (SIPO), Chinese innovators filed the most patent applications (1,010,406) in 2015 (up by 18,5% year on year), followed by those from the United States of America (526,296) and Japan (454,285). On the ground of these applications, patents granted to domestic applicants were 263,000 among which 159,000 (accounting for 66, 5%) were granted to enterprises, and 76,000 (accounting for 31, 8%) to universities and scientific research institutes.

by the Patent Cooperation Treaty in 1994. When China joined the World Trade Organization (WTO) in 2001, it became a member of the TRIPs (Trade-Related Intellectual Property Rights) agreement. To comply with its international obligations, as well as to facilitate its development into an innovative country, China has amended its Patent Law three times: first in 1992, then again in 2000, and most recently in 2009. The resulting patent system meets the international standard and is largely comparable with the ones adopted by most of the developed countries (Liegsalz and Wagner, 2013; Sun, 2003). For instance, the current system is based on the ‘‘first-to-file’’ principle and the requirements for patentability include the criteria of novelty, utility, and non-obviousness. Moreover, patents are published 18 months after the date of filing of the application, and patent rights are granted for a period of 20 years (Sun, 2003; Tang, 2008; Yang, 2008).

Secondly, the Chinese government embarked on the implementation of the 2006 “Medium to Long–term National Plan for Science and Technology Development 2006–2020” (MLP). The MLP called for China to become an “innovation society” by the end of 2020 and a world leader in science and technology by the end of 2050. The government introduced as well the “National Intellectual Property Strategy” in 2008 (planned since 2005) and the “National Patent Development Strategy” (2011-2020) in 2010. All these maneuvers aimed at improving China’s capacity to create, utilize, protect and administer its intellectual property.

Thirdly and finally, the economic context showed a higher patent propensity too over the last two decades. It was due to the strengthening of public expenditures in S&T, private investments in R&D, inflow of foreign direct investments (FDI), number of non-state enterprises, new technologies and the shift in industrial structure toward more innovative industries (Hu and Jefferson, 2009; Li, 2012).

In spite of the above efforts, several pieces of the puzzle are still lacking. It is still unclear to what extent public expenditures in S&T and private investments in R&D have affected the jump of university patents. While most of the received studies have documented the university contribution to the patent generation, scholars have left open the question as regards the specific roles of public and private investments in R&D in influencing Chinese innovative capability (Fisch et al., 2016; Hu and Mathews, 2008; Huang and Wu, 2012).

To address our research question, we estimated three OLS regression models and measured the impact of public expenditures in S&T and private investments in R&D in a sample of 86 Chinese Universities that have filed and owned 10,633 granted patents on Carbon Nanotubes. As a part of recent literature has been concerned that the huge quantity of patents produced by economic and legal reforms brings about a decline in the quality of Chinese patents (Hong and Su, 2013; Li, 2012), we also tested two measures of patent quality, i.e., claims and citations.

The results are counterintuitive and partially contradict the paper's hypotheses thus opening new streams of research in the strategic literature and offering good insights to policy makers. They show that public effort in S&T generates a positive impact on the number of patents filed by universities. However, the role of private firms seems controversial, since foreign direct investments at the regional level show a negative impact on the dependent variable and R&D expenditure of private firms is not statistically associated to the number of university patents.

The paper has several theoretical contributions. Firstly, it contributes at analyzing the jump of Chinese patents taking into account simultaneously both public expenditures and private investments that have affected innovative capabilities and supported the university research activities. In so doing, it fills an important gap in the literature that has neglected so far the firm-specific explanations of the university patent growth due to the lack of data. Second, it sheds new light on the relationships between the specific source of investments in innovative capacity and patents growth. Particularly, it put emphasis on the fact that expenditure in S&T and investments in R&D generate a different effect on patent production. Our results provide guidance also to policy makers.

The remainder of the paper is organized as follows. The next section discusses the literature review and develops the hypotheses. Section 3 describes setting, data and empirical model. Section 4 presents the results. Section 5 discusses both policy and research implications drawn from empirical results. Section 6 outlines the avenues for future research and concludes.

3.2 University patents & R&D Investments

Unlike other East Asian Tigers (such as Korea, Japan and Singapore), universities in China are significant sources of patents (Hu and Mathews, 2008; Liu and White, 2001; Liu et al., 2016). Universities comprise two-thirds of the top ten institutions (Kostoff et al., 2007) and account for six of the top ten domestic Chinese institutions that granted the most invention patents in 2015 (SIPO, 2015). Chinese universities are highly concentrated on the east coast. Research output is similarly concentrated on the east coast, which is home to eight out of China's top 10 most productive universities in terms of patent applications (Table 1).

Table 1: Top 10 Chinese Colleges and Universities Filing the Invention Patent Applications in 2015

No.	Name of University/College	Number of Patents
1	Zhejiang University	2739
2	Harbin Institute of Technology	2577
3	Southeast University	2120

4	South China University of Technology	2068
5	Shanghai Jiao Tong University	1838
6	Guangxi University	1825
7	Tsinghua University	1823
8	Tianjin University	1797
9	University of Electronic Science and Technology of China	1636
10	Jiangnan University	1627

3.2.1 Public expenditures in S&T

Chinese universities have strongly benefited of the numerous programs the government has introduced to develop a network of comprehensive research universities able to produce world-class research and compete for the world's brightest minds (Hu and Mathews, 2008). Among these research funding initiatives, two programs are worthy of attention, namely "Project 985" and "Project 211"[5]. Project 985 was first announced in 1998 and re-launched in 2004. It has been described as '*'a critical component of one of the largest sustained increases of investment in university research in human history*'' (Zhang et al., 2013). In contrast to the cost refund subsidy, this subsidy program was primarily intended to increase research productivity and excellence of selected universities by means of large investments (Yang and Welch, 2012). In total, 39 universities have been selected to receive approximately 32 billion RMB (roughly 5 billion USD) in total funding (Zhang et al., 2013).

Project 211 is a priority-funding policy that channels extra money to the nation's top universities. It was first announced in 1993 and implemented in 1995. In all, approximately 100 universities have been approved to receive additional funding to improve facilities and curriculums within some or all of their academic departments. Particular emphasis has been placed on programs that will positively affect the country's social and economic development, scientific and technological advancement and national defense system. Other key measures associated with the project included the commercialization of research findings, reform of university administration and management and strengthening of international cooperation and exchanges (Yang and Welch, 2012). According to the office data, at the end of the first phase in 2000, the amount of the funds distributed among the selected universities accounted for approximately 2.2 billion U.S. dollars (Lixu, 2004).

[5] For an extensive review of the subsidy programs that have supported university research activity over time, please see Chen et al. (2016).

On the ground of an extensive literature, which acknowledges that the higher the investments in R&D the higher the number of generated university patents (Griliches, 2007; Laursen and Salter, 2004; Mowery and Sampat, 2004; O'Shea et al., 2005), previous studies have speculated on the effectiveness of the above depicted Chinese programs and, more in general, of public investments in S&T. Hu and Mathews (Hu and Mathews, 2008) documented that well financed universities demonstrate to educate well- trained labor force and to generate a significant number of spin-offs. Well-trained human resources and spin-off firms from universities are conceived as viable sources of patentable inventions (Yuan et al., 2016; Zahra et al., 2007). Similarly, Huang and Wu (Huang and Wu, 2012) identified R&D expenditures and universities' personnel as important drivers of patenting in the nanotechnology sector. Li (Li, 2012) explained how regional patent subsidy programs have encouraged the increase in the number of university patent applications at an aggregated regional level and eventually favored an increasingly patent- friendly legal environment. Eventually, Fisch et al. (Fisch et al., 2016) argued that subsidy programs to promote research excellence at selected universities are significant drivers of patent quantity. Accordingly, we hypothesize:

Hypothesis 1a (H1a): Public expenditures in S&T impact positively on the number of Chinese university granted patents.

3.2.2 Private investments in R&D

Being the second largest economy in the world, China spends a tremendous amount on R&D (in 2016 corresponding to 2.07% of GDP) with the business sector increasing its share over government and performing over 70% of China's R&D expenditures (Hu and Jefferson, 2009). According to the data of the China's National Bureau of Statistics, state-owned firms are by far the most R&D intensive, spending an average of 4.4 - 4.5 % of sales in R&D. Foreign firms contribute for 1.7% of their sales. Private firms are the least R&D intensive, contributing the equivalent of 1.3 – 1.4 % of their sales to R&D (Hu and Jefferson, 2009).

A consistent body of empirical literature has provided ample evidence that private investments represent the major source for academic research and eventually a good engine for university patent generation (Etzokowitz and Leydesdorffb, 2000; Rosenberg, 1990; Wright, 2014). Especially in high-tech industries, such as the selected ones by Chinese government to be boosted, private firms fund basic research and search for university collaboration while aiming for radical scientific advancements and technological improvements (Guerzoni et al., 2014). Funding partnerships with universities help private firms access skills, monitor new developments and undertake exploratory research in areas outside their core business (Marotta et al., 2007). Eventually, it can help coordinate R&D agendas and avoid duplications, stimulate additional private R&D investment (additionality

effect), and exploit synergies and complementarities of scientific and technological capabilities (Perkmann et al., 2013). Efficient technological collaborations lead to spin off or patents that can be commercially exploited. Owing to the amount of significance investment needed, Chinese patent growth has been driven more by state sponsored programs subsequently followed by private investments (Zhang et al., 2010). The major part of these investments have been mainly focused on applied research, capital equipment and buildings, both public expenditure in S&T and private investments in R&D. Considering all these issues together, we hypothesize:

Hypothesis 1B (H1b): Private investments in R&D impact positively on the number of Chinese university granted patents

3.2.3 The quality of Chinese university patents

Patent quality captures the technological and economic value of patented inventions as well as the possible impact that these might have on subsequent technological developments. Claims and citations can be considered two reliable indicators for patent quality. In fact, on the one side, the number of patent claims define the legal boundaries and the inventor's exclusionary rights. It also reflects the economic value of a patent (Lanjouw and Schankerman, 2004, 2001; Tong and Frame, 1994). On the other side, citations received by subsequent patents mirror technological importance for subsequent innovations (Trajtenberg, 1990).

Several studies have argued that subsidy programs have caused Chinese applicants to file low-quality patents and obtained puzzling results. By looking at the grant ratio from 2000 to 2008, Li (Li, 2012) found an increase in the quality of patent applications. Thoma (2013) evaluated the quality of Chinese patent applications in the European Patent Office (EPO) and concluded that applications have shorter renewal life cycles. However, he argued that, because of the high cost of patenting abroad, firms may patent only inventions with high economic value in the EPO or U.S. Patent Office. Dang and Motohashi (Dang and Motohashi, 2015) provided evidence that subsidizing the filing fee generates applications of lower quality. And more recently, Fisch et al. (Fisch et al., 2016) revealed that a subsidy program to promote research excellence at selected universities is a significant driver of patent quantity and quality. Accordingly, considering claims and citations as proxies for patent quality, we hypothesize:

Hypothesis 2 (H2): Public expenditures in S&T and private investments in R&D positively influence patent claims.

Hypothesis 3 (H3): Public expenditures in S&T and private investments in R&D positively influence patent citations.

3.3 Methodology: Setting, data and empirical model

To test the hypotheses stated above we focused on the latest discoveries of the nanotechnologies. Specifically, we selected the bunch of patents owned by Chinese Universities on Carbon nanotubes (CNTs) in the period 2000 to 2016 and ran our econometric model.

3.3.1 Nanotechnologies and CNTs

Nanotechnology is the "*first major worldwide research initiative of the 21st century*" and increasingly considered to be the "*foundation of the world's next economies*"(Mangematin and Walsh, 2012). For nanotechnologies' properties of acting both as basis for technology solutions and at the convergence of other enabling technologies, such as biotechnologies, computational sciences, ICTs, and so on so forth, scholars - from both management and engineering sides - have labelled them as a general-purpose technology (Helpman, 1998; Schultz and Joutz, 2010; Shea, 2005).

Since nanotechnologies focus on the measure of materials rather than a particular application (Kostoff et al., 2007), over time they have interested a very huge range of technological domains (Islam and Miyazaki, 2010). Among all, one of the most promising technological fields in terms of prospective market is that of CNTs. Applications of CNTs cover a broad range of industries including plastics and composites, electrical and electronics, and energy, as well as a range of industrial sectors. CNTs are utilized as fundamental component or reinforcement material for these industries, and their usage is going to increase in the next future (Baglieri et al., 2014). Structural physical properties of CNTs make them unique and extraordinary. CNTs are extremely high electrical and thermal conduciveness; tip-surface area close the physical theoretical limit – the smaller the tip-surface area, the more concentrated the electric field, and the greater the field enhancement factor; they present a very small diameters (less than 100 nm) and outstanding mechanical properties, excellent is their price-performance ratio that increase their economic valuable.

3.4 Dataset

3.4.1 Chinese Universities search and selection

Our sample is composed of patents owned by 86 Chinese Universities. According to the latest data (2015) of People's Republic of China Ministry of Education, in China there were 2,246 regular institutions of higher education with more than six million enrollments in total. These institutions included universities and colleges offering specialized courses. Our dataset was structured identifying, among the 2,246 institutions, only universities and public research centers with at least 10 patents registered in CNTs.

