Spatial Distribution of Innovation Networks, Technological Competencies and Degree of Novelty in Emerging Economy Firms

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ABSTRACT *This paper analyses the relationship of the accumulation of technological competencies at the firm level, the spatial distribution of the firm´s innovation networks and the degree of novelty of product innovation. Firm-based primary data collected in two innovative regions in emerging economies are used to predict higher degrees of novelty in emerging economy firms. Similarly to advanced economy firms, the results show that international linkages and internal competences are associated with higher degrees of novelty. However, the nature of those linkages and competences are different. New to the world innovation in emerging country firms is fundamentally externally driven. Broad international linkages seem to be a compensating mechanism for the initially lower technological capabilities.*

Keywords: product innovation, emerging economies, network, technological competencies.

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Introduction

In the last decade there has been a growing number of cases of new to the world innovations from emerging economies (Asakawa & Som, 2008; Christensen et al., 2010) particularly from certain innovative regions in China and India (Chaminade & Vang, 2008; Crescenzi et al, 2012; Huggins et al., 2007; Li, 2009) triggering an increase of economic geographers in the changing geography of innovations on a global scale (Bunnell & Coe, 2001; Scott, 2000) and, particularly on the mechanisms behind this new wave of new to the world innovations coming from the global South (Hansen et al., 2014).

Existing literature suggests that both the internal technological competencies of the firm and the external networks for innovation matter for innovation performance in general and for the degree of novelty in particular. With regard to firm-level competences, higher R&D investments are clearly associated with greater degrees of novelty (Barbosa et al., 2013). In terms of external networks for innovation, international research collaboration is associated with a higher degree of novelty in product innovation (Laursen & Salter, 2006; Nieto & Santamaria, 2007), particularly collaboration with users (Harirchi & Chaminade, 2014; Laursen, 2011). Evidence on the role of local research collaboration in radical innovation is still inconclusive. Asheim & Isaksen, (2002) and Visser & Boschma (2004) found that a high dependence on local interactions has a negative effect on the degree of novelty of innovations while more recent evidence (Fitjar and Rodríguez-Pose, 2013) suggests that the effect is only negative for interactions with non-supply chain organizations in relation to more practical exchange of experiences and know-how.

Hitherto, some scholars have studied the impact of external networks for innovation, including their spatial distribution, on the degree of novelty in developed countries without considering the internal technological competencies (Asheim & Isaksen, 2002; Laursen, 2011; Visser & Boschma, 2004). Other scholars have analysed the interplay between the impact of external networks for innovation and internal competencies on the degree of novelty, without looking at the specific spatial distribution of the networks (Tödtling et al., 2009; Tsai, 2009; Tsai et al., 2011). In some cases this has been done using a very limited spatial scale like regional-extra regional (Fitjar & Rodríguez-Pose 2013), in others investigating only specific relations with users (Harirchi & Chaminade, 2014; Laursen, 2011). Furthermore, few empirical analyses have simultaneously studied which internal factors (competencies) and external factors (spatial distribution of the innovation networks) may positively affect the innovation performance of firms in emerging or

developing countries (e.g. Iammarino et al., 2008; Srholec, 2010, 2011). To our knowledge, none of the existing studies have explicitly linked competencies and the spatial distribution of the innovation networks at local, domestic and international levels to the degree of novelty. This paper addresses the latter for firms in emerging economies.

New to the world innovations from emerging economies presents an interesting puzzle. On the one hand, it is argued that the level of technological competencies of emerging country firms, although improving, is still low (Castellacci & Archibugi, 2008; Stöllinger, 2012) and the regional innovation systems in which they are located are still in development (Chaminade & Vang, 2008). In contrast, the level of international networks is quite high, which may suggest that international networks for innovation may be used as a compensation mechanism (Srholec, 2011) If this is a matter of simple knowledge acquisition or of active collaboration is something that we will also investigate looking at different types of linkages: sourcing of technology and knowledge, collaboration for innovation in relation to other firms, as well as collaboration for innovation with other knowledge providers.

This paper explores the role of internal competences and the type and geography of innovation networks of 'new to the firm' innovators in comparison with 'new to the domestic market' or 'new to the world' innovators in emerging countries. More specifically, using unique data collected in Beijing (China) and Pune (India) in 2008 from firms in the ICT, automotive and green biotechnology industries, this paper attempts to address the following research questions:

- How are firms in some of the most innovative regions in emerging economies performing in terms of product innovation?
- Which type of innovation network and which combinations of the spatial distribution of the firm´s innovation networks and internal competencies are related to higher degrees of novelty in product innovation?
- And to what extent do they differ from the available evidence for firms located in developed countries?

The paper is organized as follows. The next section discusses the theoretical framework. This is followed by a section on methodology and empirical analysis with the presentation of the sample. The data and the variables used for the econometric analysis are then introduced. The final two sections discuss the main results and provide conclusions respectively.

Literature Review

Degree of novelty in innovation

Ever since the seminal work of Joseph Schumpeter, the issue of the degree of novelty in product innovation and its impact on growth have been core aspects of innovation studies. While Schumpeter made a clear distinction between radical and incremental innovations attending to the technological content of the innovation, other sources, such as the OECD (2005), have proposed distinguishing between 'new to the firm' to 'new to the market or industry' and 'new to the world' attending to the market of the specific innovation. An innovation is new to the world if the firm has introduced a new or significantly improved good or service to the global market before competitors. It is new to the market or industry if the firm is the first in that specific market (for example, the domestic market) or industry to have implemented it. It is new to the firm if the innovation was already available from competitors in the market. This paper refers to new to the world, new to the domestic market and new to the firm following the OECD definition.

Whereas most of the new to the world innovations are implemented by firms headquartered in developed countries, developing countries' firms are often behind the technological frontier: innovations coming from developing countries are predominantly imitative and are therefore more related to the acquisition of technology developed somewhere else and adapted to local needs than to the development of new products (Bell & Pavitt, 1993; Kim, 1997; Knell & Srholec, 2009). However, in the last decade there has been an increase in the number of new to the world innovations coming from emerging economies (Asakawa & Som, 2008; Hansen et al., 2014; The Economist, 2010). The purpose of this paper is to explore the role of the internal competences and the spatial geography of the external networks for innovation explaining new to the world innovations in firms from these emerging countries.

The role of skills and other internal technological competencies on the degree of novelty of innovation

The interplay between firms' technological competencies and the ability to access external sources of knowledge is well known in the literature. Firms need a certain level of absorptive capacity to benefit from collaborating with external partners for innovation. Human capital and technological competencies, such as patents, R&D investments and machinery and equipment, are crucial determinants of the innovative capacity of firms (Lall, 1992; Srholec, 2011) often having a positive direct and indirect effect on innovation output (Dantas et al., 2007; Vega-Jurado et al., 2008).

Human capital is crucial for innovation (Acs & Audretsch 1987). It determines not only the ability of the firm to produce innovations but also its absorptive capacity, that is, the ability to utilize available information and knowledge that comes from interaction with other organizations, such as other firms, users or knowledge providers (i.e. research institutions) (Cohen & Levinthal, 1990; Giuliani & Bell, 2005).

The presence and intensity of internal R&D activities, both formal and informal, increase the absorptive capacity of firms and consequently their ability to acquire, use and access new knowledge to develop innovation, thus also having an indirect impact on the ability to innovate (Cohen & Levinthal, 1990; Díaz-Díaz & De Saá-Pérez, 2012; Romijn & Albaladejo, 2002). It also has a clear effect on the degree of novelty (Barbosa et al., 2013). In a similar vein the firm's internal capacity to develop patents also affects the ability to innovate beyond new to the firm innovations (Caloghirou et al., 2004; Grilliches et al., 1987; Lee et al., 2009; Schilling & Phelps, 2007).

In the international business literature there is abundant evidence showing that the level of technological capabilities, particularly skills and R&D, in emerging country firms is significantly lower than in more advanced countries (Athreye & Kapur, 2009; Deng, 2009; Guillén & García-Canal, 2009; Luo & Tung, 2007; Mathews, 2006; Rui & Yip, 2008). We may expect that new to the world innovators in these countries use external networks for innovation as a compensating mechanism for the lack of internal competences.

The impact of external innovation networks on the degree of novelty

In this paper, innovation networks are loosely defined as the external linkages of the firms with the objective of sourcing knowledge or technology needed in the innovation process or to develop new innovations in collaboration with other firms or other organizations. They include among others the acquisition of machinery, R&D activities, sourcing of information for innovation or research collaboration.

In economic geography, there is abundant empirical evidence on the impact of external networks for innovation on the degree of novelty, attending to the type of partners. However, there is far less evidence of the impact of external networks of innovation on the degree of novelty attending to the spatial distribution of those networks.