3.4.2 Patent search, selection and analysis

We searched, selected and analyzed 10,633 patents on CNTs. Specifically, data were extracted from the FamPat worldwide database (Questel-Orbit version May-October 2016) which provides details on more than 100 million patent applications and grants. The search for patents was performed in September 2016 - hence patents published after this date were not considered in this study. The selection of patents has been done automatically by typing the query "carbon nanotube*" in the full text. The selected patents were grouped by patent family. Eventually, the statistical analysis was performed with Orbit IP Business Intelligence web based patent analysis from Questel.

3.4.3 Econometric model

The model used in this study is a structured dynamic panel model with fixed effect and robust standard errors for clustering the regional differences. The equation to be estimated and analyzed in this study is:

$$Y_{it} = \alpha + \beta X_{it} + \gamma Z_{it} + \varepsilon_i$$

ε= Error term.

α, β= Coefficients to be estimated.

i= 1, …, n (number of universities).

t= 2000, …, 2016 (years of observations).

Where the dependent variable is alternatively (Table 2):
NPAT is the number of patents on CNTs registered by universities;
Claims considers the number of claims of the selected cohort of university patents. According to the literature (Lanjouw and Schankerman, 2001) claims specify the property rights protected by the patent. The principal claims define the fundamental novel features of the invention and subordinate claims describe detailed features of the innovation. So the more claims the patent contains the broader is the technological application of the patent;
Citations depicts number of forward citations received by the selected cohort of patents. According to the literature (Jaffe and Trajtenberg, 2002) citations are a signal of the social value of the invention and are used as quality indicator.

The independent variables are:

Pub is the number of scientific publications

Hindex is the university's impact factor calculated on the number of publications, the number of publications backward and forward (source: Web of Science);

Coassi is the dummy variable to identify if the patent property is shared with other subjects, 1 for yes 0 for no;

GRP is the level of Gross Regional Product per capita of the region;

S&Texp reflects the amount of public expenditures for Science and Technology promotion;

S&Texp2 depicts the square of the previous variable in order to catch up the existence of returns to scale.

S&Tperpubl reflects the number of personnel employed in Science and Technology in the public sector;

R&Dprivexp is the total amount of the expenditure in Research and Development in the private industry;

FFE: number of foreign funded enterprises. Foreign Investment refers to foreign cash, technology, and equipment that the Chinese government, departments, firms and other economic organizations raise through attracting foreign direct investment and other ways (National Bureau of Statistics).

Table 2: List of variables

Variable	**Type**	**Explanation**	**Source**
NPAT	Dep.	N. of patents in CNT granted	Qpat-Orbit database
Claims	Dep.	N. of Claims University/Region	Qpat-Orbit database
Citations	Dep.	N. of Citations University/Region	Qpat-Orbit database
Pub	Control.	N. of Universities' publications	web of knowledge database
Hindex	Control	H-index of universities' publications	web of knowledge database
Coassi	Indep.	Dummy for co-assignee presence	Qpat-Orbit database
GRP	Control	Gross Regional product	Chinese Statistical Bureau Database
S&Texp	Indep.	Public expenditures in S&T at Regional level	Chinese Statistical Bureau Database
S&Texp2	Indep.	S&Texp squared	Chinese Statistical Bureau Database

S&Tperspubl	Indep.	Employees in S&T in public institutions and universities at Regional level	Chinese Statistical Bureau Database
RDprivexp	Indep.	Private expenditures in R&D at Regional level	Chinese Statistical Bureau Database
FFE	Indep.	Investments of Foreign Funded Enterprises at Regional level	Chinese Statistical Bureau Database

3.5 Results

Table 3 presents the OLS regression results.

Variable	(1) NPAT		(2) Claims		(3) Citations	
Pub	3.64***	4.10***	2.86***	2.49**	2.13**	1.60
	(0.001)	(0.000)	(0.005)	(0.014)	(0.036)	(0.112)
Hindex	0.32	-0.31	0.32	0.03	0.11	-0.28
	(0.752)	(0.757)	(0.752)	(0.980)	(0.910)	(0.783)
Coassi	-1.72*	-1.80*	-1.53	-1.55	-1.24	-1.33
	(0.090)	(0.073)	(0.128)	(0.122)	(0.217)	(0.187)
GRP	-1.97*	-1.43	-1.19	-0.86	-0.69	-0.27
	(0.052)	(0.156)	(0.235)	(0.393)	(0.493)	(0.788)
S&Texp	2.46**	4.24***	4.28***	2.86***	4.87***	3.69***
	(0.016)	(0.000)	(0.000)	(0.005)	(0.000)	(0.000)
S&Texp2	-	-2.41**	-	-1.06	-	-1.78*
		(0.017)		(0.290)		(0.077)
S&Tperspubl	1.59	1.09	0.81	0.98	-2.78***	0.38
	(0.116)	(0.278)	(0.420)	(0.330)	(0.006)	(0.702)
RDprivexp	-1.67	-2.99***	-2.88***	-2.86***	-2.48**	-2.96***
	(0.101)	(0.003)	(0.005)	(0.005)	(0.015)	(0.004)
FFE	-2.29**	-3.65***	-2.75***	-2.92***	-2.48**	-2.97***
	(0.025)	(0.000)	(0.007)	(0.004)	(0.015)	(0.004)
Obs.	215	215	207	207	192	192
F	(8,67)	(9,138)	(8,133)	(9,132)	(8,117)	(9,116)
	8.94	13.66	6.92	6.28	6.77	6.48

* p<0.10; ** p<0.05; *** p<0.01

As far as model 1 is concerned, results of our estimations show that public effort in S&T generate a positive impact on the number of patents filed by universities. However, the role of private firms seems controversial, since foreign direct investments at the regional level show a negative impact on the dependent variable and R&D expenditure of private firms (RDprivexp) is not statistically associated to the number of university patents. Thus, apparently, the more private firms invest in

R&D at the regional level, the less universities develop patented research outcomes. This result partly contradicts H1. Furthermore, the presence of co-assignee generates a negative impact on university patents, very likely because universities tend to maximize the public investments in S&T acting as research partners of the private firms.

The second part of the first model aims to verify whether the effect of public S&T expenditures on university patenting shows increasing or decreasing returns (Madsen, 2007). The effect is caught through the variable on S&T expenditures squared. Outcomes of the model mainly confirm prior results and show the presence of diminishing returns of public S&T expenditure on university patents. In turn, the more regional governments invest in S&T, the more universities file patents, even though the number of patents filed diminishes the higher the level of regional S&T expenditure.

The negative effect of FDIs is confirmed also in this model. Moreover, results show that also R&D investments of private firms negatively affect university patenting, thus reinforcing the conclusions emerged by looking at the first part of Model 1. Also in this case, H1 is only partly confirmed.

Model 2 considers the average of the number of claims of university patents at the regional level as dependent variable. As mentioned above, claims are a measure of the technology breadth (generality) and of the applicability of patents. The larger the number of claims included in a patent, the broader its applicability, that is, the higher the possibility to apply that patent in diverse application fields. According to such an interpretation, results of estimations show that public investments in S&T induce universities to develop more general purpose technologies (patents with higher number of claims).

By contrast, private investments in R&D (both of local and foreign firms) do affect negatively the number of claims of university patents, and this result contradicts expectations of H2. Even though a conclusive interpretation of such results cannot be offered, it is possible to presume that they reflect the tendency that foreign firms had in the past to locate their manufacturing facilities in China mainly to take advantage of the reduced labour cost. During the last years, however, this tendency has mainly reversed. Foreign firms locate their facilities in China (also) to profit from local research capabilities and to collaborate with local Chinese universities. According to our results, however, in doing so they influence universities' patenting policy, by pushing for more specialized patents. The same pattern seems to apply to local private firms, whose investments in R&D induce universities to develop patents characterized by a lower number of claims (i.e., more specialized patents). In turn, in those regions where local private firms invest more in R&D and the presence of foreign direct investments is higher, universities generate patents that respond to the direct needs of the market. Thus, Model 2 seems to suggest that the stronger the private investment in R&D, the university research activity is more focused and market driven.

Similar conclusions can be drawn by looking at results of Model 3. The model considers the number of forward citations received from patent as dependent variable. As recalled above, citations are a proxy of the quality of patents. The more citations a patent receives, the greater is the influence that the patent has on the technological arena. As shown by Table X, public S&T expenditures do have a positive impact on the number of citations of university patents. So, when local governments invest more in S&T, local universities develop more impactful research outcomes. However, as demonstrated by the second part of Model 3, such effect presents diminishing returns, and the increase in the number of patent citations diminishes the higher the level of public investment on S&T.

By contrast, the impact of private R&D expenditure and of foreign direct investments on patent citations is negative. Again, similarly to the case of claims, these results seem to confirm that in those regions where the presence of private (local or multinational) firms is more intensive, universities tend to promote research that responds to the needs of the local technology market, albeit being less general and less impactful.

3.6 Discussion

3.6.1 Policy implications

Clearly, Chinese University patent growth has not been fostered by any single event. China has gradually redesigned the policies, institutions and incentives required to stimulate innovation in academia and business. Economic reform and a relatively stronger legal system have together created a more patents-friendly environment and have fostered the surge of patenting. We tested whether public and private R&D investments intervene in explaining the growth of Chinese university patents too.

Overall, our results offer an interesting and somehow unexpected interpretation. While the effect of public investments in S&T on university research activity largely meets expectations, the effect of private R&D investments seems counterintuitive (and largely contrasting our hypotheses). What emerges from our analyses is that private firms do strongly impact on universities' patenting activity. Firstly, universities file a lower number of patents with respect to regions with a lower level of private investment in R&D. Secondly, patents have different characteristics, being less generic (more specialized) and less impactful (lower number of citations). At the end of the day, private firms push the universities' and public research centers' research agenda according to their own industrial and technological orientation.

The results bring some suggestions to policy makers. Firstly, the R&D investment are amongst the fundamental driving force of the patent applications growth. However, a simple increase in R&D

investments does not necessarily imply a transformation from "technological follower" to "technological leader" and a change in efficiency of innovation capabilities. It is evident that other factors play important roles such as those related to the interactions and communications amongst actors. Secondly, in many cases, the policies' objective should not to simply increase investments in R&D but rather to foster appropriate long-term partnerships between universities and industry. In more details, institutional practices and national resources should focus on ensuring the conditions that allow new knowledge and technologies to be easily and rapidly absorbed and adapted by industries.

3.6.2 Research implications

Findings support and complement previous researches on Chinese patenting activity.

The results of our models, which take into account also data at firm-level, confirm the study by Xie and Zhang (2015) in that private firms have been the engine of innovation and contribute to delineate the role of firms in the growth of Chinese University patents growth. As emphasized by those authors, this role had been neglected due to lack of firm-specific patent data. Our findings are also consistent with Hong's study (2008) that highlighted the relevance of universities in the Chinese innovation system, described a strong connection between industry and university, and emphasized regional peculiarities in the knowledge transfer from university to industry.

Since they distinguish the contribution to patent generation of public expenditure from private investments, results contribute to solve the concern of Hu and Mathews (2008) and Huang and Wu (2012). The former authors documented that despite universities demonstrate to educate well- trained labor force and to generate a significant number of spin-offs, R&D investments have played less of a role in building innovative activity than would be expected. The latter authors identified R&D expenditures and universities' personnel as important drivers of patenting in the nanotechnology sector. At the same time, they retained uncertain whether and when local industry have benefitted from investments in R&D.

More importantly, our results shed new light on the private firms' capacity to absorb tacit knowledge from academia. It is generally accepted that for being successful relationships between firms and industry should be facilitated by an adequate level of absorptive capacity (Fabrizio, 2009; Kodama, 2008). The concept of "absorptive capacity" is a familiar one in innovation debates, and was first introduced by Cohen and Levinthal in 1990 to describe an individual firm's "ability to recognise the value of new information, assimilate it and apply it to commercial ends." Its dimensions span from the acquisition of external knowledge to more specific abilities in order to assimilate, transform and apply knowledge (Camison and Fores, 2010). Our findings suggest that according to their absorptive

capacity, private investments in R&D influence university research activities. In other words, as additionally demonstrated by claims and citations, firms press university to produce knowledge codified in patents that they are able to acquire, assimilate, transform and apply.

3.7 Conclusion

Universities have largely contributed to the surge of Chinese patenting with an impressive growth rate that has been driven also by high level of investments, both public and private sourced. We found that public expenditures in S&T generate a positive impact on the number of patents filed by universities, while the role of private firms seems controversial. In so doing, the study contributes to at least two lines of research. On the one hand, it contributes to make it clearer the reasons underlying the surge of Chinese patenting. On the other hand, it clearly distinguishes between the effects of public and private investments in R&D.

Although these interesting results, the study is not without limitations. The major one is that it draws data from one setting, i.e., nanotechnologies. Additionally, the study does not take into account small firms. Even if nanotechnologies are considered of strategic importance by Chinese government and research on nanotechnologies is largely funded by medium and large firms, we are not able to say whether our findings can be generalized to other industries or are likely to vary across different types of technologies and firms.