Regarding the *impact of external networks of innovation* on the degree of novelty, Laursen & Salter (2006), using data on UK industrial firms, analysed the impact of the breadth and depth of collaboration networks on the degree of novelty and concluded that breadth of collaboration is important for new to the world innovation. Breadth of collaboration, in this case, captures the diversity of the actors in the network rather than the diversity of geographical scales. In a similar vein, Nieto & Santamaria (2007) showed that the breadth of the collaborative network is important for the degree of novelty of product innovation.

The evidence is more limited regarding the *impact of the spatial distribution of innovation networks* on the degree of novelty. Some authors pointed out the negative impact of too great a focus on regional or local linkages on the degree of novelty. For example, Visser & Boschma (2004) argued that high dependence on local interactions may negatively affect the degree of novelty. Similarly, Asheim & Isaksen (2002), looking only at interactions with users in the ship industry in Norway, concluded that local interaction leads primarily to incremental innovation. Weterings & Boschma's (2009) analysis of the Dutch software firms showed that although spatial proximity indeed facilitates interaction, it does not support radical innovations. More recently, Fitjar & Rodríguez-Pose (2013) using a sample of firms in the largest Norwegian city regions went one step further by distinguishing between STI modes of interaction (interactions with universities, research centres and consultants) and DUI modes of interaction (with suppliers, users and competitors). They concluded that only the regional interaction with universities, research centres and consultants is significant and positively related to radical product innovation.

On the other hand, international innovation networks are found to be significant for new to the world or radical product innovation (Nieto & Santamaria, 2007), particularly collaboration with users (Harirchi & Chaminade, 2014; Laursen, 2011) and suppliers (Fitjar & Rodríguez-Pose, 2013). Laursen (2011), using data from the Danish innovation survey and focusing mainly on interactions with users, showed that international collaboration for innovation is significant and positively associated with radical innovation, whereas local networks for innovation are associated with incremental innovation. In a similar vein, but adding the location of both users and producers

in panel data for firms in several developed and developing countries, Harirchi & Chaminade (2014) showed that active collaboration in innovation with international users is positively associated with new to the world innovations, no matter whether the user is located in a developed or developing country.

The dichotomous distinction between local and regional versus international interactions and their impact on innovation has received strong criticism (Grillitsch & Trippl, 2014; Trippl et al., 2009). Firms actively combine knowledge sources on different spatial scales and from various channels and sources in their innovation process (Fitjar & Rodríguez-Pose 2013; Grillitsch & Trippl, 2014; Trippl et al., 2009). International collaboration for innovation can complement local and regional networks in sustaining firms' innovative performance and the generation of 'non-incremental' innovation (Bathelt et al., 2004; Belussi et al., 2010; Chang, 2009; Gertler & Levitte, 2005; MacKinnon et al., 2002; McKelvey et al., 2003; Moodysson, 2008; Ponds et al., 2007) [1].

Naturally, the firm´s technological competencies and its innovation networks are related. Internal competencies are a pre-condition for engaging in external networks for innovation. Organizations need to have a certain level of technological competencies that allow them to tap into, absorb and create knowledge conducive to innovation (Cohen & Levinthal, 1990).

The combined impact of internal competencies and external networks for innovation on the degree of novelty has also been studied recently by a number of authors. Tödtling et al. (2009), using data from Austrian firms, found that higher degrees of novelty are associated with higher R&D investments and patents, as well as cooperation with universities and research institutions. Tsai (2009), using data from the Taiwanese Technological innovation survey, found that absorptive capacity clearly influences the final impact of the collaboration networks on the degree of novelty, but only if the collaboration is with suppliers and customers. This result was further confirmed by Tsai et al. (2011) using a different set of data only for electronic manufacturing firms, also finding that external technology acquisition has a positive impact on product innovativeness.

Indeed, in terms of the spatial distribution of the innovative networks, firms in emerging economies, such as Tsai et al.'s (2011) sample, tend to rely strongly on imports of machinery and equipment and technical knowledge that may not be available in the local environment (Ernst, 2002; Gereffi, 1999; Humphrey & Schmitz, 2002; Lee et al., 1988) and on the spill-overs from multinational corporations located in their proximity (Cantwell & Piscitello, 2007; Ivarsson & Alvstam, 2011; Saliola & Zanfei, 2009). We may expect that successful innovative firms are

therefore those that are able to internalize and assimilate the foreign technologies and knowledge not only to develop incremental innovation (as is often the case) but to acquire a higher level of novelty and actively improve their innovation performance.

A critical question remains therefore to investigate *which type* of local, domestic and international linkages for firms located in regions in emerging economies are really important for increasing the degree of novelty and how much the degree of novelty of product innovation is also related to firms' technological competencies. Furthermore, it is interesting to explore if there are any significant differences between emerging country firms and developed country firms in the nature and importance of the different networks for innovation. We expect that this will help to better understand which external and internal factors may help firms in those contexts to move from incremental innovation to a high level of innovation performance and to become competitive in the global market.

Methodology and Empirical Analysis

The sample

The research for this paper was conducted using both qualitative and quantitative methods. The quantitative data used for this paper were obtained through a survey of firms conducted in 2008 in the software, automotive and green biotechnology sectors located in Beijing and Pune. The sectors were chosen both because they represent a different nature of knowledge bases and modes of innovation, showing different dynamics of interactions for innovation (Asheim & Coenen, 2005; Pavitt, 1984), but also because the three sectors follow important patterns of globalization and innovation in countries such as China and India (Altenburg et al., 2008). The two regions (Beijing and Pune) were initially selected for various reasons: they host a large number of firms in all three sectors rather than being highly specialized in one of them as is the case of the software industry in Bangalore or the automotive industry in Shanghai. In all the selected sectors the two regions have undergone very important developments during the years the survey was designed and conducted. The two regions are also very dynamic in terms of innovation and internationalization with strong science and technology infrastructure above average in their country (Crescenzi et al., 2012; Guan et al., 2009; Zheng, 2010; Zinnov, 2009) becoming potential competitors to regions in

developed countries. Although they have important different social, cultural and institutional conditions they may resemble in certain respects a functioning Regional Innovation System (RIS) which implies stronger cooperation linkages with local and regional actors with respect to other marginal regions in China and India. Finally, due to the difficulty of collecting data in emerging economies there was a certain degree of access to firms guaranteed through the cooperation with local university actors.

As there is no unique economic census of Pune, the sample was extracted from databases bought from Indian industry associations, such as the Maharashtra Chamber of Commerce. In Beijing, the sample was drawn from a database compiled by a market research company based on the economic census of China (National Bureau of Statistics of China, 2006). As the census did not include small firms in the software sector, the database was completed with data from a software testing centre (CSTC). In total, 884 useful questionnaires were collected out of the total 1,200 initially envisaged.[2] To test data reliability and for the presence of non-response bias, the consistency between the sample and the set of non-respondents was checked at least for size and sub-industry when the breakdown data were available for the total population or for the sampling frame in the specific region. In addition, some firms were contacted a posteriori to check the validity of the data. Table 1 shows the distribution of the sample in terms of sector and compares it with the estimated population. Due to the lack of official statistics and the high degree of informality in emerging economies, particularly in certain industries like auto components, the numbers for the entire population can oscillate, depending on the source and whether the informal sector is included or not. Nevertheless, apart from the software sector in Beijing[3], all the other sectors have a good estimated response rate and the final sample firm distribution and response rate were similar to comparable studies in regions of China and India, such as those by Zhou et al. (2011), Sun et al. (2013), Schiller (2011), Wei (2015) and other surveys in Asia.

[INSERT TABLE 1 ABOUT HERE]

Substantial effort was made to use the same methodology to collect data in both regions. The contact persons for the interviews were primarily the owners of SMEs (small and medium enterprises) and the R&D managers or their deputies in large firms. The firms were initially contacted by telephone to identify the senior executive and request an interview. If the interview was rejected, the researchers moved on to the next firm. Nevertheless, there were some differences

in the collection of the data. In Pune, data were collected in English through face-to-face interviews followed up by telephone calls when necessary; in Beijing, the survey was translated into Chinese and the main instrument was telephone interviews. Although some loss of information is unavoidable when using translated questionnaires, the negative impact was minimized by employing a professional translation company, checking for the correct use of terms with bilingual experts in innovation and conducting pilot studies.

The same questionnaire was used for Pune and Beijing targeting the three industries. To ensure maximum comparability of the results, considerable effort was made to standardize the instrument appropriately and avoid cultural differences in interpreting specific questions. This was done with the help of experts in the industries, the regions and the research field – innovation – with the direct supervision of UCAS in Beijing and IIMA in Pune and by running a pilot survey before finalizing the survey instrument.

Nonetheless, and due to the limitations in the data collection outlined earlier, this study should be considered exploratory. The aim is to *explore* the existence of linkages between the degree of novelty, firms' internal technological competencies and the spatial distribution of their innovation networks. It does not attempt to compare the two regions, estimate patterns for the entire population or to generalize results.