Nevertheless, it would be important to understanding heterogeneity in the relationship between university patents and research investments across industries and firms; it is on our future research agenda.

The present study shows some limitations and it is opened to further implementations especially in the econometric model. Improvements might regard the econometric model checking for some more control variables and for implemented robustness tests.

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4 Chapter 4: All that glitters is not gold. Innovation, patents and innovation policies in China.

4.1 Introduction

Literature in innovation is often centered on cross-country evaluations of innovative implementation based on the structures and dynamics of national innovation systems through comparative studies (Freeman, 2002; Lundvall, 1992; Nelson, 1993).

Countries in the World present a heterogeneous innovative framework. Innovation implementations differ not only between countries but also with-in the countries (Acs et al., 2002; Evangelista et al., 2001; Fritsch, 2002). Analyzing large countries, according to Edquist (Edquist, 2010), the national innovation system approach risks to be less relevant because of the stressed differences at regional level.

China, being one of the largest fast growing economies in the world, confirms this statement. Chinese economic and innovative landscape is in rapid transformation thanks to a rapid increment of the economic and technological development, this implies that the national innovation system is under transition from a central planned to a market-driven system (Li, 2009).

Following the approach suggested by Li (Li, 2009) this paper considers Chinese regions as independent innovative systems and analyzes the role-played by Universities, as knowledge generator, in regional development in fast growing emerging economies.

One of the most utilized tool to measure the level of innovation is the number of registered patents; China has been experimenting a massive increment of patenting activity interesting scholars from all around the World; the phenomenon has been studied from different points of view. The most targeted issue, in the studies, is still how the quantity increase affected the general qualitative level of the outputs.

The present research work suggests a different interpretation studying the impact of the innovation outputs on the general economic growth. In doing so the paper points out the attention on two different levels. The first is the institutional level analyzing the differences, on the economic growth, made by universities or private patents. The second level is the regional one, investigating the efforts given by the patent promotion policies. Since the end of 90s Chinese central government pushes regional authorities in issuing policies devoted to promotion of “domestic invention” so regions, within the first decade of the new millennium, adopted incentives to the patent activity.

Scholars tend to measure the impact of the subsidy policies analyzing, alternatively, the patent growth in number or the increment of the quality level. The present research, instead, points out the economic impact generate by promoting innovation considering the growth of Gross Regional Product per capita. Conventionally the reason behind the choice of patenting lies in protecting the invention from plagiarism or non-authorized market activities. However there are other strategic reasons that push to patent such as to hold up the competitors inventions or to have instrument to conduct also legal battles. According to this point of view one of the most interesting peculiarities of the Chinese environment is that the process of patenting promotion is totally leads by the central government being part of an entire strategy that aims to transform Chinese economy form imitation-based to innovation-based.
The quantitative analysis in the present paper has been conducted crossing three different longitudinal dataset. The first dataset from 1999 to 2015, from the National Bureau of Statistics of China (NBS) reports data aggregated to regional level, the second database, extracted by Q-Pat Orbit database reports data about universities patents applications and the third self-assessed database reports dummies, at regional level, about the application of the patent subsidy program.

4.2 Innovation and regional growth

Innovation is distributed spatially and the related activities tend to be geographically located since the vagueness and the intricacy of the new forms of knowledge make preferable the personal interaction (Li, 2009).
Regional innovation systems are among the best instruments to study the innovation activities and their influence on the geographic environment as suggested by Fritsch (Fritsch, 2002), and it also is the commonly basic tool used by scholars in comparing existing or innovative policies at regional level (Kuhlmann et al., 2010; Lundvall, 2007; Sharif, 2006).
The regional innovation system is the resultant of the interaction between different actors at institutional and private level. The relationships among these actors influence the capacity of the local environment in producing and transferring knowledge. Additionally the actors involved in the dynamic development of the system define the growing and the development of the system itself regulating relationships, influencing research agenda, allowing new entrances, building networks or generating tools to the strategic definition of the system (Baglieri et al., 2014).
Most of the peculiarities of a regional innovation system are constituted by the implementation of policies issued by central and regional government in order to promote the collaboration between public and private actors, to mobilize resources, to improve the knowledge transfer, to develop entrepreneurial activities, to legitimate research institutions and to promote spillover effects (Bergek

et al., 2008; Chaminade and Edquist, 2010; Edquist, 2010). According to the literature assumptions on RIS the present paper addresses the Chinese innovation environment for several reasons. Firstly the research is based on the study of the 29 provinces of the Chinese mainland (Hong Kong, Macao and Taiwan presents alternatives peculiarities due to the different historic paths). In China provinces are considered as independent entities from both administrative and economic point of view and provincial governments have the authority to issue economic and social developments policies (Gu and Lundvall, 2006; Liu and White, 2001). Secondly the social and cultural differences between the provinces in terms of dialects and social conventions make them very close with respect to neighbor influence. Finally, according to Li (Li, 2009), the mobility of labor force is limited between provinces due to very strict regional policies.

Chinese regional innovation system experimented in the last decades a dramatic increasing of innovation and technology development. The most common tool to measure the innovation in terms of output are patents, in China the number of the patent registration, by non-individual organization, increased more than 10 times from the late 90s to 2016. Also the financial investments in terms of technology promotion by public actors and R&D by private firms increased with no precedents. Again, according to Tylecote (2006), the great effort made by the government led to a very impressive innovative development, this makes Chinese RIS transactional because is composed by two different components: the upper level which combines with the developed economies and implements advanced technologies; the lower level which deals with the local embedded industries anchored to the traditional economic system. This duality gives a general framework in which some provinces have taken the innovation leadership with respect to the others.

The hybrid aspect of the Chinese regional innovation system makes also it unique for another aspect. As matter of facts in developed economies the key role, within the system, is played by firms, whose are entitled to boost innovation, and the institutional actors are considered incidental; in China is basically the opposite: central and provincial governments and universities are the very promoters of innovation policies (Liu and White, 2001).

Numerous studies discourse about the key role played by universities in the Chinese innovation system. Hu and Mathews (Hu and Mathews, 2008) stress the contribution in patenting increment by the education received by the labor force and the spin-offs creations; Huang and Wu (Huang and Wu, 2012) recognize R&D efforts made in terms of investments and personnel one of the most important booster in patenting surge.

In line with this part of literature the present study focuses its attention on the role played by universities but without looking at the efforts made in terms R&D expenditures or at the level of the quality of the patents. The contribution is articulate on three different levels. In the first level the

paper looks at the economic impact given by universities contribution in terms of innovation generators. The tool used to measure the impact of innovation is the number of registered patents and in analyzing how the policies adopted by the provincial governments helps universities in improving the general economic conditions. Here the main institutional actors of the innovation system (universities and governments) are investigated measuring the proficiency, in terms of economic development, of their outputs.

The hypotheses are that:

H1. The greater the innovative effort of local universities, the higher the regional economic growth.

Following the model proposed by Madsen (Madsen, 2007) the paper also investigates the impact of the innovation output production in the long-run through the analysis of the diminish returns.

H1.1: The impact of local universities' innovative effort of regional economic growth presents diminishing returns.

The second level, following the approach of the hypothesis, isolates the impact of the innovative firms' production on the regional economic growth.

H2. The greater the innovative effort of local firms, the higher the regional economic growth.

H2.1: The impact of local firms' innovative effort of regional economic growth presents diminishing returns.

Finally, the investigation, at the third level, regards the impact, in terms of economic development, of the subsidy patent program and the direct role played by the policies on the regional growth.

H3: The more regional governments promote local innovative activity, the higher the regional economic growth.

4.3 Chinese Patents Framework

4.3.1 Patenting Growth

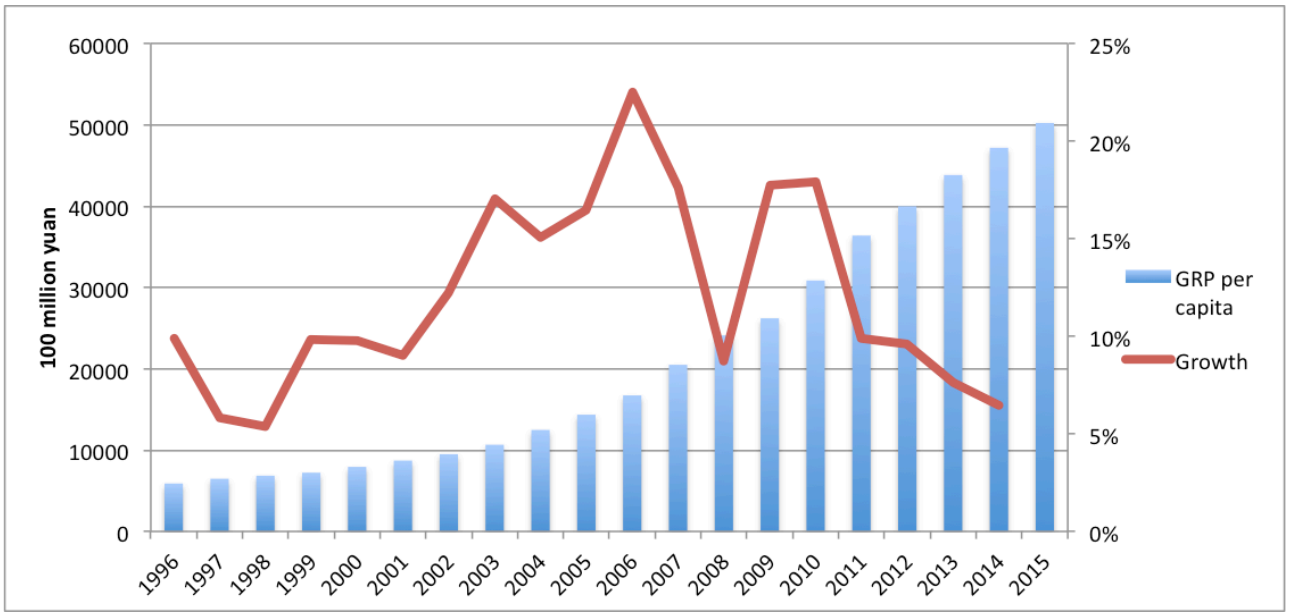
Starting from the 80s China faced a continuous growth in patent applications with a growth rate greater than other countries in the World becoming in 2011 the most prolific patent applicant (Long and Wang, 2016).

At the base of this rapid increment of patent application there is a punctual national strategy adopted by the central government that implemented all the steps to create a competitive system according to the international standards. The present patent system was established with the issuing of the Chinese Patent law in 1985 and its revisions in 1992, 2000 and 2008. In 2001 China became member of the

WTO and joins the TRIPs (Agreement on Trade-related Aspects of Intellectual Property Right). In 2008 the government adopted the "National Intellectual Property Strategy (2008-2020)" to create a modern and efficient technological and innovative environment.

As shown in figure 1 the average of the growth rate, in the last 20 year, is around 20% with some relevant picks close the 35% in 2005 and 2011 (source Chinese National Statistical Bureau).

Figure 1: GRP per capita and growth index, self-evaluation from National Statistic Bureau Dataset.



The patent application at SIPO (State Intellectual Property Office) has dramatically increased over the past decades. In 2011 China has positioned itself as global leader in patenting activity outstanding Japan and United States. This goal has been reached the same year of the issuing of Twelfth Five-Year Plan for National Economic and Social Development that aims to increase the patents applications. Following the Plan SIPO issued the National Patent Development Strategy (2012-2020) to reach the threshold of 2 million patents in 2015 (Song et al., 2016).

This huge increment is not unexpected according to the efforts made by the Government in investing in Science and Technology and the response of Chinese firms those invested in R&D creating appealing products covered by patent protection. However, according to Hu and Jefferson (Hu and Jefferson, 2009) the R&D private expenditure is not the primary cause of patent applications increasing because the percentage of private investment is still small.

Other scholars enlist also FDI (Foreign Direct Investment) among the contributions to the patent growth because domestic firms are incentivized to patent in order to create market barriers and achieve better positions in licensing negotiations (Hu, 2010; Thoma, 2013).

The patent subsidy program has retained responsible for the surge from many scholars (Lei et al., 2012; Prud'homme, 2012) that identify as positively related the push that the central government performs on provincial governments for achieving the goals established in the Plan.

4.3.2 Patent Subsidy Program

Chinese government, at the end of 90s, after the entrance of China in WTO, had some concernments about the domestic firm's technological competitiveness. Thus, in order to increase firms' capabilities and to strengthen their IP portfolio, the central government adopted policy guidelines named "Strengthen Technology Innovation, Develop High-Tech Industries, and Promote Industrialization" in order to boost the "endogenous innovation". The program intervenes in financing the different steps of the patenting process: the filling application, the examination phase and the grant-contingent grant and does not make any exception between applicants if they are universities, public or private firms and also individuals. Are implicitly excluded the foreign companies since the program is addressed to the "endogenous innovations".

The first to start in applying the policy were the most developed regions such as Shanghai, in 1999, arriving, in 2007, to the number of 29 provinces of 30 that adopted the incentives (Li, 2012). Even if the target of the policies is always the same, strengthen the internal innovation; the regions drew different policies. According to their preferences, indeed, regions established different budget constraints and subsidies amount dividing them per category: invention patents (often the highest amount of subsidies), utility models and design patents (Dang and Motohashi, 2015).

The patent subsidy program intervenes into the applying patent process. The applying procedure is structured following three steps: filling, request examination, and examination by the patent office (Liang and Xue, 2010; Yang, 2008). As reported by Dang and Motohashi (Dang and Motohashi, 2015) local governments implement in a different way the subsidies. Some incentivize only the granted patent, in order to boost only the inventions with larger opportunities to pass the examination. Since applicants do not have return incentives if applications are rejected in the examination process, others governments choose to incentive the filling and examination steps giving the subsidies to the applicants immediately.

The differences lie also in the amount of the incentives given. Indeed, governments decide to cover the entire cost of the filling/examination fees or to assign only a percentage (between 50% and 80%). Following the studies of Li (Li, 2012) and Dang and Motohashi (Dang and Motohashi, 2015) table 1 provides a detailed sum of the subsidy policies adopted by governments per year and economic intensity. From 1999 (first province Shanghai) to 2008 almost the 80% of Chinese mainland

provincial governments adopted subsidy policies for the filling step, about 50% covered examination and grant fees.

Table 1: Summary of patent subsidy programs

Province	Start year	Filing fee subsidies	Examination fee subsidies	Grant-contingent rewards
Beijing	2000	Fully	Partly	No
Tianjin	2000	Fully	No	No
Hebei	2005	Partly	No	Low
Shanxi	2003	Fully	Fully	No
Inner Mongolia	2002	Fully	Fully	No
Liaoning	2006	Fully	No	High
Jilin	2004	Partly	Partly	Low
Heilongjiang	2001	Fully	No	Low
Shanghai	1999	Fully	Fully	High
Jiangsu	2000	Fully	Fully	No
Zhejiang	2001–2005 2006 ~	No	Fully	No
		No	No	High
Anhui	2003	No	No	High
		No		
Fujian	2002–2005	Fully	Fully	No
	2006 ~	Fully	Fully	High
Jiangxi	2002	Partly	Partly	No
Shandong	2003	Partly	Partly	High
Henan	2002	Partly	Partly	Low
Hubei	2007	No	No	Low
Hunan	2004–2006	Partly	Partly	No
	2007 ~	No	No	High
Guangdong	2000	Partly	Partly	No
Guangxi	2001	Fully	Partly	High
Chongqing	2000	Fully	No	Low
Sichuan	2001	Partly	Partly	No
Guizhou	2002	Fully	Partly	No
Yunnan	2003	Partly	Partly	Low
	2004 ~	Partly	No	Low
Tibet	2004	Fully	Fully	High
Shaanxi	2003	Fully	No	High
Qinghai	2006	Fully	Partly	No
Xinjiang	2002	Partly	No	High
Hainan	2001	Partly	No	No

4.3.3 Impact of the Program

The implications on the economic impact differ from policy to policy. A lot depends from which step of the patenting process is going to be financed by the policy.

The first policy, the filling fee subsidy, covers the presentation of the patent fee and does not consider the probability of the patent to be granted. Thus the policy encourages also inventions with a high level of market vagueness because, after the presentation, the patent can be dropped before the examination if the applicant considers its economic value inferior than the further costs of examination and registration. The expectancy about the return in terms of economic development of this policy is not high and a lot depends from the innovative level of the research.

Predictions about the effects of the second policy for the examination fee subsidies are not immediate. As matter of facts the policy works on two different levels. On the first level it tends to decrease the patent application costs overall incrementing the patenting propensity. Applicants are encouraged to accede to the examination process betting on the invention filled with a possible introduction in the

market of a very innovative invention with a high potential value. But on the other hand subsidy incites applicants to push in the examination phase also patents with low patentability inclination or low economic value. Thus it is impossible speculate on the final effect of the policy, a lot depends on the general level of the research and on which effect is dominant.

The third policy, the grant-contingent policy subsidy, recognizes economic rewards once the patent is granted. The policy encourages assignees to complete the patenting process achieving the assignment of the exclusive right. Applicants with a more valuable invention are, so more prone, to complete the patenting process and, in the end, the market will benefice from a greater presence of patents with a higher economic value.

4.4 Methodology and dataset

4.4.1 Regions

According to the previous sections the important level of "consistency" of the provinces allows to treating regions as reasonably autonomous innovation systems (Edquist, 2010). Every province creates its own innovation system and, all together, forms the general framework, the Chinese innovation system (Chung, 2002). The strategic choice to use the provinces as unit of observation is also supported by some pros such as comparable and uniform dataset just divided at regional level for a reliable empirical comparison and the possibility to ignore the general framework like the national legislation because is a common factor.

In this study, twenty-nine Chinese provinces are selected as research regions, except Tibet, Mongolia, Hong Kong, Taiwan and Macao. The reason for excluding these regions is due to the differences in social, cultural and historical extractions.

Regional data are extracted using the Chinese National Bureau of Statistics official database in a temporal rage of 20 years (from 1996 to 2016).

4.4.2 Dataset

The study combines three different databases: the first one at regional level structured with the National Statistical Office database, the second made by the universities patent data from Q-pat database and the third one a dummy variables database, made by self-elaborations of the authors, in which are reported the year of introduction of the different policies at regional level. The final dataset has a balanced panel structure and comprehend a temporal range of twenty years, from 1996 to 2016. In 2014, there were 2.246 regular institutions of higher education in China (Chinese Ministry of Education). Patent data has been obtained from the Orbit intelligence patent database (version March-

May 2017), provided by Questel. Orbit is one of the most comprehensive databases and contains data on more than 100 million patent applications and grants; it also contains more than 11 million Chinese documents. The research was conducted typing the name of the university in the assignee field and considering all the patents issued in which the university is the original, the intermediate or the current assignee.

4.4.3 Estimation strategy

Following all the previous insights the efforts made by universities and private firms in innovation is driven, also, by the adoption of national and regional subsidy policies. To catch up the impact on the economic development at regional level the empirical model is structured following three directions. First the effort made by universities in patenting production; second the impact of the patent production at private firm level and finally considering overall the contribution to the process given by the incentives issued by the single administrative entities.

The model utilized is a structured dynamic panel model using fixed effect with robust standard errors in order to cluster the differences between regions. The estimated equation is:

$$\begin{aligned} growthGRP_{i,t} = {} & \alpha + \beta_1 Patentuniv_{i,t} + \beta_2 Patentuniv2_{i,t} + \beta_3 Patentindust_{i,t} \\ & + \beta_4 Patentindust2_{i,t} + \beta_5 lnGRP_{i,t-1} + \beta_6 Fixedassets_{i,t} + \beta_7 FFE_{i,t} \\ & + \beta_8 Population_{i,t} + \beta_9 Nhigheredu_{i,t} + \beta_{10} PolicyA_{i,t} + \beta_{11} PolicyB_{i,t} \\ & + \beta_{12} PolicyC_{i,t} + \varepsilon_i \end{aligned}$$

Where:

growthGRP: represents the annual growth rate of regional GRP per capita. Annual growth rate of regional GRP per capita, chosen as dependent variable, tends to measure changes in the regional level of prosperity as output of the innovation policies.

Level of GRP per capita $_{(t-1)}$: Following Fagerberg (1988) and Rodriguez-Pose and Peralta (2015) the initial level of GRP per capita is can be used as proxy for the knowledge embedded in the province and also as technological border. Moreover looking at the sign of the coefficient is possible also to determine the presence of regional convergence and/or divergence. The level of GRP per capita is transformed by the natural logarithm to maintain a linear relationship satisfying the normality assumption.

Patentuniv: represents the number of patent applications issued by Chinese universities in the province.

Patentuniv2: depicts the square of the previous variable in order to catch up the existence of returns to scale.

Patentindust: represents the number of patent applications issued by Chinese firms in the province.

Patentindu2: depicts the square of the previous variable in order to catch up the existence of returns to scale.

Fixedassets: Total Investment in Fixed Assets in the Whole Country refers to the volume of activities in construction and purchases of fixed assets of the whole country and related fees, expressed in monetary terms during the reference period. It is a comprehensive indicator that shows the size, structure and growth of the investment in fixed assets, providing a basis for observing the progress of construction projects and evaluating results of investment. Total investment in fixed assets in the whole country includes, by type of ownership, the investment by State-owned units, collective-owned units, joint ownership units, share-holding units, private units, individuals as well as investments by entrepreneurs from Hong Kong, Macao and Taiwan, foreign investors and others (National Bureau of Statistics).

FFE: number of foreign funded enterprises. Foreign Investment refers to foreign cash, technology, and equipment that the Chinese government, departments, enterprises and other economic organizations raise through attracting foreign direct investment and other ways (National Bureau of Statistics).

Population: number of residents. The year-end population refers to the population number at 24 pm. 31st December (National Bureau of Statistics).

Nhigheredu: represents the number of regular institution in higher education divided by province.

PolicyA: subsidy patenting program referred to the incentives given in the first filling patent request step. The variable is structured as dummy variable in which 0 is the absence of the policy and 1 the presence.

PolicyB: subsidy patenting program referred to the incentives given in the examination request step. The variable is structured as dummy variable in which 0 is the absence of the policy and 1 the presence.

PolicyC: subsidy patenting program referred to the incentives granted-contingent given. The variable is structured as dummy variable in which 0 is the absence of the policy and 1 the presence.

Table 1 shows the list of the variables, a brief explication of the variable contents and the source from where the variable is observed.

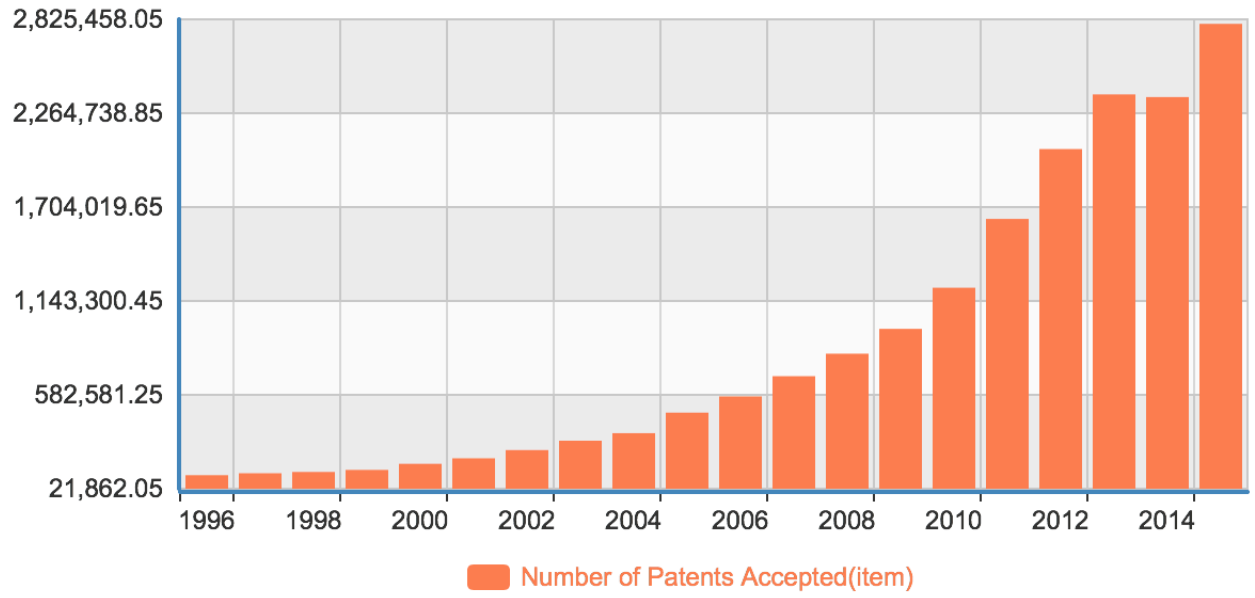
Table 2: list of variables

Variable	Explications	Source
Patentuniv	Patents granted to universities	Qpat - Orbit database
Patentuniv2	Patents granted to universities squared	Qpat - Orbit database
Patentindust	Patents granted to industries	Chinese Statistical Office Database
Patentindust2	Patents granted to industries squared	Chinese Statistical Office Database
L.lnGRP	natural log of GRP per capita (t-1)	Chinese Statistical Office Database
Fixedassets	Tot. Fixed assets	Chinese Statistical Office Database
FFE	Investments of Foreign Enterprises	Chinese Statistical Office Database
Population	Tot. Resident population	Chinese Statistical Office Database
Nhigheredu	N. of Institutions in Higher Education	Chinese Statistical Office Database
PolicyA	Dummy first regional policy	
PolicyB	Dummy second regional policy	
PolicyC	Dummy third regional policy	