The survey questions mostly refer to the year 2007 and the semi-structured questions asked firms about the company's structural characteristics and background in terms of organizational form, size, ownership, employees' sales and activities, their internal resources and competences, their type of innovation activities in terms of markets, the degree of novelty, the impact of innovation, and the composition and spatial location of their networks for sourcing technology and research collaboration. The specific phrasing of the questions used in this paper is included in the description of the variables.[4]

As the focus of this specific paper is on innovative firms in terms of products, the subsample comprises only firms that introduced a product innovation in 2007.[5] Since we do not have longitudinal data that allow us to link the product innovation with long term firm performance, in order to better track the relation between the spatial distribution of innovation networks, the competences and the product innovation performance, we include in the subsample only cases where the most significant impact on firms performance during 2007 was due principally to product innovation.

The total number of observations related to the subsample considered for this analysis is 348. Table 2 compares the location, sector and firm size of the original sample with those of the sample used for this analysis. The differences between the two samples are minimal, guaranteeing the robustness of the study.

[INSERT TABLE 2 ABOUT HERE]

In total, the firms in the sample that introduced a new to the world innovation are 11%, 38% introduced a new to the domestic market innovation and the majority (51%), as expected, introduced a new to the firm innovation. Table 3 also shows the perceptual distribution of firms in the sample with respect to the degree of novelty by region, sector and firms' structural characteristics.

[INSERT TABLE 3 ABOUT HERE]

The higher percentage of firms that have introduced new to the world innovation are located in Pune (13.64%). This may probably be due to the higher proportion of subsidiaries in this region with respect to the number of subsidiaries located in Beijing. A closer look at the data also shows that while in Pune the firms that have new to the world innovations are mainly firms in the software sectors and subsidiaries, in Beijing they are mainly small and medium single units. Firms with new to the domestic market innovation are instead mainly located in Beijing (57.81%). Regarding new to the firm innovation, Pune registers again with the higher proportion.

Also, in terms of sector, differences in the degree of novelty achieved by the surveyed firms are observed. The firms in the software sector have the highest percentage of new to the world innovations (21.57%) and new to the domestic market innovation (52.94%) although for the latter the biotech firms have around the same share. Firms in the automotive components sector have instead the highest percentage of new to the firm innovations.

Concerning the structural characteristics of the firms, no specific differences emerge between large and small- to medium-sized firms. Considering instead the organizational form, it is possible to observe that approximately 23% of the firms that have introduced new to the world innovations

are subsidiaries, but it is not possible to see with the available data whether or not they are subsidiaries of a foreign company.

Data and variables used for the econometric analysis

Dependent variable. The dependent variable is the degree of novelty. It is a categorical ordinal variable that assesses the degree of novelty of a firm's product innovation.[6] The information for this variable comes from a question on the survey, similar to those in the European community innovation survey, which asked the firm to indicate if it had introduced, during 2007, a product, process or organizational innovation. If the answer was 'yes', the respondent was asked to indicate the degree of novelty of that innovation. The options were 'new to the world' (if the firm introduced new goods or services to the global market before its competitors), 'new to the domestic market' (*idem*, but already available in other markets) and 'new to the firm' (new goods or services already available from its competitors in the domestic market). As already stated, this paper considers product innovations that the firm has identified to be the innovation with the most significant impact on the firm's performance in 2007 (thus, those firms for which the greatest impact on performance from that year derived from process or organizational innovations were not included). The dependent variable was equal to 0 when the firm introduced a new or significantly improved good or service that was already available from competitors in the market (*New to the firm)*, equal to 1 when the firm introduced a new or significantly improved good or service to the domestic market (the innovation could already have been available in other markets) before its competitors (*New to the domestic market)* and equal to 2 if the firm introduced a new or significantly improved good or service to the global market before its competitors (*New to the world)*.

Independent variables. The independent variables cover internal technological competencies as well as the spatial distribution of innovation networks, specifically, sourcing and collaboration for innovation.

Sourcing of technology and knowledge. In the survey, firms were asked to indicate if they were involved in a series of innovation activities (intramural R&D, extramural R&D, acquisition of machinery and equipment, acquisition of other external knowledge and training) and if the answer was positive, they were asked to indicate if it was mainly locally, domestically or internationally. In terms of sourcing, the engagement of the firm in extramural R&D was considered with four

possible alternatives: no extra R&D engagement; mainly local; mainly domestic; mainly international. Therefore, a set of dummy variables was created corresponding to the four above alternatives, equal to 1 if the firms belonged to the given category and 0 otherwise. With the same logic, the study considered the geographical spread of acquisition of machinery and equipment and of training specifically linked to the development, production or introduction of new products and services. Thus, 1 means that the firm predominantly sources on a specific spatial scale, but not that it exclusively does so. Unfortunately, the data does not allow us to see if other spatial scales are used, but only the main one.

Collaboration. In the survey, firms were asked to indicate who they collaborate with in their innovation process. In terms of collaboration, the study considered on which spatial scale research collaboration took place with knowledge providers (i.e. universities and research centres) or other firms as two main partners for collaboration for innovation. As in the previous variable, the question was formulated to capture on which spatial scale the collaboration *mainly* takes place but not exclusively.[7]

Other independent variables were built as proxies for measuring the technological competences of the firms:

- *Education of human capital*: a continuous variable of the percentage of employees with a formal qualification equal to, or higher than, a university bachelor degree, considered as a proxy to assess the qualification of human capital.
- *R&D employees*: a continuous variable capturing the percentage of employees in the R&D department.
- *Patents*: a dummy variable equal to 1 if the firm reported registering patents during the year 2007.

Control variables. As control variables, the study included as dummies the regional location (region equals 1 for Pune and 0 for Beijing) and the sector (auto and biotech, while software is the excluded dummy). The foreign ownership of the firm and the firm's organizational form (headoffice and subsidiary, while standalone company is the excluded dummy) were also used as control variables. Firms owned or partially owned by foreign companies (in particular from developed countries) could have a higher degree of novelty in product innovation (Knell & Srholec, 2009)[8] and a different propensity for establishing external networks (Schiller, 2011).

The final control variable is related to firm size (large firm, while SME is the excluded dummy). Some authors have argued that large firms often attain a lower degree of novelty of innovation in comparison to SMEs (Acs & Audretsch, 1988; Schumpeter, 1942; Vega-Jurado et al., 2008), whereas others (Chandy & Tellis, 2000; cf. Amara et al., 2008; Tether, 2002) believed that large firms have greater advantages in terms of capabilities and capital, favouring the development of innovation.

Appendix A presents the main statistics and description of the variables and appendix B presents the correlation between the variables.

The model

We use the generalized form of the ordered logit model which is particularly indicated in cases in which the dependent variable is categorical (comprising classes that can be ordered) and the proportional odds assumption (POA) is violated and therefore it is not possible to use a common ordered logit[9]. This model allows for estimating different coefficients for different categories (Williams, 2006). The first column contrasts category 1 'new to the firm' with categories 2 'new to the domestic market' and 3 'new to the world'. The second column contrasts the categories 1 'new to the firm' and 2 'new to the domestic market' with category 3 'new to the world'.

To evaluate the magnitude of the effects we compute the associated odds ratio (OR) that represents the proportional increase in probability of observing a movement from a group of lower categories to the next when the independent variable increases by one (in our case from 1 to 2 and 3 and from 1 and 2 to 3).

[INSERT TABLE 4 ABOUT HERE]

Discussion

Firms' technological competencies, network spatial distribution and the novelty of product innovation

The model presented in Table 4 enables the exploration of the existence of a relationship between the spatial distribution of the innovation networks, a firm´s internal competencies and the degree of novelty. Our analysis is exploratory and therefore aims to identify relationships rather than

causal relations and interprets the results based on the sign and significance of the coefficients, rather than the size of the estimation. The model allows us to observe which variables are significant in moving through different levels of innovation, i.e. from 'new to the firm' to 'new to the domestic market' to 'new to the world'.

In terms of competencies, only patents appear to be a differentiating factor between new to the firm and other higher degrees of novelty (both in the first and second columns the variable patents show odds ratios higher than 1 and significant at the 10% level). The qualification of human resources, both in terms of education and the proportion of R&D employees, is not significant. For sourcing and collaboration, column 1 of the model shows that if a firm wants to move from new to the firm innovation to a higher level, training related to innovation activities and collaboration with universities and research centres at least at the domestic level are positive and significant (the variables related to domestic training and domestic R&D collaboration with knowledge providers have odds ratios higher than 1 and are significant respectively at the 10% and 5% levels).

The second column also shows that international networks are important for new to the world innovations. In terms of sourcing, both the acquisition of machinery and equipment predominantly at the international level and the possibility of implementing international training related to innovation show results that are positive and significant at the 10% and 1% levels respectively. These results are in line with qualitative studies pointing to the positive impact of international training provided by foreign multinationals who decide to invest in supply relations with firms in emerging economies and suggest that this training may enable improvement in firms' technological capabilities to develop their own innovation (Ivarsson & Alvstam, 2011).