4.5 Descriptive analysis

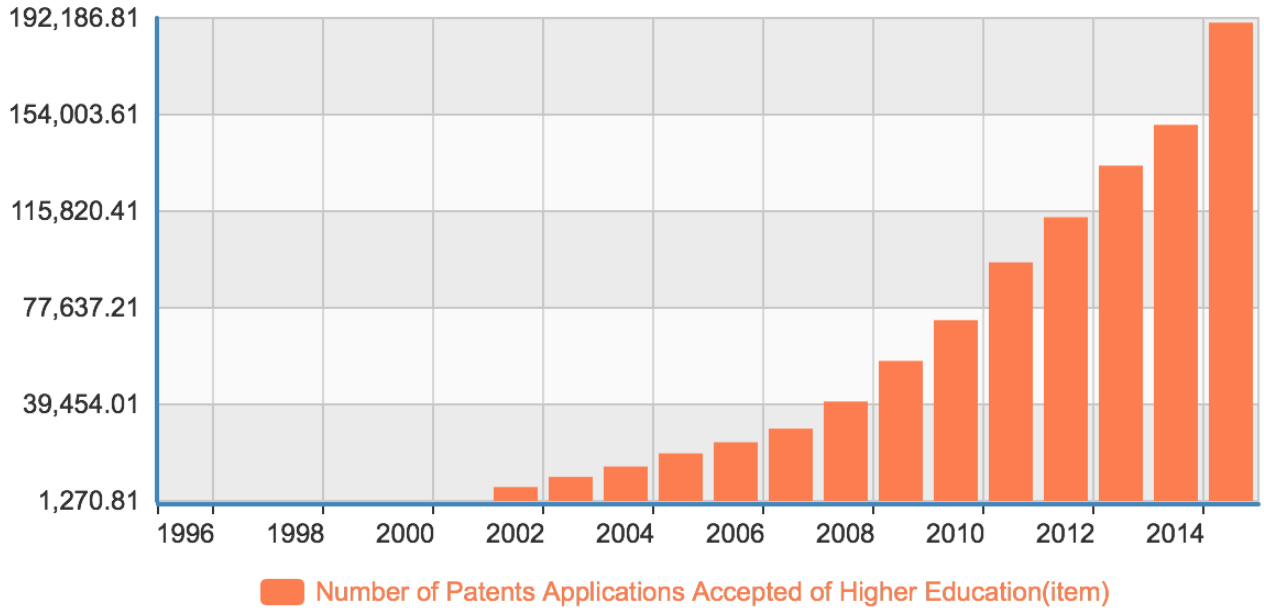
As theoretically showed in the previous sections China is experimenting in the last decades a massive surge of patent applications that led to the achievement of most prolific country in the world in terms of patent production. (Figure 2)

Figure 2: Number of patent application accepted by SIPO in National Statistic Bureau.



As shown in figure 3 this increment, at national level, regards not only the private industry but also the public research. Indeed, as seen above, universities play a key role in patent production.

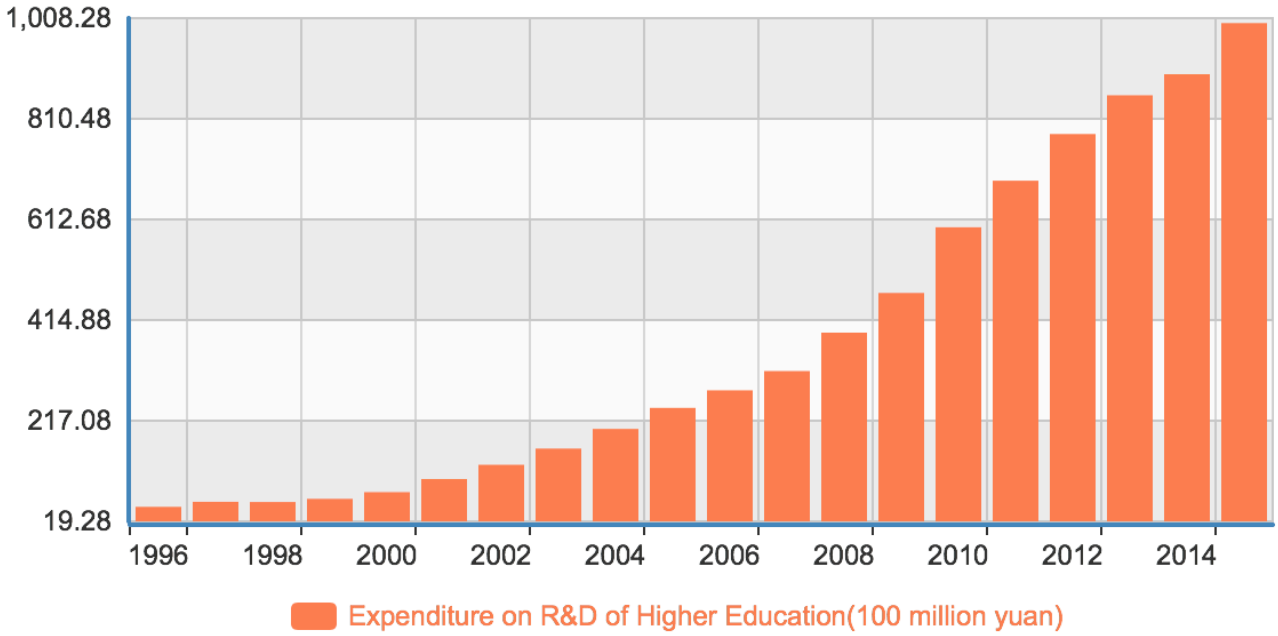
Figure 3: Number of patent application accepted in higher education by SIPO in National Statistic Bureau.



This increment has been led almost entirely by the central government that invested, in order to boost innovation, a huge amount of public funds in Science and Technology promotion. The patent activity faced the increment also thanks to subsidy program. This policy, incremented at regional level,

encourages the different step of the patent application procedure. Figure 4 shows the constant increment of public R&D expenditure in Higher Education.

Figure 4: Total amount of R&D expenditures in higher education in National Statistic Bureau.



The paper investigates the regional dimension of the phenomenon, as analyzed above the observation has been conducted at regional level. As matter of facts, Chinese provinces present some peculiarities that allow us to treat them as regional innovation system. The innovative capacity of the regions differs due many factors. Regions do not represent the same level of innovation development. The western regions are those that firsts entered in the scientific arena and the most developed in terms of innovation and patent production. Figure 5 represents the number of patent granted concentration per region into two different years: 2011 when China surpassed US in number of registered patents and 2015.

As shown by the figure the innovation level of the regions, counted in granted patents, is almost homogenous besides the western regions that are the leaders in terms of productive innovations. Region as Shanghai, Beijing and Shenzhen indeed represent the most developed technological framework inside the country. The figure also show how the general level of innovation is growing systematically as displayed by the darker intensity of the color the number of patent has been grown in general terms and also higher is the number of leading provinces in patenting activity.

Figure 5: Number of patent applications accepted by SIPO at regional level in 2011 and 2015 in National Statistics Bureau.

4.6 Results and discussion

Table 3 reports the list of the variables used into the model with the expected sign and the explanation. As shown in table the attended result for the principle variables observed, such as the number of university and industry patents, is positive because the assumptions is that the higher is the effort put

in innovation by universities and firms and the higher is the positive impact on the economic development.

Also the expected value of the policies is positive because the increment in knowledge and innovation production should have positive influences on the economic development.

Table 3: Summary of variable explanations

Variable	Expected sign	Explanation
Patentuniv	Positive	The efforts made in terms of innovation by universities are expected to generate a positive impact on the regional growth. The spread of knowledge generate more investment in industrial activities.
Patentuniv2	Negative	The effect of university patents of regional economic growth shows diminishing returns (it is inverted U-shaped).
Patentindust	Positive	The efforts made in terms of innovation by industries are expected to generate a positive impact on the regional growth. The industrial implementation of the knowledge embedded in the patent is attractive for investments.
Patentindust2	Negative	The effect of industry patents of regional economic growth shows diminishing returns (it is inverted U-shaped).
L.lnGRP	Negative	Following Rodriguez-Pose and Peralta (2015) and according to neoclassic growth theory, due to the constant or lessening returns to investment, less developed regions tend to grow faster.
PolicyA PolicyB PolicyC	Positive	The effect of the program on the regional growth is expected to be positive because it boosts innovative activities of both universities and private firms, which indirectly leads to economic growth.

Table 4 shows the regression results. In the first model results reject the first hypothesis according to which the effort made by universities in terms of patent production generates a positive impact on the economic growth. The number of patent granted by universities generates a negative impact on the regional development. The opposite sign in the coefficient of the number of universities patents confirms the H1.1 according to which in the long run the investment generates diminishing returns. Moreover, the findings about the policies imply that the first two incentives: the filling step and the examination request do not give any return in terms of direct economic impact. The third step of the program, instead, being granted-contingent, implies a positive return on the economic growth. Interesting to notice how the universities patent outcome affects also the initial level of the GRP that

indicates that, the effort made in innovation by universities, does not help the regions less developed in growing faster.

Table 4: OLS estimation

Variable	(1) GrowthGRP	(2) GrowthGRP	(3) GrowthGRP	
Patentuniv	-2.94***	-	-3.53***	-3.14***
	(0.007)	-	(0.001)	(0.004)
Patentuniv2	2.61**		3.74***	3.35***
	(0.014)		(0.001)	(0.002)
Patentindust	-	-0.33	1.83*	1.47
		(0.746)	(0.078)	(0.151)
Patentindust2	-	1.09	-0.70	-0.48
		(0.283)	(0.491)	(0.635)
L.lnGRP	3.01***	-3.28***	-2.66**	-3.45***
	(0.005)	(0.003)	(0.013)	(0.002)
Fixedassets	-5.87***	-6.23***	-5.93***	-5.92***
	(0.000)	(0.000)	(0.000)	(0.000)
FFE	2.60**	1.46	2.52**	2.46**
	(0.015)	(0.156)	(0.018)	(0.020)
Population	-3.77***	-3.61***	-4.55***	-3.84***
	(0.001)	(0.001)	(0.000)	(0.001)
Nhigheredu	8.59***	9.28***	8.98***	8.98***
	(0.000)	(0.000)	(0.000)	(0.000)
PolicyA	1.40	1.41	1.49	-
	(0.172)	(0.168)	(0.147)	
PolicyB	1.03	1.10	1.20	-
	(0.310)	(0.283)	(0.239)	
PolicyC	2.93***	3.07***	3.06***	-
	(0.007)	(0.005)	(0.005)	
L.PolicyA	-	-	-	1.99*
				(0.056)
L.PolicyB	-	-	-	1.06
				(0.298)
L.PolicyC	-	- -		3.16***
				(0.004)
Obs.	446	446	446	420
F	(10,28)	(10,28)	(12,28)	(12,28)
	44.30	26.42	33.31	39.95

* p<0.10; ** p<0.05; *** p<0.01

The second model isolates the industrial innovation productivity considering the impact of the number of the patent generate by the industries on the economic growth. According to the regression results, when isolated, the efforts of the industries do not give any benefit, per se, to the regional development but they confirm the neoclassical growth theory reported by Rodriguez-Pose and Peralta (2015) according to which due to the constant or lessening returns to investment, less developed regions tend to grow faster. About the policies result confirm the tendency seen in the precedent model and only the granted-contingent subsidy generates a positive impact.

The third model considers at the same time the patents production of universities and industries. In order to investigate deeper the effects cause by the policies the regression gas been performed two times. In the first time the policies are analyzed at the time t, in the second time the policies are considered at the time t-1 in order to catch up the influence after one year of policies implementation. The model confirms substantially the findings of the precedents regression with the negative effect of the universities patents and the limited positive influence of the industries patent. Interesting are the finding about the policies. Introducing the one-year lag the first incentive policy become significant.

As descripted above in commenting the results university patent production influences negatively the local development. Speculating is possible to assume that is because the most important universities tend to maintain partnership with big firms in a very close way, one-to-one connections. Especially in the most proficient field (electronics, pharmacy, new technologies) headquarters of the firms are located outside Chinese territory (Hong Kong, Taiwan, Singapore and similar) so that generate drainage of public resources. Thus the effort made by universities in terms of public research and innovation does not influence directly and immediately the regional economic development and the variables utilized to catch up the phenomenon do not intercept secondary and a posteriori ingenerated aspects of the development. As matter of fact is imaginable that the high level reached in innovation production offers to the universities a massive public exposure and a focused worldwide attention. China, becoming the leader in patent production, attracted the scientific and the economic community. So some limitations of the paper, in this aspect, are to have caught only a part of the economic regional development.

Similar assumptions can be made about the policies. The results show the scarce significance of the policies in terms of direct impact on the economic growth, even if for the lagged model there is an increment with respect to the filling subsidy program. In light of these results, it can be said that regional economic development in China, with respect to the observed period, did not respond entirely to the solicitations of the patent subsidy program. The outcome of the program on the regional growth is limited or ineffective

The program aimed to increment the number of the granted patent, and it achieved this goal according to the literature and the statistics, leading China as the most prolific country in patents applications, but the program do not affect, immediately the economic growth.

4.7 Conclusion

The change in Chinese economic landscape from a centrally planned regime to a market-driven economy has produced important transformations both to the national and regional innovation system. In terms of innovation outputs and patent production regions presents enormous differences. The massive patenting predominance is the result of several factors combined, among the most relevant indubitably on one hand the huge amount of investments in R&D performed by private firms and central government and on the other hand the pro-patenting subsidy program issued by the regional government under the politic pressure of the central government. But if has been largely demonstrated that all these contributions to the innovation produced positive effects on the quantity of the patent registered the present paper responded to the question: Did the patent production and the incentives policies impact on the economic growth?

In order to respond the question, the paper, after descriptively analyzed the official data in terms of number of registered patent, policies issued and general economic framework at regional level, estimates the impact on the regional economic growth of the innovations output. With the utilization of dynamic structured panel data from the National Statistics Bureau and Q-Pat Orbit database the paper crossed economic data from 29 Chinese regions with patent data of the 2246 Chinese Universities in a time period from 1996 to 2016. In order to catch up the economic impact an OLS model has been performed choosing as dependent variable the annual growth rate of GRP.

Results disclosed several interesting findings. First, separately isolated the universities and the firms patenting activities, the impact on the regional growth is negative for the universities and inconsistent for the firms. Second analyzed jointly the universities patent production still generates a negative effect however the firms' production influences positively the economic growth. Third the policies appear to be inconsistent on the direct growth with the exception of the granted-contingent policy that generates always a positive effect at demonstration of the economic relevance of the market capacity of the patent.

Findings give some interesting insight for the actors of the Chinese scientific and politic landscape. For example, for policy makers and regional governments in order to implement policies focused on the regional peculiarities; for universities and central government to focus the attention on the technology transfer process to avoid drainage of economic and technologic resources; for firms to

better appreciate the subsidy tools pointing at the quality of the patents. A complete investigation and speculation of these implications is beyond the scope of the present research work.

As mentioned above the paper presents some important limitation such as, for example, the use of secondary data and the impossibility to collect primary data; the use of variables focused only on the direct economic impact and the absence of observation of some indirect effects generate by the policies and the patenting activity and the application of the model limited only at one country. Perhaps it might be helpful in the future to perform the research taking into account the patents technology classes in order to investigate the different contribution given by the different sectors. On the econometric side more variables for the robustness check might improve the reliability of the results. Further researches may be developed for example investigating the technology transfer strategies in order to better analyze the relationship between universities and firms or implement the model catching up the effects on the long run or finally addressing as sample OECD countries.

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5 Chapter 5: HEIGH-HO, HEIGH-HO!!! Innovation and Employment. Does R&D boost occupation in China?[6]

5.1 Introduction

Since decades innovation has been gaining a more relevant role in regional studies where it is conceived as a way to enhance economic development at national and regional level (Freeman, 2002; Lundvall, 1992; Nelson, 1993). The combination of geographical spatiality and innovation has been discussed from many points of view but its effects on employment are still controversial (Buerger et al., 2012).

Regional Innovation Systems (RIS) have established themselves as one of the most common instruments for the investigation of innovation activities within a specific geographic context (Chung, 2002; Cooke, 2001). According to Fritsch (2002), RIS are characterized by the combination of different actors at institutional and private levels. The knowledge flows through the system according to the capacity of these actors to interact with each other (Baglieri et al., 2014). On the ground of these premises, the aim of this paper is to investigate the relationship between innovation, R&D expenditure and employment within a specific regional innovation system.

China in the last decades has demonstrated to be one of the most innovative country thanks to the effort made in innovating its economy and thanks to a fulminous economic and technological development that has mutated the national innovation system from central planned to market-driven (Li, 2009).

Studies about the interdependencies between innovation and employment have been largely conducted but the aim of most of them was the analysis at the firm level (Coad and Rao, 2007; Greenan and Guellec, 2000; Smolny, 2003) or at the industry level (Antonucci and Pianta, 2002; Evangelista and Savona, 2003) enlightening how innovation contributes to the employment increment in the productive units or in the industrial sectors. The mentioned approaches left a blank space in the literature with respect to the analysis of the effects of innovation on employment at the regional level analyzing the impact generated by the innovative effort on the general level of the regional employment used as proxy to measure the regional development. In doing so the present paper suggests a different approach investigating the impact of innovation on the local growth in the light of rising employment level and regional wages bills.

[6] This paper is co-authored with Fabrizio Cesaroni, Cristina Cinici e Valeria Schifilliti. An adapted version of the chapter has been presented at the IASOS International Applied Social Sciences Congrass, 21-23 September 2017. Usak University, Turkey.

Following the regional innovation system approach the paper investigates, from a policy perspective, the interactions between the different public and private actors within the system. In order to conduct the research study analyzing the correlation between employment and innovation the paper focuses its attention on the effort made by firms and universities in boosting the regional innovation through a massive effort in R&D investments and the impact of this on the local employment.

The research setting in which the test on innovation and employment is conducted is the Chinese context. Chinese innovation system is characterized by several peculiarities that make it different from other advanced economies. Mainly, from the technology development point of view, in the last decades China has experimented an exceptional increase in the technological capacity. In order to isolate the phenomenon, the paper focuses its attention on one of the most common tools used to measure the innovative level of the country: the number of patent applications. Indeed, as well demonstrated by the previous literature on the subject China has increased dramatically the number of applications during the last decades overtaking even United States in 2011 and becoming a global leader.

As matter of facts, starting from the new millennium China has been made a huge effort to drive the internal economy from the industry-based model to the innovation-driven one, experimenting an impressive growth in technology capability. Those efforts have led the country up to the top in the global scenario making China one of the most productive country in the world in terms of innovation. Thus, such an increment, is the result of unique interactions between national and regional governments, universities, and domestic and foreign firms (Liu and White, 2001). Moreover, the Chinese system can also be considered unique in terms of connections between the private and the public sectors.

According to these considerations the paper, in investigating the relationship between innovation and employment, takes into account the national peculiarities. The study is conducted running an econometric analysis based on a two stages least square model with fixed effects in which firstly is analyzed the impact of public investment in science and technology and private investment in research and development on the patent production and then, in second place, the impact of patents production (as expression of the innovative level of the country) on employment and wages.

The quantitative analysis has been run on a database contained information from 1996 to 2015 organized in a longitudinal balanced panel using data extracted from the National Bureau of Statistics of China (NBS).

5.2 Theoretical Framework

5.2.1 Chinese landscape

Since the aim of the paper is to investigate the impact of innovation on employment and local development the conducted study focuses on a specific environment that is considered one of the most productive on dynamics nowadays: China.

In the last decades the World has witnessed an incredible rising of Chinese patents applications. according to WIPO's (World Intellectual Property Office) annual World Intellectual Property Indicators (WIPI) report the China State Intellectual Property Office (SIPO) received in 2015 1.101.864 patents filing requests. With an increment rate of +18.7 China affirmed again the World leadership in innovation. The surge of China as leader in the global panorama has its roots in a disciplined political strategy actuated by the government that prompted an innovative growth spiral. At international level China signed the Paris Convention for the Protection of Industrial Property followed by the Patent Cooperation Treaty in 1994. In 2001 joined the World Trade Organization (WTO) and became a member of the TRIPs (Trade- Related Intellectual Property Rights) agreement. In the meanwhile, at institutional level with three amendments (1992, 2000 and 2009) China reorganized the Patent Law to meet the international standards and to boost the innovative development of the country. The result is a patent system in line with the most developed countries, based on the "first-to-file" principle that adopts the three criteria for patentability of novelty, utility, and non-obviousness and in which the publication of the patents requires around 18 months after the application date, and patent rights are extended for 20 years (Liegsalz and Wagner, 2013; Sun, 2003; Tang, 2008; Yang, 2008).

At the policy level the Chinese government adopted in 2006 the "Medium to Long–term National Plan for Science and Technology Development 2006– 2020" (MLP) with two declared thresholds: by the end of 2020 building an "innovation society" and by the end of 2050 leading the innovation in science and technology at global level.

The presented framework shows the effort made by Chinese institutions to invest in innovation and to increase the innovative capacity of the country.

5.2.2 Regional dimension and innovation

As far as we know from the previous studies about the spatial diffusion of innovation the knowledge generation and the consequential spillover, at geographic level, tends to be gathered in specific areas due to the personal interactions among people involved in the process (Li, 2009).

According to the literature the lens through scholars investigate the spillover effects of innovative activities in a given geographic context is the regional innovation system (RIS) (Cooke, 2001). Is

possible to considered RIS as the output of the relationships existing between the entire cohort of actors involved in a local innovative development at private and public level thank to their capacity to produce, share and transfer knowledge. Those connections allow the actors involved in redefining and influencing of the research agenda, adjusting the internal relationships, creating new networks and implementing new instruments in order to be active part in dynamic development of the system (Baglieri et al., 2014).

The Regional Innovation System is often defined in its formal peculiarities by the adoption of policies and regulations issued by governments at regional and national level with the specific aim to shape the relationships between private actors and institution, to allocate funds, to boost the private initiative, the market of technologies, increment the research productivity and to contribute at the system improvement at general level (Bergek et al., 2008; Chaminade and Edquist, 2010; Edquist, 2010).

With respect to the last point the paper wants to address its attention on the effects generated by the innovation on the local development and specifically on the employment. As matter of facts the literature has been somehow mild in studying the effect of innovation on employment in the regional dimension (Buerger et al., 2012). Prior studies have investigated the interdependencies between innovation and employment at the firm level (Coad and Rao, 2007; Greenan and Guellec, 2000; Smolny, 2003) as well as at the industry level (Antonucci and Pianta, 2002; Evangelista and Savona, 2003).

Studying the interactions at firm level is usual practice to differentiate innovation between products and processes since the impact generate dis different. Thus innovation in products is basically considered as employment booster because new products generate a growing demand exception made in the case of cannibalization in which new products substitute the old products of the same firm (Harrison et al., 2014; Reenen, 1997).

At innovation processes level the phenomenon does not have a unique explanation or pattern, the effect and the magnitude generated on the employment depends on different factors combined together. As matter of facts about innovation in processes, since is imaginable that an innovative process leads to a diminishing need of manpower, the first assumption is that innovation impacts negatively on the employment but is also imaginable that the diminishing in costs per unit might eventually generate lower prices stimulating consumption and demand (Harrison et al., 2014). Literature in the field is broad and trying to summarize the findings from the most relevant it can be concluded that: about the products the impact generated on employment is undoubtedly positive and innovation behaves as a local development booster; about the processes the panorama appears less

homogenous and a lot depends from the local peculiarities (Greenan and Guellec, 2000; Peters, 2004; Smolny, 2003). By the way a deeper analysis is beyond the scope of the present paper.

The relationship between employment and innovation has been broadly discussed by the literature taking into account several points of view: from the small urban units (Moreno-Monroy et al., 2016), to the self-employment and the entrepreneurial mood (Fritsch and Wyrwich, 2014) and according to the majority of the scholars innovation and employment are positively linked and innovation has a stronger impact on it boosting a faster employment growth.

In order to investigate the relationship between investments and innovation and measure the impact on the local development and specifically on the employment the paper hypothesizes:

H1a: Innovation impacts positively on the employment level.

H1b: Innovation impacts positively on the local growth through a positive influence on the wages' bill.

5.2.3 Public and Private Investments

As seen above innovation is a broad concept that involves a huge number of actors inside a given region, thus is not possible to consider firms as isolate entities (Cooke, 2001). The Regional Innovation System is composed by different actors that interact, compete and cooperate each other such as: universities, firms, policy makers, national and regional institutions. They way in which these interact is driven by the several forces for example: the institutional perspective, the market needs, the firms' capabilities to generate knowledge and to intercept the external inputs and the capacity of universities to generate and transfer technologies.

In specific environments such as the regional innovation systems universities can plays a key role in the organization of the RIS and the other systems that focus on the entrepreneurship (Brown, 2016). Thus, according to Jaffe (1993) universities and research centers are crucial in stimulating the regional economic growth thanks to the effort made in investing in base research and knowledge creation that is directly influenced by the effort made in R&D expenditures (Audretsch and Feldman, 1996). Focused policies and universities are crucial pillars of an entrepreneurial ecosystem that merges social, political, economic and cultural components inside the region (Smith-Lawton, 2017).

Chinese framework represents some characteristics that make it unique. As mentioned above government's efforts are leading to a drastic transformation of the landscape and are boosting the innovative capacities of the countries.

At economic level it has been possible to witness to a giant increase of investment in China by different sides: public investments in Science and Technology promotion (S&T), private investment in Research and Development activities (R&D) and a huge increment of the Foreign Direct

Investments (FDI), creation of new technologies and the transformation of the Chinese economy from industry-based to innovation-oriented (Hu and Jefferson, 2009; Li, 2012).

Chinese landscape offers some peculiarities also due to the university system. As matter of facts universities, whose are playing a key role in patenting activity and in knowledge production (Fisch et al., 2016), are public and funded in large part by public funds. In the last decades they are intensely profited of a large number of incentivizing programs promoted by the government in order to boost the research activities for competing with the most important universities in World (Hu and Mathews, 2008); indeed in 2015 among the top ten patentees at SIPO six were Chinese universities.

The public effort in boost the innovation is substantiated following different paths. On one hand increasing the economic investment on universities excellence worthy of mention the "Project 985" and "Project 211" (for an extensive review of the subsidy programs for university research activity see Chen et al. (2016)). Briefly Project 985 was launched in 1998 and renewed in 2004 with the primary intent to boost the universities' productivity and research quality with massive investments (Yang, 2008). Target of the project were 39 universities that have received nearly 32 billion RMB (5 billion USD circa) in total funding (Zhang et al., 2013).