In relation to collaboration, the odds ratio of the international R&D collaboration with knowledge providers in the second column shows that the collaboration developed with international research centres and universities is critical for new to the world innovation (it is greater than 14 and the significance level is 5%), despite these firms being located in some of the more developed regional innovation systems in China and India. Above all, the model suggests that a broader spatial distribution of technological sourcing and research collaboration, beyond the local, positively affects the degree of novelty for both 'new to the domestic market' and 'new to the world' innovations.

The model also shows other interesting results. First, it confirms differences in terms of sectors: firms in the software sector seem to perform better than firms in the automotive sector, both in the

new to the domestic market and the new to the world market, although it is beyond the scope of this paper to focus on sectorial differences, which deserve a more elaborate analysis. Second, being a subsidiary of an enterprise group is also of relevance in making the transition from new to the firm or new to the domestic market innovation to innovation that is new to the world, which is also expected.

Conclusion

This paper has investigated what helps firms in emerging economies to increase their innovation performance (from new to the firm to new to the domestic market and new to the world innovation). Many different aspects have been taken into account simultaneously: internal competences, typology of network linkages (sourcing of technology and knowledge, and collaboration for innovation) and partners (i.e. firms and other knowledge providers). We did so disentangling the spatial distribution of innovation network in three level (local, domestic and international). With respect to previous studies, this paper takes a more comprehensive overview of the phenomenon under scrutiny showing for firms in emerging economies the different role of competences, typology and geography of innovation networks.

In terms of network this paper shows that for firms located in Beijing and Pune with new to the domestic market innovations, interactions with other domestic organizations tend to matter more, whereas for new to the world innovations, international networks are needed. In this respect, our results show no significant differences between firms in emerging countries and the existing evidence in developed countries with regards to the importance of international networks for innovation in more radical innovation. Fitjar & Rodríguez-Pose (2013) investigating a sample of firms in Norway have recently shown that networks of practical learning external to the region may be relevant for radical innovation. We show that for reaching the highest degree of innovation, emerging economies firms' extra-regional networks are networks at the international level. However, some differences emerge, particularly with regards to the nature of the networks and the types of partners, as well as the kind of competences that matter for higher degrees of novelty.

R&D collaboration with other firms is not significantly related to new to the world innovations, but R&D collaboration is with universities and research centres. In emerging country firms, networks related to the acquisition of machinery and of training seems to count not only for incremental but also radical innovation. Also the nature of the competencies seems to be partially

different. Although in our analysis patents are related to higher degrees of novelty, in contrast to evidence from firms in developed countries, the internal R&D capacity seems to not be so relevant.

Regarding the network and the competences, the results suggest that the *new to the world product innovation* reported by firms located in emerging economies is i) either not the result of intensive R&D, or ii) is the result of intensive R&D which is not performed in the emerging economy.

The first explanation, in line with an emerging body of literature on innovation at the bottom of the pyramid (Prahalad, 2006, 2012), is based on the idea of developing new to the world solutions for the lower segments of the market. What matters in these radical innovations are the interactions with the potential customer and knowledge of local needs, rather than a high degree of technological sophistication. This explanation could be particularly relevant for standalone companies and headquarters in emerging economies (64.94% of our sample). The second explanation could also be valid, particularly for subsidiaries (35.06 % of our sample). This is particularly the case for firms located in Pune as a large share of the firms claiming to have introduced new to the world innovations in that region are subsidiaries.[10]

As in any exploratory analysis using novel, dedicated survey data, this study suffers from some limitations. The most important ones relate to the sampling procedure and low response rate achieved in some of the regions and sectors which only allow for exploratory analysis. However small, it is coherent with most of the literature based on primary data collected in these countries and the difficulties associated with data collection in developing countries. A second limitation is the cross-sectional nature of the data that refer to a specific year, which do not allow for the determination of causality. Unfortunately, there is little reason to expect that quantitative innovation data of sufficient quality and geographical coverage will be available in the near future. The value of this study is therefore linked to the exploratory purpose that it serves, providing some first evidence of the importance of international and local innovative networks and firms' internal competencies for the degree of novelty in innovations of firms in emerging economies. Further research should also better explore the role that centrality and social and cognitive proximity in those international networks should have to guarantee a real competitive advantage of those firms with respect to firms in developed economies as well as extend the analysis to other regions in emerging economies and other industries.

Notes

[1] Since the work of Powell et al. (1996) in organizational, business and international business literature, scholars have dedicated some works to tracking the structure and the map of the network looking at the position and embeddedness of the firms in those networks (Ahuja, 2000; Owen-Smith & Powell, 2004) as well as the social structure and evolutionary path of the linkages which influence their performances (Brass et al. 2004; Gulati, 1998; Gulati et al., 2000). The focus has been on inter-organizational relations, in particular for knowledge intensive industries (Bunker Whittington et al. 2009) and how the network position can become a source of competitive advantage (Greve, 2009; Owen-Smith & Powell, 2004). More recently, the contributions of scholars in economic geography building on the local-global debate (Bathelt et al., 2004) have addressed studying the interactions of innovation networks with territorial dynamics and regional development (Cooke, 2013; Parrilli et al., 2013; van Egeraat & Kogler, 2013). Although with contributions in both fields, there is still a lack of integration of the different literature in relation to the role of international linkages (Hervas-Oliver & Boix-Domenech, 2013).

[2] In China, questionnaires were also collected in the provinces of Tianjin and Hebei that together with Beijing constitute the Jing-Jin-Ji region. For this specific paper, only the metropolitan region of Beijing was considered.

[3] It necessary to take into account that the total software companies in Beijing included more than 6000 firms. Due to time and funding constraints our goal was to reach a minimum of around 200 responses in each area for the software sector for Pune and the Jing-Jin-Ji region (this last one includes the metropolitan region of Beijing considered in this analysis).

[4] The survey can be downloaded from http://globinn.circle.lu.se/our-projects-2/, in the project section: 'Emerging trends in Asia: From low-cost producers to innovators'.

[5] The interest of this research was not in what affects firms' decisions to innovate in general as opposed to not innovating at all. Rather, the research focus was on what leads firms to increase the novelty of their innovations from 'new to the firm' to 'new to the market', distinguishing between domestic and international markets.

[6] Product innovation refers here to the introduction of new or significantly improved goods and services.

[7] In the econometric model the excluded dummy was the first category in all the sets of variables related to collaboration and sourcing.

[8] A firm is considered to be foreign-owned when it has a minimum of 30% of foreign capital (Saliola & Zanfei, 2009).

[9] An ordered logit estimates one coefficient for each regressor that measures the effect of that regressor on the probability of moving from a lower class to the higher ones (i.e., from a lower degree of innovation to a higher degree). Since classes were more than two (in our case three) but the estimated coefficient of each regressor was just one, the implicit assumption was that the same coefficient can be applied from the passage to the low class to the other two (medium and high) and to the passage from the low and medium classes to the high one. This assumption must be tested. The Brant test (Brant, 1990) is commonly used to check for this assumption, called "Proportional Odds Assumption". In our case the POA was violated. When this happens the standard technique is to use a generalized version of the ordered logit model where the coefficient of each regressor is "left free" to assume different values according to the class(es) it takes as a starting point. For each regressor, we thus obtained two coefficients, one for the

passage from the low class to the medium and high, and one for the passage from the low and medium classes to the high (Williams, 2006).

[10] Some of these subsidiaries were probably foreign subsidiaries which aimed to exploit the local pool of skilled labour for their innovations (Belussi & Sedita, 2010; Lewin et al., 2009).

References

Acs, Z. J. & Audretsch, D. B. (1987) Innovation, market structure, and firm size, *The Review of Economics and Statistics,* 69, pp. 567–574.

Acs, Z. J. & Audretsch, D. B. (1988) Innovation in large and small firms: An empirical analysis, *American Economic Review,* 78, pp. 678–690.

Ahuja, G. (2000) Collaboration networks, structural holes, and innovation: A longitudinal study, *Administrative Science Quarterly,* 45, pp. 425–455.

Altenburg, T., Schmitz, H. & Stamm, A. (2008) Breakthrough? China's and India's transition from production to innovation, *World Development,* 36, pp. 325–344.

Amara, N., Landry, R., Becheikh, N., & Ouimet, M. (2008) Learning and novelty of innovation in established manufacturing SMEs, *Technovation* 28, pp. 450–463.

Asakawa, K. & Som, A. (2008) Internationalization of R&D in China and India: conventional wisdom versus reality, *Asia Pacific Journal of Management* 25, pp. 375–394.

Asheim, B. T. & Coenen, L. (2005) Knowledge bases and regional innovation systems: Comparing Nordic cluster, *Research Policy* 34, pp. 1173–1190.

Asheim, B. T. & Isaksen, A. (2002) Regional innovation system: The integration of local 'sticky' and global 'ubiquitous' knowledge, *Journal of Technology Transfer,* 22, pp. 77–86.

Athreye, S & Kapur, S. (2009) Introduction: The internationalization of Chinese and Indian firms—trends, motivations and strategy, *Industrial and Corporate Change*, 18, pp 209–221.