Project 211 targets the top universities with extra funds for the improvement of the research quality, the outputs commercialization, the international cooperation and relationships and to reform the internal administration (Yang and Welch, 2012). It started in 1993 and implemented in 1995. Approximately 100 universities have been received supplementary funding for around 2.2 billion of U.S. dollars (Lixu, 2004).

On the other hand, the public efforts are not directed only towards universities but also to increment the innovation through incentives to patent. Chinese central government, in 1999, once China joined the WTO, focused its attentions in improving Chinese firms' technological effectiveness; so to create the favorable condition for firms' capabilities increasing and to reinforce their IP portfolio, adopted policy guidelines issued with the title of "Strengthen Technology Innovation, Develop High-Tech Industries, and Promote Industrialization" for the "endogenous innovation" improvement. The program finances the patenting registration progression during the different steps: the filling application, the examination phase and the grant-contingent grant making no exception according to the nature public or private, corporative o individual of the patentee with the only limitation of the "endogeneity" of the innovations (are excluded all the foreign companies and individual applicants). In around eight years, from 1999 to 2007, 29 provinces of 30 adopted the incentives allocating different budget amounts according to their preferences (Dang and Motohashi, 2015; Li, 2012; Prud'homme, 2012).

Over the last decades, China has been constantly investing also in private R&D. This expenditure reached a record the considerable amount of 372,81 billion U.S. dollars accounting for 1.98 percent of China's GDP and making the country the second most R&D-intensive in the world (www.iriweb.org). This large R&D effort was also made with the goal to lead a transition from being labor-based economy and export-driven to a more maintainable innovation-led model by 2020, as stated in China's 12th Five Year Plan for Science and Technology Development, China is likely to surpass the U.S. in total annual R&D spending by 2026 continuing to enlarge the gap after this point (Wang et al., 2014).

During this economic period of transition, Chinese firms are facing the so called "strategic dilemma". This dilemma consists in making the choice to become innovation leaders, relying on in-house R&D, or to continue being low-cost, imitation-based economy (Hobday et al., 2004; Xiao et al., 2013). Given the fact that China is massive investing in technology and innovation, is understandable that Chinese firms made their R&D decisions to speed up in innovation reducing their technological gap with the industrial leaders.

According to the showed panorama the paper hypothesizes that:

H2a: Public investment on Science and Technology influences the innovative level of the region;

H2b: Private investment on R&D influences the innovative level of the region;

5.3 Methodology and dataset

Empirical evidence of the relationship between innovation, private R&D expenditure and employment in Chinese regional innovation systems is based on data collected at regional level. China is administratively divided into provinces; each province has an autonomous local government. Now, according to their peculiarities, Chinese regions can be considered as separate regional innovation system and treated individually (Edquist, 2010). Indeed, each region created its own system which is reasonably separated by the others, also from the closest, due to the local cultural differences and the different policies in term of employers mobility (Chung, 2002). By contrast studying regions as independent systems presents also some facilitation in uniform and comparing the database because is possible to ignore the general framework thanks to the presence of general uniformities such as the national legislation. Data have been extracted from the Chinese National Statistical Bureau and organized in a balanced panel database and the unit of observation is a single Chinese region. Data cover a time range from 1996 to 2015.

To empirically test the enlisted hypotheses, the paper performs a two stage least square model with fixed effects.

The estimated equation is:

$$\begin{cases} y_{i,t} = \beta_0 + \beta_{1,i} lnGRP_{i,t} + \beta_{2,i} FDI_{i,t} + \beta_{3,i} Patents_{i,t} + u_i \\ Patents_{i,t} = \gamma_0 + \gamma_{1,i} lnGRP_{i,t} + \gamma_{2,i} FDI_{i,t} + \gamma_{3,i} R\&D_{i,t} + \gamma_{4,i} Hedu_{i,t} + \gamma_{5,i} S\&T_{i,t} + \varepsilon_i \end{cases}$$

Where:

Y= represent alternatively:

- *Number of Employed Persons in Urban Units (10000 persons):* (Empl) People Employed in Urban Units refer to the total number of employees who work at various units and obtain wages or other forms of payment at the end of the reference period. This indicator is a kind of time point index and it equals to the sum of the number of employed staff and workers, labor dispatch personnel and other employed people. (National Bureau of Statistics of China).
- *Total Wage Bill of Employed Persons in Urban Units (100 million yuan)*: (Wage) Total Wage Bill is pre-tax wages, including the room charges, utility bills, housing funds and social insurance paid or withheld by employees (National Bureau of Statistics of China).

Level of GRP per capita: (lnGRP) the level of GRP per capita is can be used as proxy to identify the initial level of knowledge expressed by the province and also as technological border. The level of GRP per capita is transformed by the natural logarithm to maintain a linear relationship satisfying the normality assumption.

Total Investment of Foreign Funded Enterprises (USD million): (FDI) Foreign Investment refers to foreign cash, technology, and equipment that the Chinese government, departments, enterprises and other economic organizations raise through attracting foreign direct investment and other ways (National Bureau of Statistics of China).

Expenditure on R&D of Industrial Enterprises above Designated Size (10000 yuan): (R&Dexp) Total Expenditure of Funds on R&D refers to the real expenditure of surveyed units on their own R&D activities (basic research, application study, test and development), including direct expenditure on R&D activities, indirect expenditure of management and services on R&D activities, expenditure on capital construction and material processing by others, excluding the expenditure on production activities, return of loan, and fees transferred to cooperated and entrusted agencies on R&D activities (National Bureau of Statistics of China).

Number of Domestic Patents Application Accepted (item): (Patents) Patent is an abbreviation for the patent right and refers to the exclusive right of ownership by the inventors or designers for the creation

or inventions, given from the patent offices after due process of assessment and approval in accordance with the Patent Law. Patents are granted for inventions, utility models and designs. This indicator reflects the achievements of S&T and design with independent intellectual property (National Bureau of Statistics of China).

Number of Regular Institutions of Higher Education: (Hedu) is referred to a number of institution of higher education present in the region.

Local Governments Expenditure, Science and Technology (100 million yuan): (S&Tesp) is referred to a total amount of science and technology expenditures promotion implemented by the regional government.

The model considers as instrumental variable the number of patents accepted by the regional patent offices that is influenced by the number of higher institutions within the region, the level of public R&D expenditure financed by the local government, and the level of private firms' R&D expenditure.

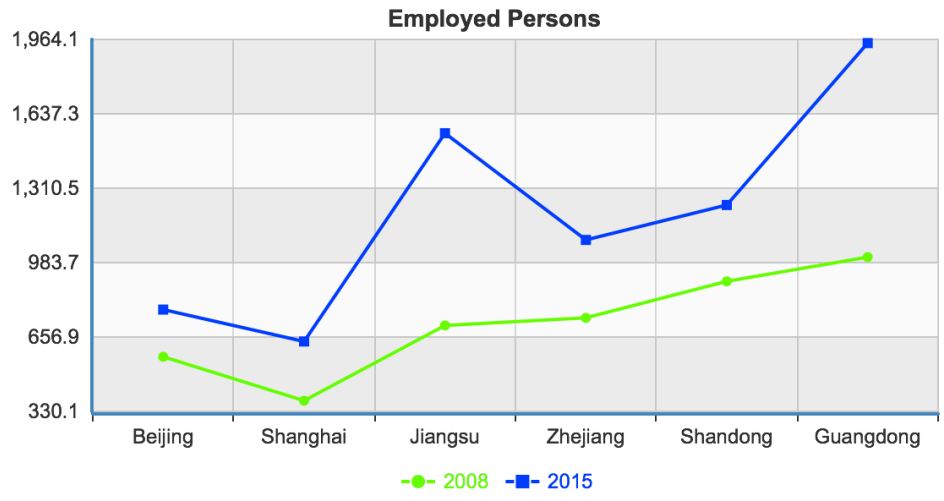
5.4 Descriptive analysis

As descripted in the theoretical section the Chinese landscape has been interested in the last decades to a massive improvement of the economic conditions.

All the graphs showed in this paragraph have been constructed taking as sample 5 provinces among the most dynamic in order to better catch up the improvements.

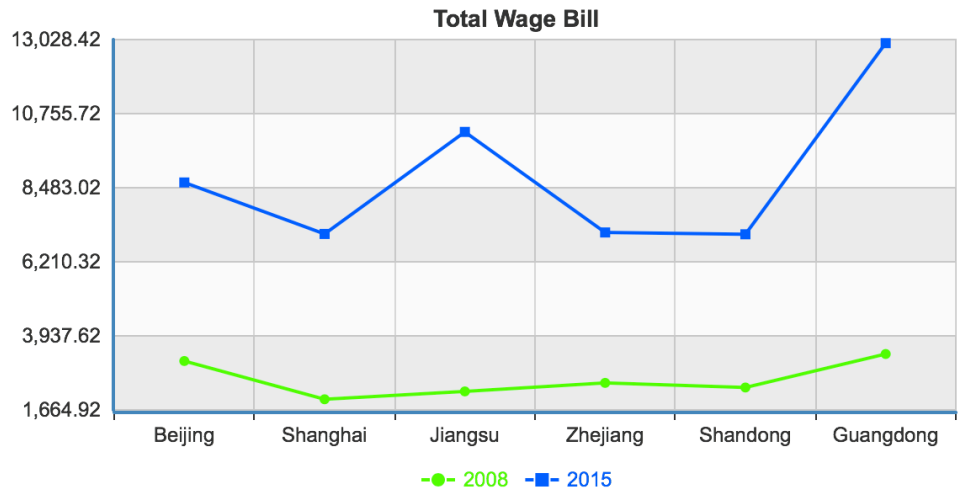
Figure 1, for example, show the increment in the number of people employed from 2008 to 2015 the average growth rate at national level is about the 44% with relevant peaks in provinces like Jiangsu with an increment of 119% in which people employed jumped from 7.076.400 in 2008 to 15.520.800 in 2015; or Guangdong with a growth rate of 93% with a number of employees switched from 10.078.700 in 2008 to 19.480.400 in 2015; or Shanghai an increment of 69%.

Figure 1: people employed at regional level from 2008 to 2015



In the same period the increment interested also the wages. Thus simultaneously with the number of people employed the total wage in China has been increased about the 213% on average at national level (figure 2). Here the increment is more relevant and the peaks registered in the regions are more relevant as showed by the national average. Indeed, value registered per single province varies from the 356% of the Jiangsu region to the 255% of Shanghai; from the 282% of Guangdong region to the 200% of Shandong.

Figure 2: Total wage bill at regional level from 2008 to 2015



As theoretically discussed these increments in the labor sector are linked, among the other factors, also with a relevant increment in terms of private, public and foreign investments which leads to an augmented innovative capacity of the country. As analytically showed in figure 3 by the data extracted from the National Bureau of Statistics of China for example the FDI flow increased by 230% from 2006 to 2015 at national level reaching the 447% in Beijing passing from 69.700 million US dollars in 2006 to 380.963 million US dollars in 2015 or the 748% of Chongqing.

The most productive efforts have been carried out by the Chinese government in terms of innovation boosting. During the last decades thanks to policies adopted to improve the innovative capacity of the country China experimented an unprecedented improvement in its technical production. This path, among other factors, passes through different stages. As seen in detail above the government massively implemented the investment in Science and Technology promotion. From 2006 to 2015 the growth rate increased at national level around the 229% (figure 4).