Barbosa, N., Faria, A. P. & Eiriz, V. (2013) Industry- and firm-specific factors of innovation novelty, *Industrial and Corporate* Change, 23, pp 865-902.

Bathelt, H., Malmberg, A. & Maskell, P. (2004) Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation, *Progress in Human Geograph*y, 28, pp. 31–56.

Bell, M. & Pavitt, K. (1993) Technological accumulation and industrial growth: contrasts between developed and developing countries, *Industrial Corporate Change,* 2, pp. 157–210.

Belussi, F., Sammarra, A. & Sedita, S. R. (2010) Learning at the boundaries in an 'Open Regional Innovation System': A focus on firms' innovation strategies in the Emilia Romagna life science industry, *Research Policy,* 39, pp. 710–721.

Belussi, F. & Sedita, S. R. (2010), Managing the fragmented value chain of global business: exploitative and explorative offshoring towards emerging market economies, in: T. Devinney, T. Pedersen & L. Tihanyi (Eds) *The Past, Present and Future of International Business and Management*, Advances in International Management Series, vol. 23, pp. 399–429 (Bradford, UK: Emerald Group Publishing Limited).

Brant, R. (1990) Assessing proportionality in the proportional odds model for ordinal logistic regression. *Biometrics,* 46, pp. 1171–1178.

Brass, D., Galaskiewicz, J., Greve, H. & Tsai, W. (2004) Taking Stock of Networks and Organizations: A Multilevel Perspective, *Academy of Management Journa l*47, pp. 795–817.

Bunker Whittington, K., Owen-Smith, J. & Powell, W. W. (2009) Networks, propinquity, and innovation in knowledge intensive industries. *Administrative Science Quarterly,* 54, pp. 90–122.

Bunnell, T. G. & Coe, N. M. (2001) Spaces and scales of innovation. *Progress in Human Geography,* 25, pp. 569–589.

Caloghirou, Y., Kastelli, I. & Tsakanika, A. (2004) Internal capabilities and external knowledge sources: complements or substitutes for innovative performance. *Technovation,* 24, pp. 29–39.

Cantwell, J. & Piscitello, L. (2007) Attraction and deterrence in the location of foreign/owned R&D activities: The role of positive and negative spillovers, *International Journal of Technological Learning, Innovation and Development,* 1, pp. 83–111.

Castellacci, F. & Archibugi, D. (2008) The technology clubs: The distribution of knowledge across nations, Research Policy, 37, pp. 1659–1673.

Chaminade, C. & Vang, J. (2008) Globalisation of knowledge production and regional innovation policy: supporting specialized hubs in the Bangalore software industry, *Research Policy,* 37, pp. 1684–1696.

Chandy, R. K. & Tellis, G. J. (2000) The incumbent's curse? Incumbency, size, and radical product innovation, *Journal of Marketing,* 64, pp. 1–17.

Chang, Y-C. (2009) Systems of innovation, spatial knowledge links and the firm's innovation performance: towards a national-global complementarity view, *Regional Studies,* 43, pp. 1199–1224.

Christensen, C. M., Hang, C.-C., Chai, K-H. & Subramanian, M. A. (2010) Editorial managing innovation in emerging economies: An introduction to the special issue, *IEEE Transactions on Engineering Management,* 57, pp. 4–8.

Cohen, W. M. & Levinthal, D. A. (1990) Absorptive capacity: A new perspective on learning and innovation, *Administrative Science Quarterly,* 35, pp. 128–152.

Cooke, P. (2013) Qualitative Analysis and Comparison of Firm and System Incumbents in the New ICT Global Innovation Network, European Planning Studies, 21, pp. 1323–1340.

Crescenzi, R., Rodrìguez-Pose, A. & Storper, M. (2012) The territorial dynamics of innovation in China and India, *Journal of Economic Geography,* 12, pp. 1055–1085.

Dantas, E., Giuliani, E. & Marin, A. (2007) The persistence of 'capabilities' as a central issue in industrialization strategies: how they relate to MNC spillovers, industrial clusters and knowledge networks, *Asian Journal of Technology Innovation* 15, pp. 19–43.

Deng, P. (2009) Why do Chinese firms tend to acquire strategic assets in international expansion? *Journal of World Business*, 44, pp. 74–84.

Díaz-Díaz, N. L. & De Saá-Pérez, P. (2012) Novelty of innovation and the effect of existing and recently hired R&D human resources, *Innovation: Management, Policy & Practice,* 14, pp. 74–89.

Ernst, D. (2002) Global production networks and the changing geography of innovation systems. Implications for developing countries, *Economics of Innovation and New Technology,* 11, pp. 497–523.

Fitjar, R. D. & Rodríguez-Pose, A. (2013) Firm collaboration and modes of innovation in Norway, *Research Policy,* 42, pp. 128–138.

Gereffi, G. (1999) International trade and industrial upgrading in the apparel commodity chain, *Journal of International Economics,* 48, pp. 37–70.

Gertler, M. & Levitte, Y. (2005) Local nodes in global networks: The geography of knowledge flows in biotechnology innovation, *Industry and Innovation,* 13, pp. 487–507.

Giuliani, E. & Bell, M. (2005) The micro-determinants of meso-level learning and innovation: Evidence from a Chilean wine cluster, *Research Policy,* 34, pp. 47–68.

Greve, H. R. (2009) Bigger and safer: The diffusion of competitive advantage, *Strategic Management Journal*, 30, pp. 1–23.

Grilliches, Z., Ariel, P. & Bronwyn, H. H. (1987) The value of patents as indicators of inventive activity, in: P. Dasgupta & P. Stoneman (Eds) *Economic Policy and Technical Performance*, pp. 97–124 (Cambridge: Cambridge University Press).

Grillitsch, M. & Trippl, M. (2014) Combining knowledge from different sources, channels and geographical scales. *European Planning Studies*, 22, pp. 2305-2325

Guan, J. C., Yam, R. C. M., Tang, E. P. Y. & Laud, A. K. W. (2009) Innovation strategy and performance during economic transition: evidences in Beijing, China, *Research Policy,* 38, pp. 802–812.

Guillén, M. F. & García-Canal, E. (2009) The American model of the multinational firm and the "new" multinationals from emerging economies, *Academy of Management Perspectives*, 23, pp. 23–35.

Gulati, R. (1998) Alliances and networks, *Strategic Management Journal,* 19, pp. 293–317.

Gulati, R., Nohria, N. & Zaheer, A. (2000) Strategic Networks, *Strategic Management Journal,* 21, pp. 203–215.

Hansen, U. E., Fold, N. & Hansen, T. (2014) Upgrading to lead firm position via international acquisition: Learning from the global biomass power plant industry, *Journal of Economic* Geography, 23, pp.1468-2702.

Harirchi, G. & Chaminade, C (2014) Exploring the relation between the degree of novelty of innovations and user–producer interaction across different income regions, *World Development*, 57, pp. 19–31.

Hervas-Oliver, J-L. & Boix-Domenech, R. (2013) The economic geography of the meso-global spaces: Integrating multinationals and clusters at the local–global level, *European Planning Studies*, 21, pp. 1064–1080.

Huggins, R., Demirbag, M. & Ratcheva, V. I. (2007) Global knowledge and R&D foreign direct investment flows: Recent patterns in Asia Pacific, Europe, and North America, *International Review of Applied Economics*, 21, pp. 437–451.

Humphrey, J. & Schmitz, H. (2002) *Developing country firms in the world economy: governance and upgrading in global value chains* INEF Report No. 61, Duisburg: University of Duisburg.

Iammarino, S., Padilla-Pérez, R. & von Tunzelmann, N. (2008) Technological capabilities and global-local interactions: The electronic industry in two Mexican regions. *World Development,* 36, pp. 1980–2003.

IDC (2008) Defining the role of the government in the transnationalisation efforts of the Indian SMEs in the auto components sector. Available at http://www.dsir.gov.in/reports/ittp_sme/AutoCompReport.pdf (accessed 22 October 2011).

Ivarsson, I. & Alvstam, C-G. (2011) Upgrading in global value-chains: A case study of technology-learning among IKEA-suppliers in China and Southeast Asia, *Journal of Economic Geography,* 11, pp. 731–752.

Kim, L. (1997) *Imitation to Innovation: The Dynamics of Korea's Technological Learning*. (Harvard: Harvard Business School Press).

Knell, M. & Srholec, M. (2009) The novelty of innovation and the level of development. Paper presented at Globelics 7th International Conference, Dakar, Senegal, October.

Lall, S. (1992) Technological capabilities and industrialization, *World Development,* 20, pp. 165–186.

Laursen, K. (2011) User-producer interaction as a driver of innovation: costs and advantages in an open innovation model, *Science and Public Policy,* 38, pp. 713–723.

Laursen, K. & Salter, A. (2006) Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms, *Strategic Management Journal* 27, pp. 131–150.

Lee, J., Bae, Z. & Choi, D. (1988) Technology development processes: A model for a developing country with a global perspective, *R&D Management,* 18, pp. 235–250.

Lee, S., Yoon, B., Lee, C. & Park, J. (2009). Business planning based on technological capabilities: Patent analysis for technology-driven roadmapping, *Technological Forecasting & Social Change,* 76, pp. 769–786.

Lewin, A. Y., Massini, S., & Peeters, C. (2009). Why are companies offshoring innovation? The emerging global race for talent, *Journal of International Business Research*, 40, pp. 901–925.

Li, X. (2009) China's regional innovation capacity in transition: An empirical approach. *Research Policy*, 38, pp. 338–357.

Luo, Y. & Tung, R. L. (2007) International expansion of emerging market enterprises: A springboard perspective, *Journal of International Business Studies*, 38, pp. 481–498.

MacKinnon, D., Cumbers, A. & Chapman, K. (2002) Learning, innovation and regional development: a critical appraisal of recent debates, *Progress in Human Geography,* 26, pp. 293–311.

Mathews, J. A. (2006) Dragon multinationals: New players in 21st century globalization, *Asia Pacific Journal of Management*, 23, pp. 5–27.

MCCIA (2008) Industrial directory of Pune. Mahratta Chamber of Commerce, Industries and Agriculture.

McKelvey, M., Alm, H. & Riccaboni, M. (2003) Does co-location matter for formal knowledge collaboration in the Swedish biotechnology pharmaceutical sector? *Research Policy,* 32, pp. 483–501.

Moodysson, J. (2008) Principles and practices of knowledge creation: On the organization of 'Buzz', *Economic Geography,* 84, pp. 449–469.

National Bureau of Statistics of China (2006) *China Statistical Year Book 2006* (Beijing: China Statistics Press).

Nieto, M. J. & Santamaria, L. (2007) The importance of diverse collaborative networks for the novelty of product innovation, *Technovation,* 27, pp. 367–377.

OECD (2005) *Olso Manual. Guidelines for Collecting and Interpreting Innovation Data*, 3rd Ed. (Paris).

Owen-Smith, J. & Powell, W. W. (2004) Knowledge networks as channels and conduits: The effect of formal structure in the Boston biotechnology community, *Organizational Science*, 15, pp. 5–21.

Parrilli, M. D., Nadvi, K. & Yeung, H. W-C. (2013) Local and regional development in global value chains, production networks and innovation networks: A comparative review and the challenges for future research, *European Planning Studies*, 21, pp. 967–988.

Pavitt, K. (1984). Sectoral patterns of technical change: Towards a taxonomy and a theory, *Research Policy,* 13, pp. 343–373.

Ponds, R., Van Oort, F. & Frenken, K. (2007) The geographical and institutional proximity of research collaboration, *Regional Science,* 86, pp. 423–443.

Powell, W. W., Koput, K. W. & Smith-Doerr, L. (1996) Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology, *Administrative Science Quarterly*, 41, pp. 116–145.

Prahalad, C. K. (2006) *The Fortune at the Bottom of the Pyramid.* (India: Pearson Education).

Prahalad, C. K. (2012) Bottom of the pyramid as a source of breakthrough innovations, *Journal of Product Innovation Management,* 29, pp. 6–12.

Romijn, H. & Albaladejo, M. (2002) Determinants of innovation capability in small electronics and software firms in southeast England, *Research Policy,* 31, pp. 1053–1067.

Rui, H. & Yip, G. S (2008) Foreign acquisitions by Chinese firms: A strategic intent perspective, Journal of World Business, 43, pp 213–226.

Saliola, F. & Zanfei, A. (2009) Multinational firms, global value chains and the organization of knowledge transfer, *Research Policy,* 38, pp. 369–381.

Schiller, D. (2011) The role of foreign and domestic firms in regional innovation systems of latecomer countries: Empirical evidence from the electronics industry in the Pearl River delta, *Erdkunde*, pp. 25–42.

Schilling, M. & Phelps, C. (2007) Interfirm collaboration networks: The impact of large-scale network structure on firm innovation, *Management Science,* 53, pp. 1113–1126.

Schumpeter, J. A. (1942) *Capitalism, Socialism, and Democracy.* (New York: Harper).

Scott, A. (2000) Economic geography: The great half-century, *Cambridge Journal of Economics,* 24, pp. 486–504.

Srholec, M. (2010) A multilevel approach to geography of innovation, *Regional Studies*, 44, pp. 1207–1220.

Srholec, M. (2011) A multilevel analysis of innovation in developing countries, *Industrial and Corporate Change,* 20, pp. 1539–1569.

Stöllinger, R. (2012) International spillovers in a world of technology clubs, *WIIW Working Paper*, The Vienna Institute for International Economic Studies, p. 25.

Sun, Y., Zhou, Y., Lin, G. C. & Wei, Y. D. (2013) Subcontracting and supplier innovativeness in a developing economy: Evidence from China's information and communication technology industry, *Regional Studies,* 47, pp. 1766–1784.

Tether, B. (2002) Who co-operates for innovation, and why. An empirical analysis, *Research Policy,* 31, pp. 947–967.

The Economist (2010) The world turned upside down. A special report on innovation in emerging markets http://www.economist.com/node/15879369 (accessed 20 April 2015).

Tödtling, F., Lehner, P. & Kaufmann, A. (2009) Do different types of innovation rely on specific kinds of knowledge interactions?, *Technovation,* 29, pp. 59–71.

Trippl, M., Tödtling, F. & Lengauer, L. (2009) Knowledge sourcing beyond buzz and pipelines: Evidence from the Vienna Software Cluster, *Economic Geography,* 85, pp. 443–462.

Tsai, K.-H. (2009) Collaborative networks and product innovation performance: Toward a contingency perspective, *Research Policy,* 38, pp. 765–778.

Tsai, K.-H., Hsieh, M.-H. & Hultink, E. J. (2011) External technology acquisition and product innovativeness: The moderating roles of R&D investment and configurational context, *Journal of Engineering and Technology Management,* 28, pp. 184–200.

van Egeraat, C. & Kogler Dieter, F. (2013) Global and regional dynamics in knowledge flows and innovation networks, *European Planning Studies*, 21, pp. 1317–1322.

Vega-Jurado, J. Gutierrez-Gracia, A. FernANDez-de-Lucio, I. & Manjarres-Henriquez, L. (2008) The effect of external and internal factors on firms' product innovation, *Research Policy,* 37, pp. 616–632.

Visser, E. J. & Boschma, R. (2004) Learning in districts: Novelty and lock-in in a regional context, *European Planning Studies,* 12, pp. 793–808.

Wei, D. (2015) Network linkages and local embeddedness of foreign ventures in China: The case of Suzhou municipality. *Regional Studies,* 49, pp. 287–299.

Weterings, A.B.R. & R.A. Boschma (2009) User-producer interaction in the Dutch software industry: does spatial proximity matter? *Research Policy* 38, pp. 746-755.

Williams, R. (2006) Generalized ordered logit/partial proportional odds models for ordinal dependent variables, *Stata Journal, StataCorp LP*, 6(1), pp. 58–82.

Zheng, L. (2010) Comparison of China and India in R&D globalisation, UK–China Innovation Workshop for Sustainable and Equal Development, March, Tishigua University.

Zhou, Y., Sun, Y., Wei, Y. D. & Lin, G. C. (2011) De-centering 'spatial fix' – patterns of territorialization and regional technological dynamism of ICT hubs in China, *Journal of Economic Geography,* 11, pp. 119–150.

Zinnov (2009) Strategic guide on Indian R&D captives. Zinnov Report. Available at http://www.zinnov.com/randd/collaterals/Report%20on%20R&D%20Offshoring%202008.pdf (accessed 10 September 2009).