Figure 3: Foreign Direct Investment at regional level from 2008 to 2015

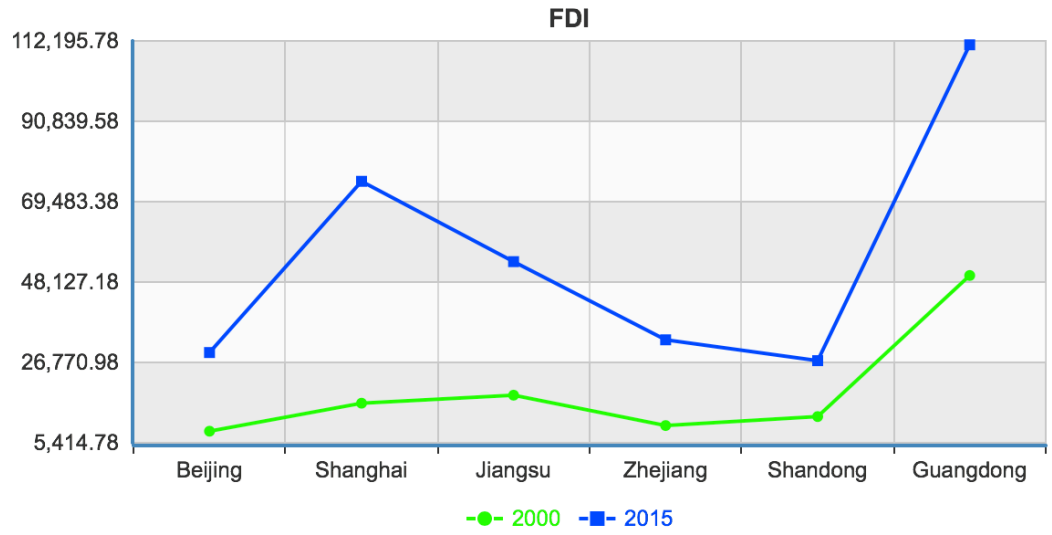
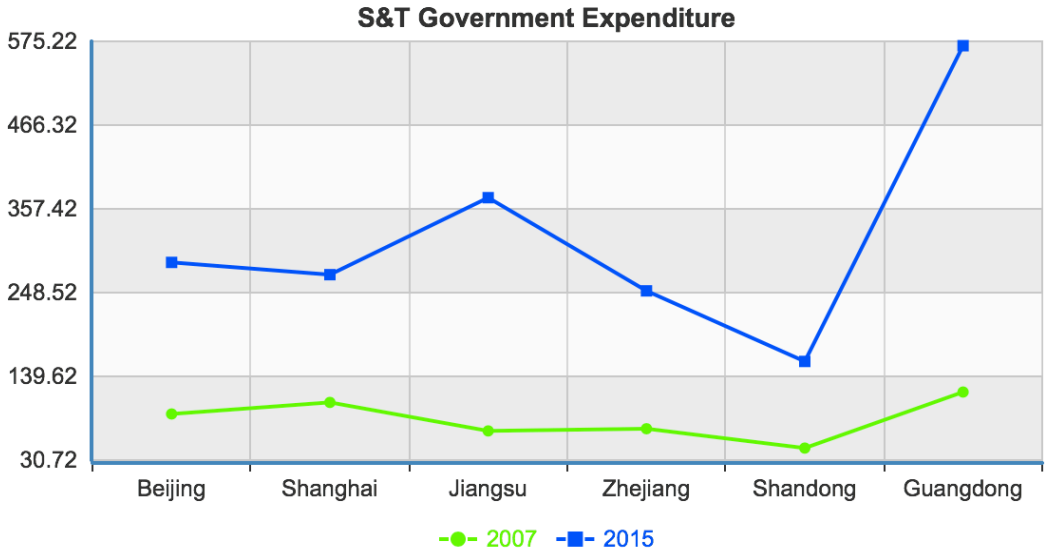


Figure 4: Science and Technology promotion expenditure at regional level from 2008 to 2015



Meanwhile, in the same period, the private R&D investment followed the same path and private industries relied on the policies implemented by the government increasing their investments in R&D of 254% at national level (figure 5).

All these factors led to an absolute imposition of China as global leader in technology. In 2011 the number of patent accepted at SIPO outclassed the number of patents accepted at USPTO and for the first time China became the World leader in technology production continuing the transformation of its economy from industry-based to technology-driven. The increment in the growth rate in the applications touched impressive thresholds. At national level in 15 years from 2000 to 2015 the

increment registered is around 1913% with peaks as 5117% in Jiangsu province or 2879% in Zhejiang with a nominal value of patents accepted of 428.337 in Jiangsu and 307.264 in Zhejiang (figure 6).

Figure 5: Research and Development expenditure at regional level from 2008 to 2015

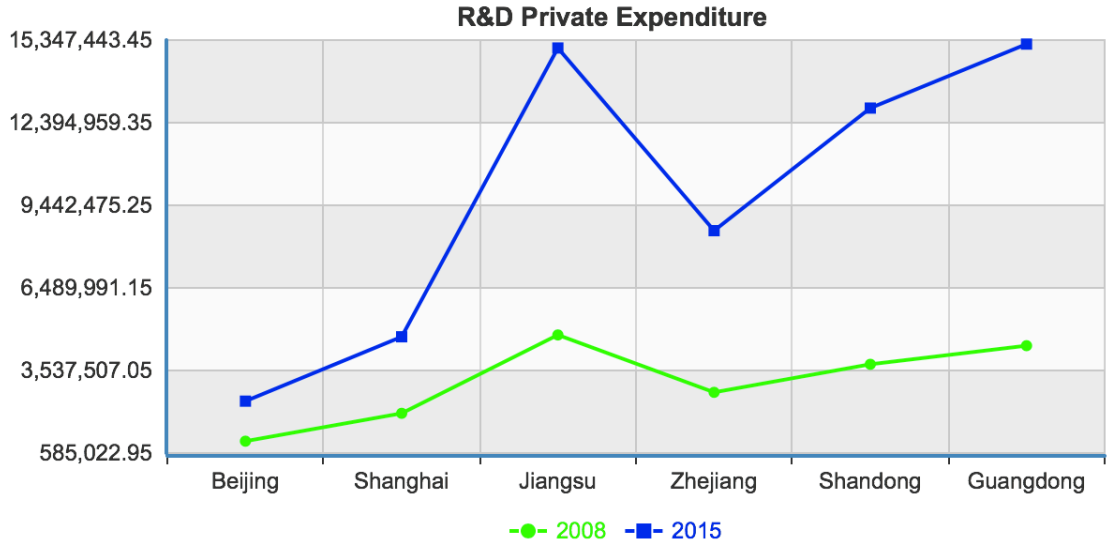
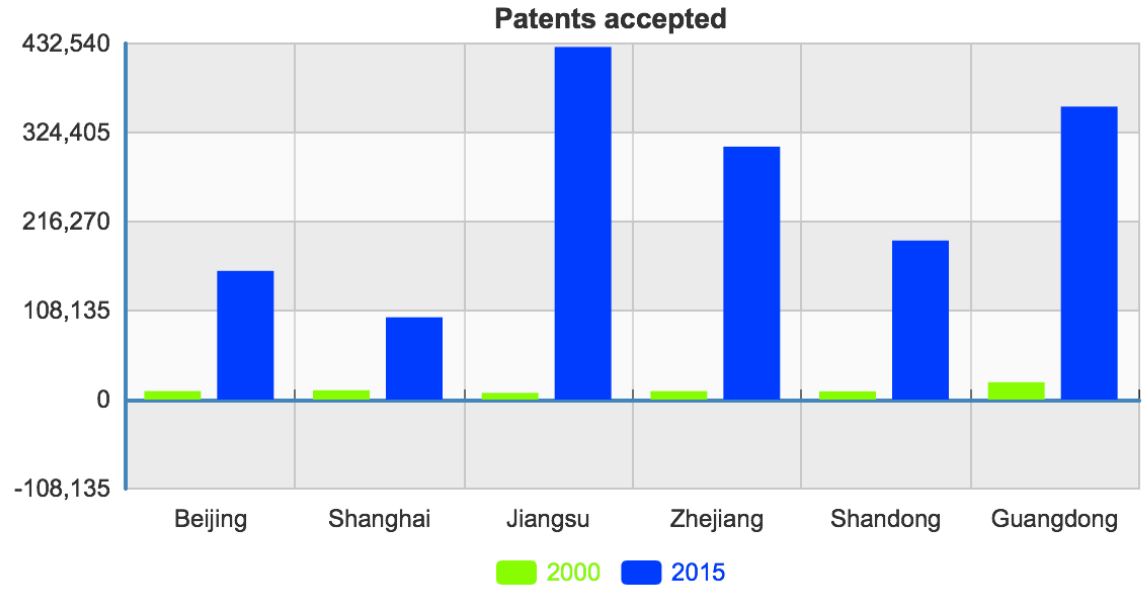


Figure 6: numbers of patent application accepted at SIPO from 2008 to 2015



5.5 Results and Discussion

Tables 2 and 3 report respectively the first and the second stage of the regression.

Table 1: list of variables

Variable	Explanation	Source
Empl	N. of Employed Persons in Urban Units	Chinese Statistical Bureau Database
Wage	Total Wage Bill of Employed Persons in Urban Units	Chinese Statistical Bureau Database
Patents	N. of Domestic Patents Application Accepted	Chinese Statistical Bureau Database
lnGRP	Level of GRP per capita	Chinese Statistical Bureau Database
FDI	Total Investment of Foreign Funded Enterprises	Chinese Statistical Bureau Database
R&Dpriv	Expenditure on R&D of Industrial Enterprises	Chinese Statistical Bureau Database
Hedu	N. of Institution in Higher Education	Chinese Statistical Bureau Database
S&Texp	Public expenditures in S&T at Regional level	Chinese Statistical Bureau Database

The regression has been run on two different models. The first model considers as dependent variable the number of employees in the second model the wage bill of the region. The models have been run with those two variable in order to intercept the impact exercised by innovation on the regional development. Since the independent variable used to measure the technology level of the region is the number of patents accepted at the regional patent we run a second least square model in order to isolate the variables that influence the technology production embedded into the patents.

Thus table 2 shows the results of the first stage in which patent are instrumented. The table shows the positive impact generated by the S&T and the R&D expenditure on the patent production. Results confirm the H2a and the H2b determining that the increased effort made by public and private in boosting the research and development activities led to a positive increment of the patents production. Results in table 3 confirm the H1a and the H1b. As matter of facts is possible to observe how patents impact on the employment and on the total wage. Of course indirectly is showed the stimulus given by the expenditure in science and technology and research and development carried out by public and private actors to the local development.

Table 2: first stage least square results

First Stage Least Square		
	(1)	(2)
Variable	Patents	Patents
lnGRP	1.31	1.31
	(0.193)	(0.193)
FDI	1.64	1.64
	(0.104)	(0.104)
R&Dpriv	7.48***	7.48***
	(0.000)	(0.000)
Hedu	-1.05	-1.05
	(0.297)	(0.297)
S&Texp	3.93***	3.93***
	(0.000)	(0.000)
Obs.	217	217
F	(5,181)	(5,181)
	136.30	136.30

* p<0.10; ** p<0.05; *** p<0.01

Table 3: second stage least square results

Second Stage Least Square		
	(1)	(2)
Variable	Empl	Wage
Patents	7.95***	8.11***
	(0.000)	(0.000)
lnGRP	0.82	3.30***
	(0.414)	(0.001)
FDI	-0.53	3.25***
	(0.596)	(0.001)
Obs.	217	217
F	(30,183)	(30,183)
	32.41	16.02

* p<0.10; ** p<0.05; *** p<0.01

The model entirely confirms the thesis according to which innovation impact positively on the local development and, how is specifically showed in the paper, on employment. The original intuition

behind these results is that the model showed the contribution of both lines of investment: public and private. According to the mentioned aspect policy implications are very relevant. Eventually is worthy to notice the behavior of the FDI that positively influence the wage but not the employment. This aspect could be matter for further researches. Trying to speculate is possible to assume that foreign firms or foreign funded projects pursuit a significant level of specialization among the employees hiring more qualified people (with higher level of salary). This finding confirms the transformation of Chinese economic landscape from industry to technology driven economy in which is more promoted the specialization instead of the basic man power and the fact that foreign enterprises outsourcing specialized knowledge and not anymore simple manufacturing industry.

5.5.1 Policy implications

Obviously the impact of innovation on regional development and specifically on employment has been determined from several events. Policies implemented by China in the last decades totally reshaped the economic landscape influencing the behavior of the different actors: public, private and foreigners. The push given by the change in the political and institutional panorama led China to an international accreditation. The clear economic vision in the long-run makes the country faithful for private (domestic and foreign) investments thanks also to a massive investment made the government in science and technology promotion. What emerge from the proposed analysis is firstly that the private and public substantial investments create the basis for a technology development which led China to accredit itself in the international scientific panorama reaching in a decade the role of leader in patent applications. Secondly that the technological progress impacts positively on the local development measured in terms of employment and total wage bill and finally the role of FDI that is more incisive in raising the level of the wage.

These findings bring some insights for the policy maker. First of all, the impact given by the change in the formal panorama with the modernization of the institutional structures and tools to catch up the technological challenge. Secondly that the push given by the augmented public investment in S&T generated a diffuse trust among private and international investors that participate to national economic and technological growth. Lastly the transformation of China from follower to leader in technology has been well interpreted outside the country because the foreigner investors seem to be more interested in pursuing higher degree of specialization in the labor market instead of basic manpower.

5.5.2 Research implications

The finding emerged from the present analysis corroborate and implement previous researches on technology and employment and have been emerged some regional peculiarities (China) hat also confirm the singularity of the Chinese panorama emerged in precious studies.

The study started from some general assumption and its contribution lies in the study of the two components of investment in science and technology: the public and the private.

Previous studies focused their attention, as recalled above, on the relationship between innovation and employment at firms' level or as a private initiative driven phenomenon. The findings of the present study shed new light on the contribution given by the public choice of investing in science and technology and on the spillover effects given as consequence of this choice. In other words, the paper demonstrated the strong linkage between public effort in technology and employment passing through the augmented private investment share and the enhanced technology capacity of the national innovation system.

5.6 Conclusion

Innovation is one of the most important goal pursued by the Chinese government in the last decades. The enormous effort made by China to reduce the technology gap first, and to become a global leader after, reshaped the entire economic panorama at national and regional level.

Technology has been demonstrated to be a strategic driver for the local development and the findings of this study contribute to enrich the research field on regional development by analyzing the singular relationship between public and private sectors and the impact of the innovation activity of Chinese organizations on local economic development. It offers clear policy suggestions by emphasizing the relevant role that technology development has on regional wealth. Furthermore, it suggests that private investments are key in this direction, especially if complemented with public investments in Science and Technology.

The study present limitations and it would be essential to understand the complexity of the relationship between innovation and employment in the light, also, of a strategic, economic and legal national framework. Nevertheless, further investigation is needed to explore the complementary effect between private and public intervention.

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