Table 1. Estimation of the population and response rate in the two regions divided by sector

Sector	Beijing region			Pune region		
	Sample (N)	Total population of firms according to census of Beijing 2008 (N)	Estimated response rate (% total population)	Sample (N)	Total population of firms according to MCCIA 2008 (software and green biotechnology) and Ministry of S&T (IDC 2008) (automotive components) (N)	Estimated response (% total population)
Automotive components	98	600	16.33	273	<500	>54.6
Software	120	6224	1.9	221	600	36.83
Green biotechnology	68	300 (estimated)	22.66	107	<500	>21.4

Table 2. Sample and subsample characteristics

	Subsample (% of firms)	Sample (% of firms)
Beijing	36.78	32.35
Pune	63.22	67.65
Auto	43.97	41.97
Software	43.97	38.24
Biotech	12.07	19.80
Large firm	17.24	14.20
SME	82.76	85.80
Standalone company	59.48	58.82
Headoffice	5.46	8.48
Subsidiary	35.06	32.35
N	348	884

Table 3. Degree of novelty of product innovation by region, sector and firms' structural characteristics

	New to the firm (%)	New to the domestic market (%)	New to the world (%)	N
Beijing	35.94	57.81	6.25	128
Pune	59.55	26.82	13.64	220
Software	25.49	52.94	21.57	153
Auto	79.08	19.61	1.31	153
Biotech	40.48	52.38	7.14	42
Large firm	40.00	48.33	11.67	60
SME	53.13	36.11	10.76	288
Standalone company	54.59	40.58	4.83	207
Headoffice	63.16	36.84	0.00	19
Subsidiary	42.62	34.43	22.95	122

Table 4. Generalized ordered logit (Odds Ratio)

	Model	
	Odds Ratio for the case "from 1 to 2 and 3"	Odds Ratio for the case ("from 1 and 2 to 3")
Region	0.606	2.400
	[0.232]	[2.231]
Auto	**0.131*** **	**0.0269*** **
	[0.066]	[0.035]
Biotech	0.693	0.882
	[0.328]	[0.764]
Large firm	1.209	0.746
	[0.464]	[0.518]
Foreign ownership	1.892	1.3.83
	[0.831]	[0.952]
Headoffice	1.958	1.58e-06
	[1.307]	[0.002]
Subsidiary	1.484	**2.979***
	[0.527]	[1.857]
Education of human capital	0.992	1.002
	[0.006]	[0.011]
R&D employees	1.001	1.019
	[0.008]	[0.012]
Patents	**2.195***	**2.715***
	[0.882]	[1.612]
International extramural R&D	5.913	0.381
	[7.087]	[0.492]
Domestic extramural R&D	2.103	2.160
	[1.108]	[1.621]
Local extramural R&D	1.528	0.746
	[0.943]	[1.001]
International acquisition of machinery and equipment	1.396	**3.911***
	[0.774]	[3.231]
Domestic acquisition of machinery and equipment	0.733	0.263
	[0.283]	[0.226]
Local acquisition of machinery and equipment	1.243	0.325
	[0.648]	[0.300]
International training	1.116	**10.559*** **
	[0.901]	[8.941]
Domestic training	**2.360***	0.992

	[1.043]	[0.856]
Local training	0.642	3.327
	[0.237]	[2.457]
International R&D collaboration with other firms	2.402	1.253
	[1.815]	[1.014]
Domestic R&D collaboration with other firms	0.876	0.702
	[0.362]	[0.545]
Local R&D collaboration with other firms	1.002	1.916
	[0.510]	[1.735]
International R&D collaboration with knowledge providers	1.502	**14.749****
	[1.879]	[1.749]
Domestic R&D collaboration with knowledge providers	**3.040****	2.910
	[1.311]	[2.492]
Local R&D collaboration with knowledge providers	1.149	1.498
	[0.521]	[1.530]
N	348	348
LI	-209.54252	-209.54252
LR chi2(50)	244.40	244.40
P	0.0000	0.0000
Pseudo R2	0.3684	0.3684

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

Appendix A. Descriptive statistics

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
Degree of novelty	Categorical variable: 0 new to the firm (1); 1 new to the domestic market (2); 2 new to the world (3)	348	.6005747	.6779353	0	2
Region (4)	Dummy variable equal to 1 if the firm belongs to Pune, and 0 to Beijing	348	.6321839	.4829053	0	1
Auto (5)	Dummy variables equal to 1 if the firm belongs to the indicated sector	348	.4396552	.4970598	0	1
Biotech (6)	Dummy variables equal to 1 if the firm belongs to the indicated sector	348	.1206897	.3262353	0	1
Software (7)	Dummy variables equal to 1 if the firm belongs to the indicated sector	348	.4396552	.4970598	0	1
SME (8)	Dummy variables equal to 1 if the firm has less than 250 employees	348	.8275862	.3782836	0	1
Large firm (9)	Dummy variables equal to 1 if the firm has equal or more than 250 employees	348	.1724138	.3782836	0	1
Foreign ownership (10)	Dummy variables that take the value 1 with a minimum of capital owned by foreign investors of 30%	348	.1724138	.3782836	0	1
Headoffice (11)	Dummy variable that takes the value 1 when the firm is a head office of an enterprise group	348	.0545977	.2275204	0	1
Subsidiary (12)	Dummy variable that takes the value 1 when the firm is a subsidiary of an enterprise group	348	.3505747	.477837	0	1
Standalone company (13)	Dummy variable that takes the value 1 when the firm is a single unit	348	.5948276	.4916323	0	1
Education of human capital (14)	Continuous variable: percentage of employees with a formal qualification equal to, or higher than, a university degree	348	45.65891	37.55254	0	100
R&D employees (15)	Continuous variable: percentage of employees in the R&D department	348	15.2306	22.47634	0	100
Patents (16)	Dummy variable equal to 1 if the firm registered patents during the year 2007	348	.1896552	.3925926	0	1
International extramural R&D (17)	Dummy variable equal to 1 if the firm has mainly international extramural R&D	348	.0431034	.2033824	0	1
Domestic extramural R&D (18)	Dummy variable equal to 1 if the firm has mainly domestic extramural R&D	348	.1063218	.3086929	0	1
Local extramural R&D (19)	Dummy variable equal to 1 if the firm has mainly local extramural R&D	348	.0603448	.2384675	0	1
No extramural R&D (20)	Dummy variable equal to 1 if the firm has no extramural R&D	348	.7902299	.4077307	0	1
International acquisition of machinery and equipment (21)	Dummy variable equal to 1 if the firm has acquired mainly international machinery and equipment	348	.1063218	.3086929	0	1
Domestic acquisition of machinery and equipment (22)	Dummy variable equal to 1 if the firm has acquired mainly domestic machinery and equipment	348	.3017241	.4596671	0	1
Local acquisition of machinery and equipment (23)	Dummy variable equal to 1 if the firm has acquired mainly local machinery and equipment	348	.1005747	.3011978	0	1
No acquisition of machinery and equipment (24)	Dummy variable equal to 1 if the firm has no acquired machinery and equipment	348	.4913793	.5006455	0	1
International training (25)	Dummy variable equal to 1 if the firm has done mainly international training for innovation	348	.0718391	.2585931	0	1
Domestic training (26)	Dummy variable equal to 1 if the firm has done mainly domestic training for innovation	348	.2212644	.4156958	0	1
Local training (27)	Dummy variable equal to 1 if the firm has done mainly local training for innovation	348	.4712644	.4998923	0	1
No training (28)	Dummy variable equal to 1 if the firm has not done training for innovation	348	.2356322	.4250044	0	1
International R&D collaboration with other firms (29)	Dummy variable equal to 1 if the firm has research collaboration mainly international with other firms	348	.066092	.2488005	0	1
Domestic R&D collaboration with other firms (30)	Dummy variable equal to 1 if the firm has research collaboration mainly domestic with other firms	348	.2471264	.431962	0	1

Local R&D collaboration with other firms (31)	Dummy variable equal to 1 if the firm has research collaboration mainly local with other firms	348	.091954	.2893771	0	1
No R&D collaboration with oth (32)	Dummy variable equal to 1 if the firm has no research collaboration with other firms	348	.5948276	.4916323	0	1
International R&D collaboration with knowledge providers (33)	Dummy variable equal to 1 if the firm has research collaboration with international universities or research centres	348	.0488506	.2158659	0	1
Domestic R&D collaboration with knowledge providers (34)	Dummy variable equal to 1 if the firm has research collaboration with domestic universities or research centres	348	.25	.4336362	0	1
Local R&D collaboration with knowledge providers (35)	Dummy variable equal to 1 if the firm has research collaboration with local universities or research centres	348	.1321839	.3391783	0	1
No R&D collaboration with knowledge providers (36)	Dummy variable equal to 1 if the firm has no research collaboration with international universities or research centres	348	.5689655	.495934	0	1

Appendix B. Correlations between main variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)													
(2)	-0.8002*												
(3)	-0.3562*	-0.2754*											
(4)	0.2277*	-0.3076*	0.1142*										
(5)	0.5001*	-0.3393*	-0.2730*	0.3515*									
(6)	-0.0770	0.1080*	-0.0449	-0.2296*	-0.3282*								
(7)	-0.4495*	0.2684*	0.3024*	-0.2008*	-0.7846*	-0.3282*							
(8)	0.0992	-0.0950	-0.0109	-0.0011	0.0211	-0.0644	0.0211						
(9)	-0.0992	0.0950	0.0109	0.0011	-0.0211	0.0644	-0.0211	-10.000					
(10)	-0.2666*	0.0324	0.3768*	0.0642	-0.2051*	-0.0523	0.2394*	-0.0736	0.0736				
(11)	0.0591	-0.0068	-0.0841	0.1571*	0.1184*	0.0663	-0.1619*	-0.0577	0.0577	-0.1097*			
(12)	-0.1211*	-0.0573	0.2834*	0.2607*	0.0287	-0.1243*	0.0529	-0.1589*	0.1589*	0.3502*	-0.1766*		
(13)	0.0903	0.0589	-0.2365*	-0.3261*	-0.0827	0.0901	0.0235	0.1811*	-0.1811*	-0.2896*	-0.2912*	-0.8902*	
(14)	-0.3281*	0.3028*	0.0540	-0.4775*	-0.6853*	0.1184*	0.6076*	-0.0362	0.0362	0.0090	-0.0525	-0.1471*	0.1673*
(15)	-0.2212*	0.1937*	0.0528	-0.4875*	-0.4154*	-0.0249	0.4317*	0.0242	-0.0242	-0.0825	-0.0419	-0.1571*	0.1721*
(16)	-0.2283*	0.0570	0.2772*	-0.0262	-0.1627*	-0.0892	0.2213*	-0.0897	0.0897	0.1673*	-0.0517	0.1976*	-0.1681*
(17)	-0.1876*	0.0951	0.1525*	0.0152	-0.1025	-0.0352	0.1256*	-0.0904	0.0904	0.2402*	-0.0510	0.1109*	-0.0842
(18)	-0.2017*	0.1891*	0.0287	-0.1235*	-0.1741*	-0.0706	0.2204*	-0.0647	0.0647	-0.0094	-0.0008	-0.0190	0.0188
(19)	-0.0647	0.0987	-0.0500	0.0682	-0.1758*	0.0172	0.1645*	-0.0121	0.0121	-0.0198	0.0453	-0.0597	0.0371
(20)	0.2842*	-0.2484*	-0.0685	0.0461	0.2857*	0.0609	-0.3257*	0.1012	-0.1012	-0.1012	-0.0004	-0.0060	0.0061
(21)	-0.0153	-0.0986	0.1781*	0.1471*	0.1265*	-0.0419	-0.0989	-0.0647	0.0647	0.1140*	0.0402	0.1569*	-0.1711*
(22)	0.0701	0.0370	-0.1699*	-0.0309	0.1241*	-0.0129	-0.1156*	-0.0314	0.0314	-0.1509*	0.0349	-0.1812*	0.1600*
(23)	-0.0918	0.1106*	-0.0252	-0.2006*	-0.2192*	-0.0652	0.2620*	0.0009	-0.0009	-0.0768	0.0037	-0.0054	0.0035
(24)	0.0003	-0.0397	0.0613	0.0584	-0.0600	0.0770	0.0095	0.0682	-0.0682	0.1144*	-0.0591	0.0729	-0.0435
(25)	-0.1717*	-0.1043	0.4378*	0.1891*	-0.1568*	-0.0689	0.2020*	-0.1087*	0.1087*	0.3149*	-0.0179	0.2154*	-0.2011*
(26)	-0.2515*	0.3073*	-0.0756	-0.2538*	-0.1374*	0.1213*	0.0578	-0.1416*	0.1416*	0.0133	-0.0367	0.0146	0.0028

(27)	0.4328*	-0.3279*	-0.1829*	0.1710*	0.4511*	-0.1200*	-0.3723*	0.1414*	-0.1414*	-0.2785*	0.0772	-0.1145*	0.0756
(28)	-0.1586*	0.1486*	0.0227	-0.0679	-0.3008*	0.0645	0.2585*	0.0383	-0.0383	0.1230*	-0.0440	-0.0106	0.0307
(29)	-0.2012*	0.1002	0.1665*	0.0350	-0.0958	-0.0631	0.1372*	-0.1542*	0.1542*	0.1848*	-0.0639	0.1197*	-0.0867
(30)	-0.2231*	0.2486*	-0.0297	-0.4610*	-0.3867*	0.0945	0.3247*	0.0499	-0.0499	-0.0322	-0.1084*	-0.1696*	0.2150*
(31)	-0.0453	0.0158	0.0480	-0.0460	-0.1216*	-0.0263	0.1389*	0.0136	-0.0136	0.0654	-0.0765	-0.0046	0.0398
(32)	0.3245*	-0.2784*	-0.0864	0.4144*	0.4598*	-0.0356	-0.4364*	0.0262	-0.0262	-0.1037	0.1726*	0.0912	-0.1685*
(33)	-0.2039*	-0.0411	0.3908*	0.1176*	-0.2007*	-0.0021	0.2021*	-0.0377	0.0377	0.3906*	-0.0545	0.2805*	-0.2474*
(34)	-0.3219*	0.3244*	0.0106	-0.4129*	-0.3376*	0.0509	0.3042*	0.0527	-0.0527	-0.0527	-0.0219	-0.0765	0.0845
(35)	-0.0237	0.0422	-0.0278	-0.1246*	-0.1748*	0.1419*	0.0816	-0.0914	0.0914	-0.0434	-0.0191	-0.0734	0.0802
(36)	0.3864*	-0.2946*	-0.1604*	0.3950*	0.5021*	-0.1407*	-0.4098*	0.0328	-0.0328	-0.0943	0.0559	-0.0050	-0.0210

	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
(14)													
(15)	0.5421*												
(16)	0.1023	0.0928											
(17)	0.0038	0.0041	0.0056										
(18)	0.2127*	0.1522*	-0.0004	-0.0732									
(19)	0.1075*	0.0404	-0.0610	-0.0538	-0.0874								
(20)	-0.2258*	-0.1409*	0.0332	-0.4119*	-0.6695*	-0.4919*							
(21)	-0.1266*	-0.1269*	-0.0004	0.0186	0.0322	-0.0483	-0.0055						
(22)	-0.1231*	-0.0667	-0.0625	0.0146	0.0576	0.1752*	-0.1534*	-0.2267*					
(23)	0.3006*	0.2860*	0.0088	-0.0710	0.1016	-0.0045	-0.0389	-0.1153*	-0.2198*				
(24)	0.0102	-0.0326	0.0523	0.0178	-0.1339*	-0.1284*	0.1676*	-0.3390*	-0.6461*	-0.3287*			
(25)	-0.0450	0.0028	0.1777*	0.1053*	-0.0599	-0.0238	0.0067	0.0845	-0.1829*	-0.0190	0.1272*		
(26)	0.1693*	0.1389*	0.1306*	0.0914	0.1306*	-0.0479	-0.1164*	-0.0716	0.2076*	-0.0401	-0.1224*	-0.1483*	
(27)	-0.2573*	-0.1848*	-0.1924*	-0.1720*	-0.1389*	-0.0458	0.2178*	-0.0268	0.0316	0.0862	-0.0643	-0.2627*	-0.5032*
(28)	0.1643*	0.0797	-0.0095	0.0489	0.0721	0.1152*	-0.1463*	0.0501	-0.1289*	-0.0506	0.1179*	-0.1545*	-0.2960*
(29)	0.0277	0.0011	0.0778	0.1713*	0.0583	-0.0674	-0.0902	0.1334*	-0.0237	-0.0120	-0.0533	0.2395*	0.0254
(30)	0.4384*	0.3895*	0.0457	0.0424	0.1698*	0.1066*	-0.2121*	-0.1112*	0.0588	0.0742	-0.0301	-0.1336*	0.3205*

(31)	0.0832	0.0712	-0.0017	0.0304	-0.0452	0.0446	-0.0070	-0.0130	-0.0359	-0.0403	0.0652	-0.0115	-0.0498
(32)	-0.4482*	-0.3847*	-0.0785	-0.1419*	-0.1521*	-0.0858	0.2361*	0.0378	-0.0186	-0.0354	0.0150	0.0029	-0.2651*
(33)	-0.0360	-0.0469	0.1284*	0.4114*	-0.0349	-0.0014	-0.1779*	0.0948	-0.0618	-0.0315	0.0172	0.2467*	0.0077
(34)	0.4166*	0.3759*	0.0423	-0.0245	0.3175*	0.1324*	-0.3056*	-0.0915	0.1265*	0.0938	-0.1162*	-0.0835	0.2198*
(35) l	0.1409*	0.0444	0.0060	-0.0828	0.0305	0.2218*	-0.1115*	0.0030	-0.0347	0.1234*	-0.0442	-0.0429	-0.0650
(36)	-0.4450*	-0.3386*	-0.0970	-0.1010	-0.2833*	-0.2668*	0.4209*	0.0367	-0.0599	-0.1527*	0.1243*	-0.0050	-0.1511*
	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)				
(28)	-0.5242*												
(29)	-0.1816*	0.0431											
(30)	-0.1806*	-0.0198	-0.1524*										
(31)	-0.1012	0.1748*	-0.0847	-0.1823*									
(32)	0.3101*	-0.1072*	-0.3223*	-0.6942*	-0.3856*								
(33)	-0.2140*	0.0941	0.1007	0.0247	-0.0721	-0.0302							
(34)	-0.2393*	0.1173*	0.0067	0.4385*	0.0000	-0.3886*	-0.1308*						
(35)	-0.0285	0.1232*	-0.0355	-0.0072	0.2575*	-0.1272*	-0.0884	-0.2253*					
(36)	0.3219*	-0.2277*	-0.0254	-0.3892*	-0.1447*	0.4400*	-0.2604*	-0.6633*	-0.4484*				

*p < 0.05